

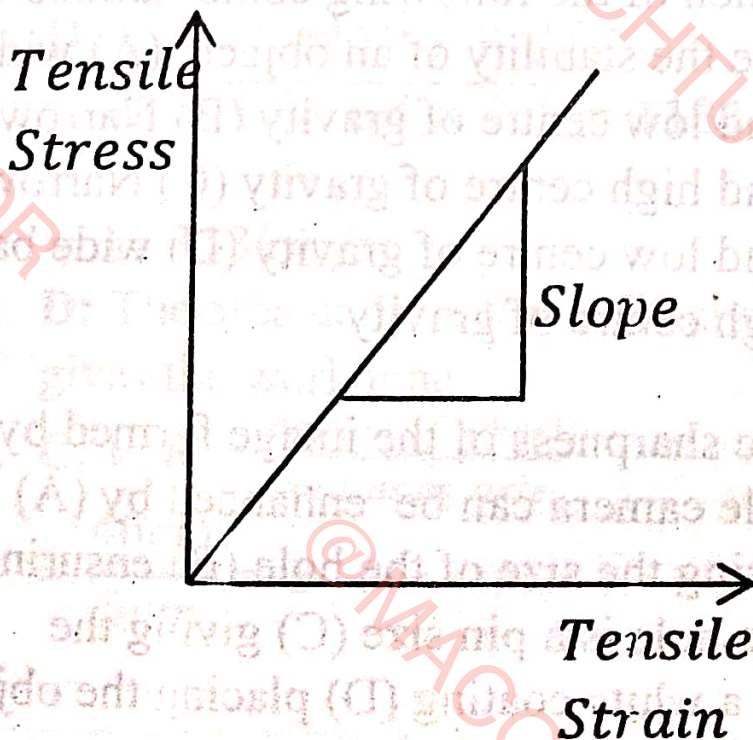
PHYSICS

2024 UTME PHYSICS

MODEL QUESTIONS

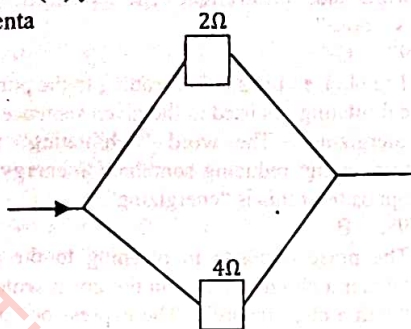
QUESTIONS

1. The defect of the eye lens which occurs when the ciliary muscles are weak is called (A) myopia (B) presbyopia (C) spherical aberration (D) astigmatism
2. The majority carriers in a p-type semi-conductors are (A) electrons (B) diodes (C) valence band (D) holes
3. The thermometric property for thermocouple is change in (A) length (B) volume (C) electromotive force (D) resistance
4. An example of a non-rechargeable cell is (A) nickel-iron (B) dry leclanche (C) mercury-cadmium (D) lead-acid



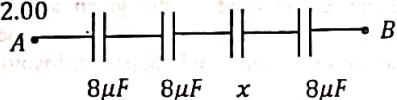
5. The slope of the graph above represents (A) surface tension (B) elasticity (C) Young's modulus (C) viscosity

6. The mixture of red and cyan colour will produce (A) yellow (B) white (C) green (D) magenta



7. Calculate the power dissipated in the 2Ω resistor if the power dissipated in the 4Ω resistor is $5W$ (A) $10W$ (B) $30W$ (C) $40W$ (D) $20W$

8. The velocity ratio of an inclined plane which makes an angle of 60° to the horizontal is (A) 1.255 (B) 1.055 (C) 1.155 (D) 2.00



9. If the effective capacitance between A and B is $2\mu F$, calculate the value of x (A) $6\mu F$ (B) $8\mu F$ (C) $4\mu F$ (D) $16\mu F$

10. The dimension of power is (A) ML^2T^{-2} (B) ML^2T^{-3} (C) $ML^{-1}T^{-2}$ (D) MLT^2

11. Electrolysis can be investigated using (A) voltmeter (B) galvanometer (C) ammeter (D) Voltmeter

12. Find the amount of current that should be passed for $120s$ to deposit $0.002kg$ of a metal. [Electrochemical equivalent of the metal = $1.3 \times 10^{-7} kgC^{-1}$]

(A) $1.3 \times 10^3 A$ (B) $1.3 \times 10^5 A$ (C) $7.8 \times 10^{-2} A$ (D) $7.8 \times 10^{-4} A$

13. Two tuning forks of frequencies $10Hz$ and $8Hz$ are sounded together, the beat frequency is (A) $2Hz$ (B) $18Hz$ (C) $8Hz$ (D) $80Hz$

14. Which of the following combinations will increase the stability of an object? (A) wide base and low centre of gravity (B) Narrow base and high centre of gravity (C) Narrow base and low centre of gravity (D) wide base and high centre of gravity

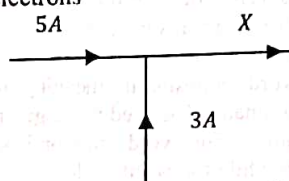
15. The sharpness of the image formed by a pin-hole camera can be enhanced by (A) increasing the size of the hole (B) ensuring that the hole is a pin size (C) giving the screen a white coating (D) placing the object further away from the hole

16. A missile of mass $10kg$ is projected at an angle of 30° to the horizontal with an initial velocity $10ms^{-1}$. What is the time of flight? (A) $16s$ (B) $1.96s$ (C) $1.0s$ (D) $3.5s$

17. If a Jewel is placed at the bottom of a pond $5m$ deep, calculate the apparent displacement of the jewel when it is viewed directly from above the pond [Refractive index of water = $\frac{4}{3}$] (A) $1.75m$ (B) $1.25m$ (C) $3.75m$ (D) $2.25m$

18. Which of the following is used as a control rod in nuclear reactors? (A) carbon (B) boron (C) plutonium (D) lead

19. Photometer is used to measure (A) wavelength of light (B) frequency of light (C) intensity of light (D) kinetic energy of liberated electrons



20. From the diagram, current X is (A) $8A$ (B) $2A$ (C) $15A$ (D) $20A$

21. The specific heat capacity of glycerin is $2520Jkg^{-1}K^{-1}$. This means that $2520J$ of heat (A) decreases the temperature of $1g$ of glycerin by $1K$ (B) increases the temperature of $1kg$ of glycerin by $1K$ (C) decreases the temperature of $1kg$ of glycerin by $10K$ (D) increases the temperature of $1g$ of glycerin by $2K$

22. During the conversion of ice to water by addition of heat. One of these is correct by addition of heat. One of these is correct (A) the temperature decreases (B) the temperature changes rapidly (C) there is no temperature (D) the temperature remains constant

23. The bursting of water pipes during very cold weather when the water in the pipes form ice could be attributed to (A) contraction of water on freezing (B) expansion of water on freezing (C) expansion of ice on melting (D) contraction of pipes when cooled

24. Starting from rest, a car of mass $2000kg$ accelerates steadily to $15ms^{-1}$ in $10s$. Calculate the average power developed during the period (A) $15000W$ (B) $15550W$ (C) $45000W$ (D) $10000W$

25. Myopia can be corrected using (A) suitable converging lens (B) suitable diverging mirror (C) suitable converging mirror (D) suitable diverging lens

26. An open pipe is different from a close pipe because (A) it contains odd harmonics while a close pipe has even harmonics (B) it overtones are even harmonics (C) its vibrations are longitudinal while that of a close pipe are transverse (D) it contains odd and even harmonics while close pipe has odd harmonics

27. What is the frequency of vibration if the balance wheel of a wrist-watch makes 90 revolutions in $25s$? (A) $0.01Hz$ (B) $0.04Hz$ (C) $2.27Hz$ (D) $3.60Hz$

28. An object of mass $2kg$ moves with a velocity of $10ms^{-1}$ round a circle of radius $4m$. Calculate the centripetal force on the object (A) $50N$ (B) $40N$ (C) $25N$ (D) $100N$

29. Calculate the escape velocity of a satellite launched from the earth's surface if the radius of the earth is 6.4×10^6m (A) $25.3kms^{-1}$ (B) $4.2kms^{-1}$ (C) $4.0kms^{-1}$ (D) $11.3kms^{-1}$

30. The area under a force-distance graph represents (A) Acceleration (B) velocity (C) power (D) work

31. A wheel and axle have radii $400m$ and $5cm$ respectively. Assuming that the machine has an efficiency of 85% , an applied force of $120N$ to the wheel will raise a load of (A) $166N$ (B) $450N$ (C) $816N$

32. A force of $100N$ stretches an elastic string to a total length of $20cm$. If an additional force of $100N$ stretches the string $5cm$ further, find the natural length of the string (A) $15cm$ (B) $12cm$ (C) $10cm$ (D) $8cm$

33. If the relative density of a metal is 19 , what will be the weight of $20cm^3$ of the metal when immersed in water? (A) $3.8N$ (B) $4.0N$ (C) $3.6N$ (D) $3.13N$

34. Which of the following is the most suitable for use as an altimeter? (A) mercury barometer (B) a fortin barometer (C) a mercury manometer (D) an aneroid barometer

35. What is the Fahrenheit equivalent of $35^\circ C$? (A) $63^\circ F$ (B) $32^\circ F$ (C) $95^\circ F$ (D) $31^\circ F$

36. The cubic expansivity of a metal is evaluated as $3.6 \times 10^{-6}K^{-1}$. What is its superficial expansivity? (A) $1.2 \times 10^{-6}K^{-1}$ (B) $2.4 \times 10^{-6}K^{-1}$ (C) $3.6 \times 10^{-6}K^{-1}$ (D) $4.8 \times 10^{-6}K^{-1}$

37. A gas occupies a volume of $300cm^3$ at a temperature of $27^\circ C$. What is its volume at $54^\circ C$, assuming the pressure is constant? (A)

600cm³ (B) 150cm³ (C) 273cm³ (D) 327cm³

38. The small droplets of water that form on the grass in early hours of the morning is (A) hail (B) mist (C) dew (D) fog

39. The heat from the sun reaches the earth by (A) insulation (B) radiation (C) conduction (D) convection

40. The pitch of a sound note depends on (A) timbre (B) harmonics (C) quality (D) frequency

Solution

- B:** Presbyopia is an age-related ocular phenomenon caused by a combination of factors, including lens stiffening and weakness of the ciliary muscles. As the crystalline lens loses flexibility and the ciliary muscles weaken, the eye's ability to change focus and accommodate near objects diminishes, leading to difficulty focusing on proximal objects.
- D:** - In a p-type semiconductor, the holes are the majority carriers while the electrons are the minority carriers.
- In an n-type semiconductor, the holes are the minority carriers while the electrons are the majority carriers.
- C:** A thermocouple measures temperature based on the changing electromotive force between two dissimilar metals joined together.
- B:** A dry cell (Leclanche cell) is a type of primary cell / battery, it is designed for single use and cannot be recharged. Once the chemical reactions within the cell are exhausted, the battery cannot be restored to its original state, and thus, it must be discarded.
- C:** Young's modulus is the ratio of the tensile stress to the tensile strain. So, when tensile stress is plotted against tensile strain, the slope of the graph obtained represents Young's modulus.
- D:** Red + Green = Yellow
Red + Blue = Magenta
Green + Blue = Cyan
Red + Green + Blue = White
- A:** Since the resistors are connected in parallel, they have the same potential difference.
$$P = \frac{V^2}{R}$$
And since V is constant, we can correctly say $P \propto \frac{1}{R}$
So, $P = \frac{k}{R}$, $PR = k$
Then, $P_1 R_1 = P_2 R_2$
 $P_1 = 5W, R_1 = 4\Omega, P_2 = ?, R_2 = 2\Omega$

$$5W \times 4\Omega = P_2 \times 2\Omega$$

$$P_2 = \frac{5W \times 4\Omega}{2\Omega} = 10W$$

8. **C:** For a plane inclined at θ° to the horizontal, velocity ratio = $\frac{1}{\sin\theta}$

Here, $\theta = 60^\circ$

$$\text{Then, } V.R = \frac{1}{\sin 60^\circ} = 1.1547 = 1.155$$

9. **B:** Since the capacitors are connected in series, $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4}$

$$\frac{1}{2} = \frac{1}{8} + \frac{1}{8} + \frac{1}{x} + \frac{1}{8}$$

$$\frac{1}{x} = \frac{1}{2} - \frac{1}{8} - \frac{1}{8} - \frac{1}{8}$$

$$\frac{1}{x} = \frac{4}{4} - \frac{1}{4} - \frac{1}{4} - \frac{1}{4}$$

$$\frac{1}{x} = \frac{1}{4}$$

$$x = 4\mu F$$

$$\therefore x = 8\mu F$$

10. **B:** Power = $\frac{\text{Force} \times \text{distance}}{\text{time}}$
= $\frac{\text{mass} \times \text{acceleration} \times \text{distance}}{\text{time}}$
= $\frac{M \times L T^{-2} \times L}{T} = M L^2 T^{-3}$

11. **D:** Voltmeter (not to be confused with voltmeter) is an instrument used to measure the quantity of electricity (in coulombs) that passes through an electrolyte during electrolysis. It helps in investigating electrolysis by providing data on how much electric charge has been transferred during the reaction.

12. **A:** $m = zIt$

$$0.02 = 1.3 \times 10^{-7} \times I \times 20$$

$$0.02 = 1.56 \times 10^{-5} I$$

$$I = \left(\frac{0.02}{1.56 \times 10^{-5}} \right) A$$

$$= 1282.05 A = 1.282 \times 10^3 A$$

13. **A:** $F_{\text{beat}} = F_1 - F_2 = 10\text{Hz} - 8\text{Hz} = 2\text{Hz}$

14. **A:** - Wide base increases stability by distributing weight over a larger area, making it less likely for the object to tip over.

- Low centre of gravity enhances stability by concentrating mass closer to the ground, reducing the likelihood of tipping.

15. **B:** For the image formed by a pin-hole camera to be sharp, the hole has to be very small.

A large hole gives a blurred image.

16. **C:** $T = \frac{2u \sin \theta}{g} = \frac{2 \times 10 \times \sin 30^\circ}{10}$
= 1.0s

17. **B:** $n = \frac{R.D}{A.D}$

$$\frac{4}{3} = \frac{A.D}{5}$$

$$A.D = \left(\frac{3 \times 5}{4} \right) m = 3.75m$$

Apparent displacement = Real depth -

$$\text{Apparent depth} = 5m - 3.75m =$$

$$1.25m$$

18. **B:** Boron is effective at neutron absorption due to its high neutron capture cross-section. This property allows it to absorb excess neutrons, thereby controlling the fission process and maintaining the reactor's stability and safety.

19. **C:** A photometer is an instrument designed to measure the intensity of light. It can assess the amount of light in a specific area or measure the brightness of a light source.

20. **A:** As can be seen in the diagram, 5A and 3A enter the junction while X leaves the junction.

According to Kirchoff's junction rule, the current entering a junction must be equal to that leaving the junction.

$$\text{Thus, } X = 3A + 5A = 8A$$

21. **B:** Specific heat capacity is a property of a material that indicates the amount of heat energy required to raise the temperature of a unit mass by one degree Celsius (or one kelvin).

22. **D:** Temperature is always constant during a change of state.

23. **B:** Water pipes can burst in cold weather because water expands as it freezes.

When water in pipes freezes, it expands and increases pressure on the pipe walls. If the pressure exceeds the pipe's strength it can cause the pipe to burst.

24. **C:** $a = \frac{v-u}{t} = \frac{15\text{m/s} - 0}{10\text{s}} = 1.5\text{ms}^{-2}$

$$F = ma = (2000 \times 1.5)\text{N} = 3000\text{N}$$

$$\text{Power} = \text{Force} \times \text{velocity} =$$

$$3000\text{N} \times 15\text{m/s} = 45000\text{W}$$

25. **D:** Myopia causes distant objects to appear blurry because light is focused in front of the retina. A diverging lens spreads light rays apart, shifting the focus onto the retina, which helps individuals with myopia see distant objects more clearly.

26. **D:** - An open pipe produces both odd and even harmonics.

- A close pipe produces only odd harmonics.

27. **D:** $F = \frac{v}{t} = \left(\frac{90}{25} \right) \text{Hz} = 3.6\text{Hz}$

28. **A:** Centripetal force, $F_c = \frac{mv^2}{r}$

$$= \left(\frac{2 \times 10^4}{4} \right) \text{N} = 50\text{N}$$

29. **D:** Escape velocity = $\sqrt{2gr}$

$$= \sqrt{2 \times 10 \times 6.4 \times 10^6} = 11313.7\text{m/s}$$

$$= 11.313\text{km/s}$$

30. **D:** The area under a force-distance graph gives the workdone.

31. **C:** $V.R = \frac{\text{Radius of wheel}}{\text{Radius of axle}}$

$$= \frac{40\text{cm}}{5\text{cm}} = 8$$

$$\epsilon = \frac{M.A}{V.R} \times 100\%$$

$$85\% = \frac{M.A}{8} \times 100\%; M.A = \frac{8 \times 85}{100} = 6.8$$

$$M.A = \frac{Effort}{Load}$$

$$6.8 = \frac{Load}{120N}, Load = 120N \times 6.8 = 816N$$

32. A: Since the additional force of 100N stretches the string by 5cm, the first 100N also stretches the string by 5cm. Then, original / natural length = 20cm - 5cm = 15cm

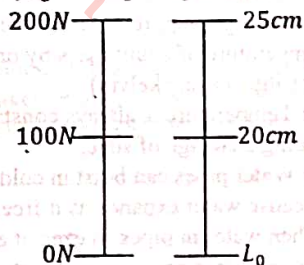
Method 2

$$F_1 = 100N, L_1 = 20cm$$

$$F_2 = 100N + 100N = 200N, L_2 = 20cm + 50cm = 25cm$$

The natural length is the length when no force is applied on the string i.e when $F = 0N$

$$\text{Then, } F_3 = 0, L_3 = L_0$$



$$\frac{200 - 0}{100 - 0} = \frac{25 - L_0}{20 - L_0}$$

$$\frac{200}{100} = \frac{25 - L_0}{20 - L_0}$$

$$\frac{200}{100} = \frac{25 - L_0}{20 - L_0}$$

$$25 - L_0 = 2(20 - L_0)$$

$$25 - L_0 = 40 - 2L_0$$

$$25 - L_0 = 40 - 2L_0$$

$$-L_0 + 2L_0 = 40 - 25$$

$$L_0 = 15cm$$

33. C: $R.D = 19$. Then, density = $19gcm^{-3}$

$$\text{Mass} = \text{density} \times \text{Volume}$$

$$= 19gcm^{-3} \times 20cm^3 = 380g = 0.38kg$$

$$\text{Weight} = mg$$

$$= (0.38 \times 10)N = 3.8N$$

However, this is not the answer!

We have only obtained the normal weight (weight in air) of the object.

We need to calculate upthrust to be able to get the weight when immersed in water

$$\text{Loss in mass} = \rho_{H_2O} = 1gcm^{-3} \times 20cm^3 = 20g = 0.02kg$$

$$\text{Loss in weight} = (0.02 \times 10)N = 0.2N$$

$$\text{Thus, apparent weight in water} = 3.8N - 0.2N = 3.6N$$

34. D: An aneroid barometer, which uses a sealed metal chamber to detect pressure changes can be calibrated to measure altitude based on atmospheric pressure variations

35. C: $\frac{F-32}{9} = \frac{C}{5}$

$$\frac{F-32}{9} = \frac{35}{5} = 7$$

$$F-32 = 9 \times 7$$

$$F-32 = 63$$

$$F = (63 + 32)^\circ F = 95^\circ F$$

36. B: $\gamma = 3.6 \times 10^{-6}K^{-1}$

$$\gamma = 3\alpha$$

$$\text{Then, } \alpha = \frac{\gamma}{3} = \frac{3.6 \times 10^{-6}K^{-1}}{3} = 1.2 \times 10^{-6}K^{-1}$$

$$\text{However, } \beta = 2\alpha$$

$$\text{Thus, } \beta = 2 \times 1.2 \times 10^{-6}K^{-1} = 2.4 \times 10^{-6}K^{-1}$$

37. D: $V_1 = 300cm^3, T_1 = 27^\circ C = (27 + 273)K = 300K$

$$V_2 = ?, T_2 = 54^\circ C = (54 + 273)K = 327K$$

Using Charles' law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}, V_2 = \frac{V_1 T_2}{T_1} = \frac{300cm^3 \times 327K}{300K} = 327cm^3$$

38. C: Dew is the moisture that condenses from the air and settles on surfaces when temperatures drop below the dew point

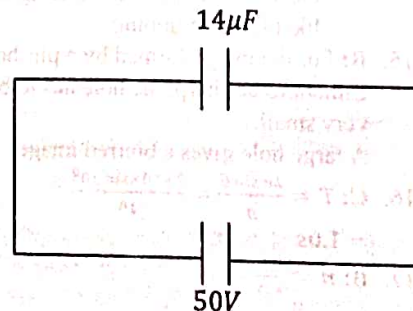
39. B: The heat from the sun reaches the earth by radiation. Unlike conduction and convection which require a material medium to transfer heat, radiation involves the transfer of energy through electromagnetic waves

40. D: \Rightarrow Pitch depends on frequency
 \Rightarrow Quality depends on overtone
 \Rightarrow Loudness depends on amplitude

PHYSICS 2023 UTME MODEL PHYSICS QUESTIONS PHYSICS

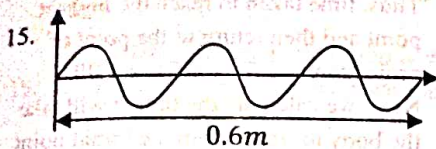
1. A string of length 1.4m is extended by 0.04m when a load of 0.8kg is suspended at the end. How far will it extend if a force of 32N is applied, assuming the elastic limit is not exceeded ($g = 10m/s^2$) (a) 0.16m (b) 0.24m (c) 0.06m

2.



From the diagram above, calculate the energy stored in the capacitor (a) $1.75 \times 10^{-2}J$ (b) 1.74×10^4J (c) 3.5×10^4J (d) $3.5 \times 10^{-2}J$

3. A car accelerates uniformly from rest at $3ms^{-2}$. Its velocity after travelling a distance of 32.67m is (a) 14m/s (b) 13m/s (c) 12m/s (d) 11m/s
4. An object of mass 10kg is released from a height of 5m above the ground level. The kinetic energy of the object just before it hits the ground is (a) 2000J (b) 500J (c) 250J (d) 1000J
5. A body is projected vertically upwards with a speed of 5m/s from a point 1.4m above the ground. Calculate the total time taken for the body to reach the ground (a) 0.228s (b) 0.253s (c) 1.228s (d) 4.124s
6. A device that converts mechanical energy into electrical energy is (a) a dynamo (b) a transformer (c) an electric motor (d) an induction coil
7. A car travelling at 50m/s overcomes a frictional resistance of 100N while moving. Calculate the power developed by the engine ($1hp = 0.75KW$) (a) 6.7hp (b) 4hp (c) 3.3hp (d) 14.1hp
8. The quality of a note depends on its (a) amplitude (b) overtones (c) pitch (d) frequency
9. Which of the following relations about the focal length f_o of the objective and focal length of the eye piece of a compound is correct? (a) $f_e = 2f_o$ (b) $f_o > f_e$ (c) $f_o < f_e$ (d) $f_o = f_e$
10. The functional difference between a lens and a mirror is that a lens (a) transmits incident rays while a mirror absorbs them (b) absorbs incident rays while a mirror transmits them (c) refracts a beam of light while a mirror reflects it (d) reflects a beam of light while a mirror refracts it
11. Which type(s) of motion do the wheels of moving car undergo? (a) Translational motion only (b) Rotational motion only (c) random and rotational motion (d) rotational and translational motion
12. The temperature at which the water vapour present in the air is just sufficient to saturate the air is the (a) dew point (b) ice point (c) saturation point (d) boiling point
13. What is the best method of demagnetizing a steel bar magnet? (a) Hammering (b) Heating (c) electrical method (d) none
14. The magnitude of the angle of dip at the equator is (a) 180° (b) 360° (c) 0° (d) 90°



The diagram above illustrates an electromagnetic wave travelling with a speed of $3 \times 10^8 \text{ m/s}$. Calculate the frequency of the wave (a) $1.5 \times 10^9 \text{ Hz}$ (b) $1.5 \times 10^7 \text{ Hz}$ (c) $5.0 \times 10^8 \text{ Hz}$ (d) 10^9 Hz

16. An object is placed between two plane mirrors inclined at 45° to each other. How many images will be formed? (a) 8 (b) 7 (c) 6 (d) 5
17. A milliammeter can be converted to a voltmeter by using a (a) resistance box (b) shunt (c) multiplier (d) rheostat
18. A $15 \mu\text{F}$ capacitor is connected to a 240V , 50Hz a.c. capacitor. Calculate the reactance of the capacitance (a) 16Ω (b) 68Ω (c) 212Ω (d) 114Ω
19. An object weighs 15kg in air and 11kg in a particular liquid. What is the upthrust exerted by the liquid on the object? (a) 40N (b) 25N (c) 260N (d) 110N
20. A machine is used to lift a load of 20N through a height of 10m . If the efficiency of the machine is 40% , how much work is done? (a) 80J (b) 800J (c) 500J (d) 50J
21. The following waves do not need a material medium for their propagation except (a) X-rays (b) Radio waves (c) light waves (d) sound waves
22. Which of the following is a property of steel? (a) It can easily be magnetized and demagnetized (b) it can be used for making permanent magnets (c) it can be used for making temporary magnets (d) it cannot retain its magnetism longer than iron
23. If the cost of electricity is #5 per Kwh, what is the cost of operating an electrical appliance rated 250V , 4A for three hours? (a) #30 (b) #15 (c) #25 (d) #33
24. An image in a convex lens is upright and magnified three times. If the focal length of the lens is 15cm , what is the object distance? (a) 14cm (b) 10cm (c) 20cm (d) 22cm
25. The property of a fluid that is used to determine its suitability as a lubricant is (a) relative density (b) surface tension (c) viscosity (d) capillarity

26. A body of mass 120g placed at the 10cm mark on a uniform metre rule makes the rule settle horizontally on a fulcrum placed at the 35cm mark. Calculate the mass of the rule (a) 200g (b) 60g (c) 140g (d) 110g
27. A stone is pushed from the edge of a table with a horizontal velocity of 15m/s . If the height of the table from the floor is 1.5m , calculate the distance from the foot of the table to the point of impact with the floor (a) 8.22m (b) 2.22m (c) 14m (d) 11m
28. The radius of a wheel is 30cm and that of its axle is 6cm . Calculate the effort required to lift a load of 120N using the machine, assuming 100% efficiency (a) 124N (b) 40N (c) 24N (d) 20N
29. A hypsometer is used for determining (a) relative density (b) relative humidity (c) atmospheric pressure (d) steam point
30. Two resistors 5Ω and 10Ω are arranged first in series and later in parallel to a 24V source, the ratio of total power dissipated in the series and the parallel arrangements respectively is (a) 3: 5 (b) 5: 3 (c) 2: 9 (d) 1: 5
31. A piece of iron weighs 125N in air and 100N in a liquid of density 1000kgm^{-3} , the volume of the iron is (a) $2.5 \times 10^{-3}\text{m}^3$ (b) $5 \times 10^{-3}\text{m}^3$ (c) $2 \times 10^{-3}\text{m}^3$ (d) $4.4 \times 10^{-3}\text{m}^3$
32. When an object is placed between the principal focus and the optical centre of a convex lens, it could be used as a (a) simple microscope (b) compound microscope (c) projector (d) telescope
33. In which of the following types of motion is a body is a body moving at a constant speed still said to be accelerating? (a) Rectilinear motion (b) Vibrational motion (c) Circular motion (d) Translational motion
34. Which of the following is not a direct consequence of rectilinear propagation of light? (a) eclipses (b) shadows (c) Images in a pin-hole camera (d) diffraction of light
35. A rectangular glass prism of thickness d and absolute refractive index n is placed on a point object which is viewed vertically downward from above the prism. Which of the following expressions correctly define the apparent upward displacement of the object? (a) $\frac{d}{n}$ (b) $\frac{n}{d}$ (c) $\frac{d}{n-2}$ (d) $\frac{d(n-1)}{d}$

36. At low humidity is an environment, the human skin is usually (a) damp and rough (b) dry and smooth (c) damp and smooth (d) dry and rough
37. If the radius of the earth is 6400km , the escape velocity of a satellite from the earth is (a) $1.27 \times 10^4\text{m/s}$ (b) $1.13 \times 10^4\text{m/s}$ (c) $9.00 \times 10^3\text{m/s}$ (d) $8.08 \times 10^4\text{m/s}$
38. The correct unit of energy density is (a) $\text{kgm}^{-1}\text{s}^{-2}$ (b) $\text{kgm}^{-3}\text{s}^{-2}$ (c) $\text{kgm}^{-2}\text{s}^{-2}$ (d) $\text{kgm}^3\text{s}^{-2}$
39. The wavelength of the first overtone of a note in a closed pipe of length 33cm is (a) 17cm (b) 33cm (c) 22cm (d) 44cm
40. A force acting on a body causes a change in the momentum of a body from 12kgms^{-1} to 16kgms^{-1} in 0.2s . calculate the magnitude of the impulse (a) 28Ns (b) 20Ns (c) 4Ns (d) 0.8Ns

SOLUTION

1. A: Method 1

$$e = 0.04\text{m}, F = W = mg = (0.8 \times 10)\text{N} = 8\text{N}$$

$$F = ke$$

$$8\text{N} = k \times 0.04\text{m}$$

$$k = \frac{8\text{N}}{0.04\text{m}} = 200\text{Nm}^{-1}$$

Since applying 32N will not cause the elastic limit to be exceeded, Hooke's law still applies

$$F = 32\text{N}, k = 200\text{Nm}^{-1}, e = ?$$

$$F = ke$$

$$32\text{N} = 200\text{Nm}^{-1} \times e$$

$$e = \frac{32\text{N}}{200\text{Nm}^{-1}} = 0.16\text{m}$$

Method 2

$$\frac{F_1}{e_1} = \frac{F_2}{e_2}$$

$$\frac{8\text{N}}{0.04\text{m}} = \frac{32\text{N}}{e_2}$$

$$e_2 = \frac{0.04\text{m} \times 32\text{N}}{8\text{N}} = 0.16\text{m}$$

2. A: Method 1

$$C = 14\mu\text{F} = 14 \times 10^{-6}\text{F} = 1.4 \times 10^{-5}\text{F}, V = 50\text{V}$$

$$E = \frac{1}{2}CV^2$$

$$= \frac{1}{2} \times 1.4 \times 10^{-5} \times 50^2$$

$$= 0.0175\text{J} = 1.75 \times 10^{-2}\text{J}$$

Method 2

$$Q = CV$$

$$= (1.4 \times 10^{-5} \times 50)\text{C}$$

$$= 7 \times 10^{-4}\text{C}$$

$$E = \frac{1}{2} QV$$

$$= \frac{1}{2} \times 7 \times 10^{-4} \times 50$$

$$= 0.0175J$$

$$= 1.75 \times 10^{-2}J$$

Method 3

$$E = \frac{1}{2} \frac{Q^2}{C}$$

$$= \frac{1}{2} \times \frac{(7 \times 10^{-4})^2}{1.4 \times 10^{-5}}$$

$$= 0.0175J = 1.75 \times 10^{-2}J$$

3. A: **Method 1**

$$u = 0, a = 3m/s^2, s = 32.67m, v = ?$$

$$v^2 = u^2 + 2as$$

$$= 0^2 + 2 \times 3 \times 32.67$$

$$= 196.02$$

$$v = \sqrt{196.02} = 14m/s$$

Method 2

$$v = u + at$$

Since 't' is not known, we will find it first.

$$s = ut + \frac{1}{2} at^2$$

$$32.67 = 0 \times t + \frac{1}{2} \times 3 \times t^2$$

$$32.67 = 1.5t^2$$

$$t^2 = \frac{32.67}{1.5} = 21.78$$

$$t = 4.6669s$$

$$v = 0 + 3 \times 4.6669$$

$$= 14m/s$$

Method 3

$$s = \left(\frac{u+v}{2}\right)t$$

$$32.67 = \left(\frac{0+v}{2}\right)4.6669$$

$$32.67 = \frac{v \times 4.6669}{2}$$

$$v = \left(\frac{32.67 \times 2}{4.6669}\right) m/s$$

$$v = 14m/s$$

4. D: **Method 1**

$$u = 0, s = H = 10m, a = +g = 10m/s^2, m = 10kg$$

$$v^2 = u^2 + 2as$$

$$v^2 = 0^2 + 2 \times 10 \times 20$$

$$v^2 = 200$$

$$K.E = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 10 \times 200$$

$$= 1000J$$

Method 2

The kinetic energy just before the object hits the ground equals the potential energy at the highest level

$$K.E_{max} = P.E_{max} = mgh$$

$$= (10 \times 10 \times 10)J = 1000J$$

5. C:



Let us first calculate the time it takes to cover distance H (to reach the highest point)

$$u = 5m/s, a = -g = -10m/s^2, v = 0, t = ?$$

$$v = u + at$$

$$0 = 5 + (-10)(t)$$

$$0 = 5 - 10t$$

$$10t = 5, t = \left(\frac{5}{10}\right)s = 0.5s$$

Let us calculate the distance H

$$v^2 = u^2 + 2as$$

$$0^2 = 5^2 + 2 \times (-10) \times H$$

$$0 = 25 - 20H, 20H = 25, H = \left(\frac{25}{20}\right)m = 1.25m$$

To get the time taken to travel from the highest point to the ground level, we need the distance from the highest point to the ground level.

$$\text{The distance, } s = 1.4m + H$$

$$= 1.4m + 1.25m$$

$$= 2.65m$$

We should not forget that the velocity at the highest point serves as the initial velocity for this return leg and it equals zero

$$u = 0, s = 2.65m, a = +g = 10m/s^2, t = ?$$

$$s = ut + \frac{1}{2} at^2$$

$$2.65 = 0 \times t + \frac{1}{2} \times 10 \times t^2$$

$$2.65 = 5t^2$$

$$t = \sqrt{\frac{2.65}{5}} = 0.728s$$

$$\text{Total time taken} = \text{time taken to reach the highest point} + \text{time taken to travel from the highest point to the ground level}$$

$$= 0.5s + 0.728s$$

$$= 1.228s$$

Method 2

Since it takes 0.5s to get to the highest point, it will take 0.5s to return to the point of projection.

Thus, time taken to reach the highest point and then return to the point of projection = $0.5s + 0.5s = 1.00s$

Next, we calculate the time it will take the body to travel from the initial point to the ground level.

The cognizance that the velocity will be restored to $5m/s$ as the body travels from the highest point to the point of projection is key here.

$$\text{Now, } u = 5m/s, a = +g = 10m/s^2, s = 1.4m$$

$$s = ut + \frac{1}{2} at^2$$

$$1.4 = 5t + \frac{1}{2} \times 10t^2$$

$$1.4 = 5t + 5t^2$$

$$5t^2 + 5t - 1.4 = 0$$

Solving quadratically, we have $t = 0.228s$ or $t = -1.228s$ (which is inadmissible)

$$\text{Thus, total time taken} = 1.00s + 0.228s = 1.228s$$

6. A: - A dynamo converts mechanical energy into electrical energy

- An electric motor converts electrical energy into mechanical energy

7. A: Power = Force \times velocity

$$= 100N \times 50m/s$$

$$= 5000W$$

$$= \left(\frac{5000}{1000}\right)KW = 5KW$$

Since 1hp is given as 0.75KW

$$5KW = \frac{1hp}{0.75KW} \times 5KW$$

$$= 6.6667hp = 6.7hp$$

8. B: - Pitch depends on frequency

- Quality depends on overtones / harmonics

- Loudness depends on amplitude

9. C: - For a compound microscope, $f_o < f_e$

- For a telescope, $f_o > f_e$

10. C: A lens refracts light while a mirror reflects it

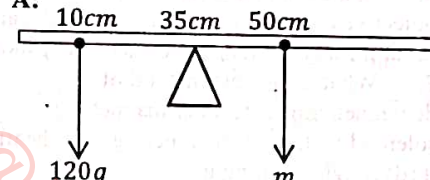
11. D: The wheels of a moving car undergo both rotational motion and translational motion same is true for a coin set into motion (whether on a horizontal surface or down an inclined plane)

Note: In either of the above cases the center undergoes translational motion while other points undergo rotational motion about the centre

12. A: This is known as the dew point

13. C: The electrical method is the best method for making a magnet and the best method for destroying it!

14. C: - At the equator, the angle of dip is 0°
 - At the pole, the angle of dip is 90°
15. A: Since there are three wavelengths in the given diagram, we have:
 $3\lambda = 0.6m, \lambda = \frac{0.6m}{3} = 0.2m$
 $v = 3 \times 10^8 m/s$
 $f = \frac{v}{\lambda} = \left(\frac{3 \times 10^8}{0.2}\right) Hz$
 $= 1.5 \times 10^9 Hz$
16. B: $N = \frac{360}{\theta} - 1$
 $= \frac{360}{45^\circ} - 1$
 $= 8 - 1 = 7$
17. C: - To convert a galvanometer / milliammeter to a voltmeter, a high resistance (known as the multiplier) should be connected with it in series
 - To convert a galvanometer / milliammeter to an ammeter, a low resistance (known as the shunt) should be connected with it in parallel.
18. C: $C = 15\mu F = 1.5 \times 10^{-5} F, F = 50 Hz$
 $X_c = \frac{1}{2\pi FC}$
 $= \frac{1}{2 \times 3.142 \times 50 \times 1.5 \times 10^{-5}}$
 $= 212.179 \Omega = 212 \Omega$
19. A: Mass in air = $15 kg$. Then, weight in air = $(15 \times 10) = 150 N$
 Mass in liquid = $11 kg$. Thus, weight in liquid = $110 N$
 Upthrust = loss in weight = $150 N - 110 N = 40 N$
20. C: $\epsilon = \frac{\text{work output}}{\text{work input}} \times 100\%$
 $40\% = \frac{(20 \times 10) J}{\text{work input}} \times 100\%$
 $\text{work input} = \left(\frac{20 \times 10 \times 100}{40}\right) J = 500 J$
21. D: - Electromagnetic waves do not require a material medium for their propagation while mechanical waves do
 - X-ray, radio waves and light waves are electromagnetic waves while sound waves are mechanical waves
22. B: - Soft iron is easily magnetized but it loses the magnetism easily, it is used in making electromagnets
 - Steel is not easily magnetized. It, however, retains its magnetism longer than soft iron. Steel is used for making permanent magnets
23. B: Power = IV
 $= 4A \times 240V = 1000W$

- $= 1KW, t = 3hrs$
 Electrical energy used = Power \times time
 $= 1KW \times 3hrs = 3 KWh$
 Since the cost is #5 per KWh, total cost
 $= \#(5 \times 3) = \#15$
24. B: $m = 2, f = +15cm$ (since the lens is convex)
 $m = \frac{v}{u}; 3 = \frac{v}{u}; v = 3u$
 However, the image is a virtual one since it is said to be upright
 Thus, $v = -3u$
 $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$
 $\frac{1}{15} = \frac{1}{u} + \frac{1}{-3u}; \frac{1}{15} = \frac{1}{u} - \frac{1}{3u}$
 $\frac{1}{15} = \frac{3-1}{3u}$
 $\frac{1}{15} = \frac{2}{3u}; u = \left(\frac{15 \times 2}{3}\right) = 10cm$
25. C: The property of a fluid that is used to determine its sustainability as a lubricant is its viscosity. A more viscous fluid is a better lubricant
26. A: 
 From the principle of moment,
 $120 \times (35 - 10) = m \times (50 - 35)$
 $120 \times 25 = m \times 15$
 $m = \left(\frac{120 \times 25}{15}\right) g = 200g$
27. A: $U_x = \frac{15m}{s}, R = ?$
 $R = U_x \times t$
 It is evident from the above that the horizontal range can be obtained if 't' is known
 Since the height of the table is known, we can easily calculate the time (t)
 $S = H = 1.5m, U_y = 0$ (Since the velocity is purely horizontal)
 $a = +g = 10m/s^2, t = ?$
 $s = ut + \frac{1}{2}at^2$
 $1.5 = 0 \times t + \frac{1}{2} \times 10 \times t^2$
 $1.5 = 5t^2$
 $t = \sqrt{\frac{1.5}{5}} = 0.5477s$
 Now, $R = U_x \times t$
 $= (15 \times 0.5477)m = 8.22m$
28. C: $V.R = \frac{\text{Radius of wheel}}{\text{Radius of axle}} = \frac{30cm}{6cm} = 5$
 $\epsilon = 100\%, V.R = 5$

- $\epsilon = \frac{M.A}{V.R} \times 100\%$
 $100\% = \frac{M.A}{5} \times 100\%$
 $M.A = \frac{5 \times 100\%}{100\%} = 5$
 $M.A = \frac{\text{load}}{\text{effort}}$
 $5 = \frac{120N}{\text{Effort}}$
 $\text{Effort} = \frac{120N}{5} = 24N$
29. D: Relative density \Rightarrow Hydrometer
 Relative humidity \Rightarrow Hygrometer
 Atmospheric pressure \Rightarrow Barometer
 Steam point \Rightarrow Barometer
30. C: $R_1 = 5\Omega, R_2 = 10\Omega$
 When in series, $R_{total} = R_1 + R_2 = (5 + 10)\Omega = 15\Omega$
 Power (in series) = $\frac{V^2}{R} = \frac{24^2}{15} W$
 When in parallel,
 $R_{total} = \frac{R_1 \times R_2}{R_1 + R_2} = \left(\frac{5 \times 10}{5 + 10}\right) \Omega = \left(\frac{10}{3}\right) \Omega$
 Power (in parallel) = $\frac{V^2}{R} = \frac{24^2}{10/3}$
 $P_{(in series)} : P_{(in parallel)} = \frac{24^2}{15} \div \frac{24^2}{10/3}$
 $= \frac{10}{15 \times 3} = 2:9$
31. A: R.D of iron = $\frac{\text{weight of iron}}{\text{Upthrust when fully immersed in water}}$
 $= \frac{125N}{125N - 100N} = \frac{125N}{25N} = 5$
 Density = $R.D \times 1000kgm^{-3}$
 $= 5 \times 1000kgm^{-3}$
 $= 5000kgm^{-3}$
 $W = mg$
 $m = \frac{W}{g} = \left(\frac{125}{10}\right) kg = 12.5kg$
 Volume = $\frac{\text{mass}}{\text{density}} = \frac{12.5kg}{5000kgm^{-3}} = 2.5 \times 10^{-3} m^3$
32. A: A convex lens is used as simple microscope / magnifying glass when the object is placed between the principal focus and the optical centre i.e at a distance less than the focal length from the lens
33. C: During a circular motion, the direction is constantly changing. Thus, even though the speed of the body undergoing the motion is constant, the body is still accelerating
 Remember velocity is a vector quantity and as such is defined by both magnitude and direction. So, as the direction changes, the velocity changes.

As you already know, a changing velocity implies acceleration

34. **D:** The consequences of the rectilinear propagation of light are the formation of shadow, the formation of eclipses and the working of a pin-hole camera
35. **D:** Real depth = d , apparent depth = ?
 $R.D = n$

$$n = \frac{d}{\text{Apparent depth}}$$

$$\text{Apparent depth} = \frac{d}{n}$$

Apparent displacement = Real depth - apparent depth

$$= d - \frac{d}{n} = \frac{dn - d}{d} = \frac{d(n-1)}{d}$$

36. **D:** At low humidity, the human skin is usually dry and rough. This is attributed to high evaporation rate

37. **B:** Escape velocity = $\sqrt{2gR}$

$$R = 6400\text{km} = 6400 \times 10^3\text{m}$$

$$= 6.4 \times 10^6\text{m}$$

$$\text{Thus, } V_{\text{escape}} = \sqrt{2 \times 10 \times 6.4 \times 10^6}$$

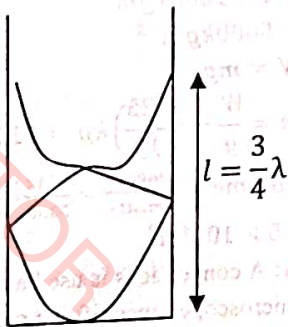
$$= 11313.7\text{m/s}$$

$$= 1.13 \times 10^4\text{m/s}$$

38. **A:** Energy density is defined as the amount of energy stored in a given system or a region of space per unit volume

$$\text{Energy density} = \frac{\text{Energy}}{\text{volume}} = \frac{J}{\text{m}^3} = \frac{\text{kgm}^2\text{s}^{-2}}{\text{m}^3} = \text{kgm}^{-1}\text{s}^{-2}$$

39. **D:** For the first overtone / second harmonics in a closed pipe, we have



Then,

$$33\text{cm} = \frac{3\lambda}{4}$$

$$\lambda = \frac{33\text{cm} \times 4}{3} = 11\text{cm} \times 4 = 44\text{cm}$$

40. **C:** $F = \frac{mv - nu}{t}$

$$Ft = mv - nu$$

$$Ft = P_f - P_i$$

$$= 16\text{kgms}^{-1} - 12\text{kgms}^{-1}$$

$$= 4\text{kgms}^{-1} = 4\text{Ns}$$

PHYSICS 2022 UTME MODEL PHYSICS QUESTIONS

1. Which types of motion does a coin undergo as it moves down as inclined plane?
 (a) rotational and translational motion (b) circular and random motion (c) translational motion (d) rotational motion

2. An object of mass 20kg is released from a height of 5m above the ground level. The kinetic energy of the object just before hitting the ground (a) 1000J (b) 2000J (c) 1500J (d) 4000J

3. The small droplets of water that form on the grass in the early hours of the morning is (a) dew (b) fog (c) hail (d) mist

4. The equation $p^a v^b T^c = \text{constant}$ reduces to Boyle's law of (a) $a = 0, b = 1, c = -1$ (b) $a = 1, b = 1, c = 0$ (c) $a = 1, b = 1, c = 1$ (d) $a = 1, b = 1, c = -1$

5. The distance between two successive troughs of a wave is 30cm and the velocity is 300ms^{-1} . Calculate the frequency (a) 100Hz (b) 2250Hz (c) 1000Hz (d) 225Hz

6. In a compound microscope, the objective and the eyepiece focal lengths are (a) at infinity (b) long (c) the same (d) short

7. What is the best method of demagnetizing a steel bar magnet? (a) solenoid method (b) hammering it (c) heating it (d) rough handling it

8. The magnitude of the angle of dip at the equator is (a) 180° (b) 0° (c) 90° (d) 60°

9. A glass bottle of initial volume $2 \times 10^4\text{cm}^3$ is heated from 20°C to 50°C . If the linear expansivity of glass is $9 \times 10^{-6}\text{C}^{-1}$, the volume of the bottle at 50°C is (a) 20013.5cm^3 (b) 20016.2cm^3 (c) 2005.4cm^3 (d) 20008.1cm^3

10. When the linear momentum of a body is constant, the net force acting on it (a) is zero (b) decreases (c) increases (d) remain constant

11. A device that converts mechanical energy into electrical energy is (a) a transformer (b) a dynamo (c) an electric motor (d) an induction coil

12. A quantity of water at 20°C is mixed with another quantity of water at 70°C . The final steady temperature of the mixture is 40°C . Determine the ratio of the mass of the hot water to that of the cold water (a) 2:1 (b) 2:3 (c) 5:2 (d) 2:7

13. The quantity of a note depends on its (a) pitch (b) frequency (c) amplitude (d) overtone

14. An ammeter can be adapted to measure potential difference by using a (a) rheostat (b) multiplier (c) shunt (d) resistance box

15. A transformer has 800 turns of wire in the primary coil and 80 turns in the secondary coil. If the input voltage is 150V . Calculate the magnitude of the output voltage (a) 15V (b) 150V (c) 36V (d) 55V

16. An element of nucleon number P and atomic number Q emits an alpha particle from its nucleus. The resultant numbers of the new element formed are respectively (a) $P+2$ and $Q-2$ (b) $P-4$ and $Q+2$ (c) $P-4$ and $Q-2$ (d) $P+2$ and $Q+2$

17. Calculate the total distance covered by a train before coming to rest if its initial speed is 30ms^{-1} with a constant retardation of 0.2ms^{-2} (a) 1500m (b) 2750m (c) 2100m (d) 2250m

18. An object of volume 1m^3 and mass 2kg is fully immersed in a liquid of density 1kgm^{-3} . Calculate its apparent weight (a) 1N (b) 2N (c) 10N (d) 20N

19. Which of the following is not a factor that can increase the rate of evaporation of water in a lake? (a) increase in the kinetic energy of the molecules of water (b) rise in temperature (c) increase in the pressure of the atmosphere (d) increase in the average speed of the molecules of water

20. Where can a man place his face to obtain an enlarged image when using a concave mirror to shave? (a) at infinity (b) at the principal focus (c) between the centre of curvature and the principal focus (d) between the principal focus and the pole

21. A particle carrying a charge of $1 \times 10^{-8}\text{C}$ enters a magnetic field of $3 \times 10^2\text{ms}^{-1}$ at right angles to the field. If the force on this particle is $1.8 \times 10^{-8}\text{N}$, what is the magnitude of the field? (a) $6.0 \times 10^{-1}\text{T}$ (b) $6 \times 10^3\text{T}$ (c) $6 \times 10^{-3}\text{T}$ (d) $6 \times 10^{-4}\text{T}$

22. A glass block of thickness 10cm and refractive index $\frac{3}{2}$ is placed on an object. If an observer views the object vertically, the displacement of the object is (a) 8.5cm (b) 3.33cm (c) 5.00cm (d) 6.67cm

23. A girl stands on a scale in a lift. If the reading on the scale is less than her weight, then the lift is moving (a) downwards with uniform acceleration (b) downwards with uniform speed (c) upwards at uniform speed (d) upwards at uniform acceleration

24. In the formation of sea breeze, wind blows from (a) sea to land (b) land to sea (c) sky to land (d) sea to sky

25. A simple pendulum of length 0.4m has a period of 2s . What is the period of a similar pendulum of length 0.8m at the same place? (a) $\sqrt{2}\text{s}$ (b) $2\sqrt{2}\text{s}$ (c) 4s (d) 8s

26. An object is moving with a velocity of 10ms^{-1} . At what height must a similar body be situated to have a potential energy equal in value to the kinetic energy of the moving body? (a) 5m (b) 2.5m (c) 10m (d) 3m

27. A wave that travels through stretched strings is known as (a) microwave (b) seismic wave (c) mechanical wave (d) electromagnetic wave

28. What is the velocity of sound at 100°C if the velocity of sound at 0°C is 340ms^{-1} ? (a) 440ms^{-1} (b) 397ms^{-1} (c) 497ms^{-1} (d) 240ms^{-1}

29. The angle of deviation of light of various colours passing through a triangular prism increases in the order (a) red \rightarrow green \rightarrow blue (b) blue \rightarrow green \rightarrow red (c) green \rightarrow violet \rightarrow blue (d) blue \rightarrow red \rightarrow green

30. Capacitors are used in the induction coil to (a) dissipate energy (b) control circuits (c) prevent electric sparks (d) distort the electric fields

31. If a current of 2.5A flows through electrolyte for 3 hours and 1.8g of a substance that will be deposited if a current of 4A flows through it for 4.8 hours? (A) 4.8g (b) 3.2g (c) 2.4g (d) 4.6g

32. Which of the following units is equivalent to the watt? (a) kgm^2s^{-1} (b) $kgms^{-2}$ (c) $kgms^{-2}$ (d) kgm^2s^{-3}

33. A diverging lens of focal length 30cm produces an image 20cm from the lens. determine the object distance (a) 10cm (b) 12cm (c) 60cm (d) 50cm

34. A string under tension produces a note of frequency 14Hz. Determine the frequency when the tension is quadrupled (a) 56Hz (b) 28Hz (c) 18Hz (d) 14Hz

35. The work function of a metal is $2.56 \times 10^{-19}J$. Calculate the frequency of a photon whose energy is required to eject from the metal an electron with kinetic energy of 3.0eV [$1eV = 1.6 \times 10^{-19}J$, $h = 6.6 \times 10^{-34}Js$] (a) $1.12 \times 10^{15}Hz$ (b) $2.2 \times 10^{14}Hz$ (c) $1.12 \times 10^{-53}Hz$ (d) $4.4 \times 10^{14}Hz$

36. When a red rose flower is observed in blue light, what colour does the observer see? (a) blue (b) red (c) black (d) yellow

37. The density ρ of a spherical ball of diameter d and mass m is given by (a) $\rho = \frac{3m}{2\pi d^3}$ (b) $\rho = \frac{3m}{4\pi d^3}$ (c) $\rho = \frac{6m}{\pi d^3}$ (d) $\rho = \frac{4m}{\pi d^3}$

38. A coin is pushed from the edge of a laboratory bench a horizontal velocity of $15ms^{-1}$. If the height of the bench from the floor is 1.5m, calculate the distance from the foot of the bench to the point of impact with the floor [$g = 10ms^{-2}$] (a) 8.22m (b) 2.25m (c) 1.5m (d) 1.41m

39. Two sound waves have frequencies of 12Hz and 10Hz. Calculate their beats period (a) 2.0s (b) 1.2s (c) 1.0s (d) 0.5s

40. A lens that is thinner at the middle and thicker at the edges is (a) diverging (b) converging (c) plano-convex (d) converging meniscus

SOLUTION

1. A: A coin that rolls on an inclined plane exhibits both rotational and translational motion. The center of the coin undergoes translational motion as the coin moves from one point to the other on the inclined plane. All other parts of the coin undergo rotational motion (about the centre)

2. B: $u = 0$, $s = 5m$, $a = g = 10m/s^2$, $v = ?$
 $v^2 = u^2 + 2as$

$$v^2 = 0^2 + 2 \times 10 \times 5 = 100$$

$$K.E = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 20 \times 100 = 1000J$$

METHOD 2

The kinetic energy at the lowest point equals the potential energy at the highest point (the maximum value for each)

$$K.E_{max} = P.E_{max} = mgh_{max}$$

$$= 20 \times 10 \times 5 = 1000J$$

3. A: The small droplets of water that form on the grass in the early hours of the morning is known as dew

4. B: $P^aV^bT^c = \text{constant}$ (Given)

$PV = \text{constant}$ (Boyle's law)

Let the expression for Boyle's law be written so as to compare with the given one

$P^1V^1T^0 = \text{constant}$ (Boyle's law)

$$\therefore a = 1, b = 1, c = 0$$

5. C: $\lambda = 30cm = \left(\frac{30}{100}\right)m = 0.3m$, $v = 300ms^{-1}$

$$f = \frac{v}{\lambda} = \left(\frac{300}{0.3}\right)Hz = 1000Hz$$

6. D: The lenses used in a compound microscope are of short focal lengths. It must however be noted that the objective lens is still shorter than the eyepiece lens

7. A: The electrical method (solenoid method) is the best way for making a magnet and the best way for demagnetizing a magnet!

8. B: The magnitude of the angle of dip at the equator is 0° . At the poles, the magnitude is 90°

9. B: $V_1 = 2 \times 10^4cm^3$, $\theta_1 = 20^\circ$, $\theta_2 = 50^\circ$

$$\alpha = 9 \times 10^{-6}K^{-1}, \Delta\theta = 50^\circ - 20^\circ = 30^\circ$$

$$V_2 = V_1(1 + 3\alpha\Delta\theta)$$

$$= 2 \times 10^4(1 + 3 \times 9 \times 10^{-6} \times 30)$$

$$= 2 \times 10^4(1 + 8.1 \times 10^{-4})$$

$$= 2 \times 10^4(1.0081) = 20016.2cm^3$$

10. A: When the linear momentum of a body is constant, the net force acting on it is zero.

This result can be obtained using Newton's second law of motion

From Newton's second law;

$$F = \frac{mv - mu}{t}$$

If the linear momentum is constant,

$$mv = mu = x$$

$$\text{Thus, } F = \frac{x-x}{t}$$

$$F = \frac{0}{t}, F = 0$$

11. B: A dynamo is a device that converts mechanical energy into electrical energy

NB: An electric motor converts electrical energy into mechanical energy

12. B: $m_c C \Delta\theta_c = m_h C \Delta\theta_h$

$$m_c \times \Delta\theta_c = m_h \times \Delta\theta_h$$

$$\Delta\theta_c = 40^\circ - 20^\circ = 20^\circ$$

$$\Delta\theta_h = 70^\circ - 40^\circ = 30^\circ$$

Then.

$$\frac{m_c \times 20}{m_h} = \frac{m_h \times 30}{m_c}$$

$$\frac{m_c}{m_h} = \frac{20}{30} = \frac{2}{3}$$

$$\frac{m_c}{m_h} = \frac{2}{3}$$

Thus, $m_h : m_c = 2 : 3$

13. D:

- Pitch depends on frequency
- Quality depends on overtone
- Loudness depends on amplitude

14. B: To convert a millimeter to a voltmeter, a high resistance known as multiplier is connected with it in series

NB: To convert a milliammeter to an ammeter, a low resistance known as shunt is connected with it in parallel.

15. A: Input voltage = $V_p = 150V$

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$\frac{80}{800} = \frac{V_s}{150V}$$

$$\frac{80}{800} = \frac{V_s}{80 \times 150V}$$

$$V_s = \frac{800 \times 150V}{800} = 15V$$

16. C: When a nucleus undergoes an alpha decay, the mass number decreases by 4 while the atomic number decreases by 2. Do not forget that the mass number is same as the nucleon number

17. D: $u = 30ms^{-1}$, $v = 0$, $a = 0.2ms^{-2}$, $s = ?$,

$$v^2 = u^2 + 2as$$

$$0^2 = 30^2 + 2(-0.2)s$$

$$0 = 900 - 0.4s$$

$$0.4s = 900$$

$$s = \left(\frac{900}{0.4}\right)m = 2250m$$

18. C: Upthrust, $U = \rho vg = (1 \times 1 \times 10)N = 10N$

Weight of the object in air = $mg = (2 \times 10)N = 20N$

Apparent weight = $20N - 10N = 10N$

19. C: Rate of evaporation increases with an increase in the kinetic energy of the molecules of water, rise in temperature and increase in the average speed of the molecules of water.

NB: An increase in the atmospheric pressure causes a decrease in the rate of evaporation

20. D: He should place his face between the principal focus and the pole. In this way, the image obtained will be substantially enlarged and upright.

21. C: $q = 1 \times 10^{-8}C$, $V = 3 \times 10^2ms^{-1}$, $F = 1.8 \times 10^{-8}N$, $\theta = 90^\circ$, $B = ?$

$$F = qVB \sin\theta$$

$$1.8 \times 10^{-8} = 1 \times 10^{-8} \times 3 \times 10^2 \times B \times \sin 90$$

$$1.8 \times 10^{-8} = 3 \times 10^{-6} \times B$$

$$B = \left(\frac{1.8 \times 10^{-8}}{3 \times 10^{-6}}\right)T$$

$$B = 6 \times 10^{-3}T$$

22. B: Refractive index = $\frac{\text{Real depth}}{\text{Apparent depth}}$

$$\frac{3}{2} = \frac{10cm}{\text{Apparent depth}}$$

$$\text{Apparent depth} = \frac{10cm \times 2}{3} = 6.67cm$$

$$\text{Apparent depth} = \frac{2 \times 10 \text{ cm}}{3} = 6.6667 \text{ cm}$$

$$\text{Displacement} = \text{Real depth} - \text{Apparent depth} = 10 \text{ cm} - 6.6667 \text{ cm} = 3.3333 \text{ cm}$$

23. A: The lift should be moving downwards with a uniform acceleration. This is the only way to be less than the actual weight of the girl. If the girl records a weight, the lift is ascending with a uniform acceleration

The reading of the scale, $R = mg \pm ma$

When the lift ascends, $R = mg + ma$

When the lift descends, $R = mg - ma$

24. A:

- In the formation of sea breeze, wind blows from the sea to the land

- For land breeze, wind blows from the land to the sea

25. B: $\frac{T_1}{\sqrt{L_1}} = \frac{T_2}{\sqrt{L_2}}$

$$\frac{T_1}{\sqrt{0.4}} = \frac{T_2}{\sqrt{0.8}}$$

$$T_2 = \frac{2 \times \sqrt{0.8}}{\sqrt{0.4}}$$

$$= 2 \times \sqrt{\frac{0.8}{0.4}} = 2\sqrt{2} \text{ s}$$

26. A: When the potential energy equals the kinetic energy, we have:

$$mgh = \frac{1}{2}mv^2$$

$$h = \frac{\frac{1}{2}v^2}{g} = \frac{v^2}{2g}$$

$$\left(\frac{10^2}{2 \times 10}\right) m = 5m$$

27. C: String waves are mechanical waves

NB: Mechanical waves are also known as material waves

28. B: $V_1 = 340 \text{ ms}^{-1}$, $\theta_1 = 0^\circ \text{ C} = 273 \text{ K}$,

$V_2 = ?$, $\theta_2 = 100^\circ \text{ C} = (100 + 273) \text{ K} = 373 \text{ K}$

$$\frac{V_1}{\sqrt{\theta_1}} = \frac{V_2}{\sqrt{\theta_2}}$$

$$\frac{340}{\sqrt{273}} = \frac{V_2}{\sqrt{373}}$$

$$V_2 = \frac{340 \times \sqrt{373}}{\sqrt{273}}$$

$$= 340 \times \sqrt{\frac{373}{273}}$$

$$= 340 \times \sqrt{1.3663}$$

$$= 397.42 \text{ ms}^{-1} = 397 \text{ ms}^{-1}$$

29. A:

Red, Orange, Yellow, Green, Blue, Indigo, Violet

Increasing angle of deviation

30. C: Capacitors are used in the primary circuit of induction coil to prevent electric sparks

31. D: $m = zIt$

$$Q = It. \text{ Then } m = zQ$$

Thus, $z = \frac{m}{Q}$

Since z is constant, $\frac{m_1}{Q_1} = \frac{m_2}{Q_2}$

$$Q_1 = I_1 t_1 = (2.5 \times 3 \times 3600) \text{ C} = 27,000 \text{ C}$$

$$Q_2 = I_2 t_2 = (4 \times 4.8 \times 3600) \text{ C} = 69,120 \text{ C}$$

Then,

$$\frac{1.8}{27,000} = \frac{m_2}{69,120}$$

$$m_2 = \left(\frac{1.8 \times 69,120}{27,000}\right) g = 4.6g$$

32. D: Watt is the unit of power.

$$\text{Since Power} = \frac{\text{Work}}{\text{time}} = \frac{\text{Force} \times \text{distance}}{\text{time}}$$

$$= \frac{\text{time}}{m \times \text{acc} \times \text{distance}}$$

$$\text{Watt} = \frac{\text{kg} \times \text{ms}^{-2} \times \text{m}}{\text{s}} = \text{kgm}^2 \text{ s}^{-3}$$

33. C: $f = -30 \text{ cm}$ (since it is a diverging lens)

$$v = -20 \text{ cm} ()$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{-30} = \frac{1}{u} + \frac{1}{-20}$$

$$\frac{1}{-30} - \left(\frac{1}{-20}\right) = \frac{1}{u}$$

$$\frac{1}{-30} + \frac{20}{20u} = \frac{1}{u}$$

$$\frac{1}{-30} + \frac{20}{20u} = \frac{1}{u}$$

$$\frac{1}{u} = \frac{20}{30} = \frac{2}{3}$$

$$u = 60 \text{ cm}$$

34. B: $F \propto \sqrt{T}$

$$\frac{F_1}{\sqrt{T_1}} = \frac{F_2}{\sqrt{T_2}}$$

If the tension is quadrupled, $T_2 = 4T_1$

$$\frac{14}{\sqrt{T_1}} = \frac{F_2}{\sqrt{4T_1}}$$

$$F_2 = \frac{14 \times \sqrt{4T_1}}{\sqrt{T_1}}$$

$$= \frac{14 \times \sqrt{4} \times \sqrt{T_1}}{\sqrt{T_1}}$$

$$= 14 \times \sqrt{4} = 28 \text{ Hz}$$

35. A: $E = W_0 + K.E$

$$hf = W_0 + K.E$$

$$6.6 \times 10^{-34} \times f = 2.56 \times 10^{-19} + 3 \times 1.6 \times 10^{-19}$$

$$6.6 \times 10^{-34} \times f = 7.36 \times 10^{-19}$$

$$f = \left(\frac{7.36 \times 10^{-19}}{6.6 \times 10^{-34}}\right) \text{ Hz} = 1.12 \times 10^{15} \text{ Hz}$$

36. C: A red rose flower reflects only red and absorbs other colours. Thus, it will absorb the blue light and reflect no colour (since it can only reflect red)

37. C: Volume of a sphere (v)

$$= \frac{4}{3} \pi r^3$$

$$r = \frac{d}{2}$$

Then, $V = \frac{4}{3} \times \pi \times \left(\frac{d}{2}\right)^3$

$$V = \frac{4\pi \times d^3}{3 \times 8}$$

$$V = \frac{\pi d^3}{6}$$

Density (ρ) = $\frac{m}{v}$

$$= m \div \frac{\pi d^3}{6}$$

$$= \frac{m \times 6}{\pi d^3} = \frac{6m}{\pi d^3}$$

38. A: $R = UT$

$$T = \sqrt{\frac{2H}{g}}$$

$$R = U \times \sqrt{\frac{2H}{g}}$$

$$= 15 \times \sqrt{\frac{2 \times 1.5}{10}}$$

$$= 15 \times \sqrt{0.3} = 8.22 \text{ m}$$

39. D:

Beat frequency = $F_2 - F_1$

$$= 12 \text{ Hz} - 10 \text{ Hz} = 2 \text{ Hz}$$

$$T = \frac{1}{F} = \left(\frac{1}{2}\right) \text{ s} = 0.5 \text{ s}$$

40. A:

- A lens that is thicker at the edge than at the middle is a concave or diverging lens

- A lens that is thicker at the middle than at the edge is a convex or converging lens

PHYSICS

2021 UTME MODEL PHYSICS QUESTIONS

- The half life of a radioactive substances is 5 days. What percentage of it will remain after 20days? (a) 12.5% (b) 25% (c) 6.25% (d) 42%
- Which of the following is true for a coin rolling down an inclined plane? (a) the motion of its centre is rotational while that of any other point in the coin is translational (b) the motion of the centre and that of any other point on the coin is translational (c) the motion of its centre is translational while that of any other point on the coin is rotational (d) the motion of its center is translational while that of any other point on the coin is rotational
- The energy stored in an elastic material when a force of 1000N causes it an extension of 1cm is?
- What is the reading on the kelvin scale when the reading on the Fahrenheit scale is 188°F (a) 359.7K (b) 273K (c) 90K (d) 156K
- Given that $M^x L^y T^z$ is the dimension for G , the universal gravitational constant, the respective values of x, y & z are (a) -1, 3, -2 (b) -1, -2 & 3 (c) 2, -1 & 1 (d) 2, 1 & -1
- A load of 20N on a wire of cross-sectional area $8 \times 10^{-7} \text{ m}^2$ produces an extension of 10^{-4} m . Given that the length of the wire is 3m, determine the Young's modulus of the material (a) $9 \times 10^{-11} \text{ Nm}^{-2}$ (b) $8.5 \times 10^{-11} \text{ Nm}^{-2}$ (c) $7.5 \times 10^{-11} \text{ Nm}^{-2}$ (d) $7 \times 10^{-11} \text{ Nm}^{-2}$

7. Provided that the amount of work required to move $500\mu\text{C}$ of charge from point A to point B is 0.05J , the potential difference between A and B is (a) 100V (b) 50V (c) 200V (d) 500V
8. Which of the following has the shortest wavelength? (a) Infra-red rays (b) Ultraviolet rays (c) Radio waves (d) Gamma rays
9. Two 10Ω resistors are connected in parallel. What is the combined resistance (a) 10Ω (b) 20Ω (c) 5Ω (d) 75Ω
10. A 14kg body is released from rest on smooth inclined plane. What is the acceleration of the body down the plane, given that the angle between the plane and the horizontal is 60° ? [$g = 10\text{m/s}^2$] (a) 10m/s^2 (b) 5m/s^2 (c) 8.66m/s^2 (d) 4.33m/s^2
11. Which of the following is used for the construction of a searchlight? (a) parabolic mirror (b) concave mirror (c) convex mirror (d) spherical mirror
12. The force of repulsion between two point positive charges $4\mu\text{C}$ and $5\mu\text{C}$ that are 0.02m apart is (a) $9 \times 10^2\text{N}$ (b) $4.5 \times 10^2\text{N}$ (c) $1.8 \times 10^3\text{N}$ (d) $2.7 \times 10^3\text{N}$
13. An ebonite rod rubbed with fur attracts a glass rod rubbed with silk because (a) ebonite has a negative charge while a glass has a positive charge (b) ebonite has a positive charge while glass has a negative charge (c) both have negative charges (d) both have positive charges
14. The iron core of an induction coil is made from bundles of wires so as to (A) prevent sparking (a) obtain high secondary voltage (c) minimize eddy-currents (d) generate eddy-currents
15. When a metallic surface is illuminated by light of a given frequency and intensity, it is true that (a) both the number and of emitted photoelectrons depend on the frequency of the light (b) both the number and energy of the emitted photoelectrons depend on the intensity of the light (c) the number of the emitted photoelectrons depends on the intensity of the light while the energy depends on the frequency of the light (d) the number of the emitted photoelectrons depends on the frequency while the energy depends on the intensity
16. The velocity 'V' of a particle in a time 't' is given by the equation $V = 5t^2 + 11$. What is the instantaneous acceleration after 2 seconds? (a) 20m/s^2 (b) 10m/s^2 (c) 5m/s^2 (d) 17m/s^2
17. Which of the following is a first class lever? (a) sugar tong (b) wheel barrow (c) nutcracker (d) scissors
18. In a p-type semiconductor, the majority carries are the (a) electrons (b) holes (c) electrons and holes (d) ions
19. What effort will be required to lift a load of 150N using a machine whose velocity ratio and efficiency are respectively 5 and 75% (a) 40N (b) 50N (c) 20N (d) 30N
20. The equation of a travelling wave is $y = 0.15 \sin 200\pi(x - 5.5t)$. the frequency and wavelength of the wave are respectively (a) 500Hz and 0.25m (b) 550Hz and 0.01m (c) 400Hz and 0.4m (d) 325Hz and 2m
21. A ray of light strikes a plane mirror at an angle of incidence 30° . If the mirror is rotated

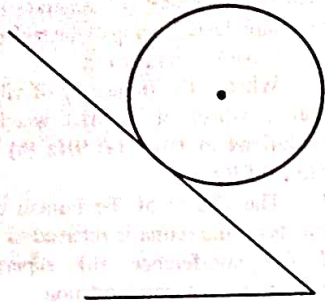
- through 40° , through what angle is the refracted ray rotated? (a) 70° (b) 10° (c) 40° (d) 80°
22. What are the first three harmonics of a stretched string of length 2m , given that the velocity of the waves is 150m/s (a) $37.5\text{Hz}, 75\text{Hz}, 150\text{Hz}$ (b) $37.5\text{Hz}, 75\text{Hz}, 112.5\text{Hz}$ (c) $187.75\text{Hz}, 56.25\text{Hz}, 93.75\text{Hz}$ (d) $18.75\text{Hz}, 37.5\text{Hz}, 56.25\text{Hz}$
23. A plane sound wave of frequency 85.5Hz and velocity 343m/s is reflected from a vertical wall. At what distance from the wall does the wave have an antinode? (a) 1m (b) 2m (c) 3m (d) 4m
24. The driving mirror of a car has a radius of curvature of 1m . A vehicle behind the car is 4m from the mirror. Find the image distance behind the mirror (a) 1.143m (b) 0.571m (c) 0.444m (d) 4.5m
25. The angles of inclination at the pole and equator are respectively (a) 90° & 0° (b) 0° & 90° (c) 90° & 45° (d) 45° & 90°
26. When is a satellite said to be in a parking orbit? (a) when its period is greater than the period of the earth (b) when its period is less than the period of the earth (c) when its period is equal to the period of earth (d) when its period is equal to half of the period of the earth
27. If an object is placed between two parallel plane mirrors with their reflecting surfaces facing each other. Calculate the number of images formed (a) 6 (b) infinite (c) two (d) four
28. What happens to the rays in a parallel beam of light? (a) they converge as they travel (b) they diverge as they travel (c) they meet at infinity (d) they intersect
29. The velocity of sound in air will be doubled if its absolute temperature is (a) halved (b) constant (c) doubled (d) quadrupled
30. A converging lens has a focal length of 50cm . Determine its power (a) 0.02D (b) 2.00D (c) 0.01D (d) 1.00D
31. A submarine is observed to rise from a real depth of 80m to 60m in water, calculate the change in apparent depth (a) 45m (b) 60m (c) 15m (d) 80m ($n = \frac{4}{3}$)
32. A glass bottle containing a liquid is heated. If the liquid level falls, it follows that (a) the liquid expands more than the bottle (b) the bottle and the liquid (c) the bottle and the liquid expand equally (d) the liquid does not expand
33. Which of the following gas laws is equivalent to the workdone? (a) Charles' law (b) Pressure law (c) Boyle's law (d) Gay Lussac's law
34. If α, β, γ represent the coefficients of linear, area and cubic expansivities, which of the following is correct? (a) $\alpha = 2\beta$ (b) $\gamma = \frac{3}{2}\beta$ (c) $\gamma = \frac{3}{2}\beta$ (d) $\beta = \frac{3}{2}\gamma$
35. The instrument used by designers to obtain different colour patterns is called (a) sextant (b) Periscope (c) microscope (d) Kaleidoscope
36. Lenz's law is a law of the conservation of (a) energy (b) momentum (c) velocity (d) charge
37. An empty density bottle weighs 2N . If it weighs 5N when filled with water and 4N when filled with olive oil, the relative density of olive oil is (a) $\frac{2}{5}$ (b) $\frac{1}{5}$ (c) $\frac{1}{3}$ (d) $\frac{2}{3}$

38. A short chain is sometimes attached to the back of a petrol tanker to (a) caution the driver when overspeeding (b) generate more friction (c) ensure the balancing of the tanker (d) conduct excess charges to the earth
39. What is the frequency of vibration if the balance wheel of a wrist watch makes 90 revolutions in 10s? (a) 9Hz (b) 0.111Hz (c) 3Hz (d) 5Hz
40. The ability of the human eye to focus objects on the retina is referred to as the power of (a) interference (b) superposition (c) diffraction (d) accommodation

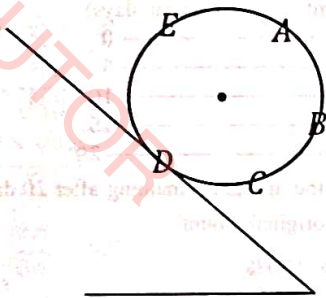
SOLUTION

1. C: Method 1
Let the amount present originally be N
- | Amount | Time (in days) |
|--------|----------------|
| N | 0 |
| N/2 | 5 |
| N/4 | 10 |
| N/8 | 15 |
| N/16 | 20 |
- Thus, the amount remaining after 20 days = $\frac{1}{16}$ of the original amount
 $= \frac{1}{16} \times 100\%$
 $= 6.25\%$
- Method 2
 $N_t = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$
 $N_t = \text{Amount present after time } t$
 $N_0 = \text{original amount}$
 Then, percentage remaining after time
 $t = \frac{N_t}{N_0} \times 100\%$
 Here, $t = 20\text{days}$ and $t_{1/2} = 5\text{days}$
 Let us get the percentage remaining
 $\left(\frac{N_t}{N_0} \times 100\%\right)$ from the given equation
 $N_t = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$
 Dividing both sides by N_0 , we have
 $\frac{N_t}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$
 Multiply both sides by 100%
 $\frac{N_t}{N_0} \times 100\% = \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}} \times 100\%$
 $= \left(\frac{1}{2}\right)^{\frac{20}{5}} \times 100\%$
 $= \left(\frac{1}{2}\right)^4 \times 100\% = \frac{1}{16} \times 100\% = 6.25\%$
- Method 3
 $N_t = N_0 e^{-\lambda t}$
 $\lambda = \frac{0.693}{t_{1/2}}$
 $= \frac{0.693}{5\text{day}} = 0.1386\text{day}^{-1}$
 Then,
 $\frac{N_t}{N_0} = e^{-\lambda t}$
 Thus, $\frac{N_t}{N_0} \times 100\% = e^{-\lambda t} \times 100\%$
 $= e^{-0.1386 \times 20} \times 100\%$
 $= 0.0625 \times 100\% = 6.25\%$
2. C: The coin undergoes rotational motion about its center while the center undergoes

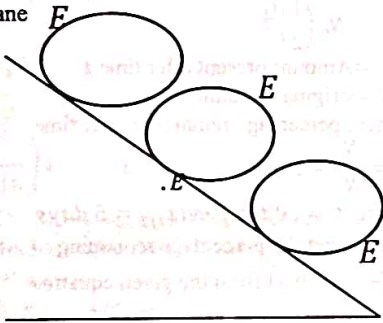
translational motion. In order to understand this, let a coin be placed on an inclined plane



Let us indicate some points on this coin. The motion of these points will be studied as the coin rolls down the plane



Now, let us picture this coin as it rolls down the plane



As can be seen, the centre of the coin for the three positions fall on a straight line. This shows that the center undergoes a translational form of motion. Also, it can be seen that all the points (A, B, C, D, E) rotate as the coin moves down the plane. This proves that these points undergo rotational motion.

3. A: Method 1

$$F = 1000N, e = 1cm = 0.01m$$

Energy, E , stored in an elastic material is obtained as:

$$E = \frac{1}{2}Fe = \left(\frac{1}{2} \times 1000 \times 0.01\right)J = 5J$$

Method 2

$$F = ke$$

$$1000N = k \times 0.01m$$

$$k = \frac{1000N}{0.01m} = 1 \times 10^5 Nm^{-1}$$

$$E = \frac{1}{2}ke^2$$

$$= \left(\frac{1}{2} \times 1 \times 10^5 \times 0.01^2\right)J = 5J$$

Method 3

$$E = \frac{1}{2}F^2/k$$

$$= \left(\frac{1}{2} \times \frac{1000^2}{1 \times 10^5}\right)J$$

$$= 5J$$

4. A: Method 1

$$\frac{0F-32}{9} = \frac{0C}{5}$$

$$\frac{188-32}{9} = \frac{5C}{5}$$

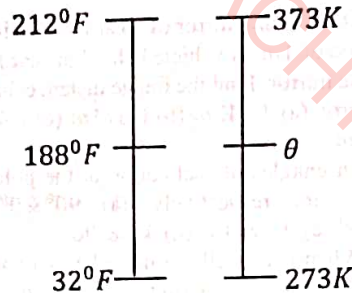
$$\frac{156}{9} = \frac{0C}{5}; 0C = \frac{156 \times 5}{9} = 86.6667^\circ C$$

Thus, the temperature is equivalent to $86.6667^\circ C$. This is then compared to the kelvin scale

$$T(K) = T(^\circ C) + 273 = (86.6667 + 273)K = 359.7K$$

Method 2

We may use interpolation approach. This will require the lower and upper fixed points of the two scales



Then,

$$\frac{212 - 32}{188 - 32} = \frac{373 - 273}{\theta - 273}$$

$$\frac{188 - 32}{188 - 32} = \frac{100}{\theta - 273}$$

$$\frac{156}{9} = \frac{100}{\theta - 273}$$

$$\theta - 273 = \frac{(100 \times 156)}{180} = 86.6667$$

$$\theta = (86.6667 + 273)K = 359.7K$$

5. A: To get the dimension of the universal gravitational constant G , we first make it the subject:

$$F = \frac{Gm_1m_2}{r^2}$$

$$G = \frac{Fr^2}{m_1m_2}$$

$$F = ma$$

$$= M \times LT^{-2} = MLT^{-2}$$

r , the radius is a form of length. So the dimension of r is L . Thus, that of $r^2 = L^2$

Therefore;

$$F = \frac{MLT^{-2} \times L^2}{M \times M}$$

$$= M^{-1}L^3T^{-2}$$

6. C: Method 1

Force (F) = 20N, Area (A) = $8 \times 10^{-7}m^2$, Extension (e) = $10^{-4}m$, length (L) = 3m

$$T. \text{strain} = \frac{e}{l} = \frac{10^{-4}m}{3m} = 3.333 \times 10^{-5}$$

$$T. \text{stress} = \frac{F}{A} = \frac{20N}{8 \times 10^{-7}m^2} = 2.5 \times 10^7 N/m^2$$

$$\text{Young's modulus} = \frac{T. \text{stress}}{T. \text{strain}}$$

$$= \frac{2.5 \times 10^7 N/m^2}{3.333 \times 10^{-5}} = 7.5 \times 10^{11} N/m^2$$

Method 2

$$\text{Young's modulus} = \frac{Fl}{Ae}$$

$$= \frac{20N \times 3m}{8 \times 10^{-7}m^2 \times 10^{-4}m} = 7.5 \times 10^{11} N/m^2$$

7. A: Potential difference (V) =

$$\frac{\text{Workdone (W)}}{\text{charge (q)}}$$

$$W = 0.05J, q = 500\mu C = 500 \times 10^{-6}C = 5 \times 10^{-4}C$$

$$V = \left(\frac{0.05}{5 \times 10^{-4}}\right) = 100V$$

8. D: - The electromagnetic wave with the highest frequency is gamma ray while that with the lowest frequency is radio wave.

- In term of wavelength, radio wave has the longest wavelength while gamma ray has the shortest

Radio waves \rightarrow Infar-red ray \rightarrow Visible light \rightarrow Ultraviolet ray \rightarrow X-ray \rightarrow Gamma ray

Increasing frequency \rightarrow
Decreasing wavelength

9. C: method 1

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{1}{10} + \frac{1}{10} = \frac{2}{10}$$

$$\frac{1}{R_{total}} = \frac{2}{10}$$

$$2R_{total} = 10$$

$$R_{total} = \left(\frac{10}{2}\right)\Omega = 5\Omega$$

Method 2

If two resistors are connected in parallel, instead of relating the resistance in reciprocal from as presented in method 1, we can write:

$$R_{total} = \frac{R_1 \times R_2}{R_1 + R_2} = \left(\frac{10 \times 10}{10 + 10}\right)\Omega$$

$$= \left(\frac{100}{20}\right)\Omega = 5\Omega$$

Method 3

Regardless of the number of resistors connected in parallel, luck has really smiled on us if these resistors have equal resistance! All we need do is divide the resistance value by the numbers of resistors involved to get the overall resistance!!! Yes, you read that well.

Let us consider three 5Ω resistors that are connected in a parallel. First of all, let us approach the question traditionally

$$\frac{1}{R_{total}} = \frac{1}{5} + \frac{1}{5} + \frac{1}{5}$$

$$= \frac{1+1+1}{5} = \frac{3}{5}$$

$$\frac{1}{R_{total}} = \frac{3}{5}$$

$$3R_{total} = 5 \times 1$$

$$R_{total} = \left(\frac{5}{3}\right)\Omega = 1.67\Omega$$

Using the approach described instead, we should just divide 5Ω by 3. Thus, $R_{total} = \frac{5\Omega}{3} = 1.67\Omega$

So, if four 4Ω resistors are connected in parallel, $R_{total} = \left(\frac{4}{4}\right)\Omega = 1\Omega$, if five 6Ω resistors are connected in parallel, $R_{total} = \frac{6\Omega}{5} = 1.2\Omega$, if three 2Ω resistors are connected in series, $R_{total} = \frac{2\Omega}{3} = 0.67\Omega$ e.t.c

Back to the question given, Here, two 10Ω resistors are connected in parallel. Thus, $R_{total} = \frac{10\Omega}{2} = 5\Omega$

10. C: Method 1

Using the question given, Here, two 10Ω resistors are connected in parallel. Thus, $R_{total} = \frac{10\Omega}{2} = 5\Omega$

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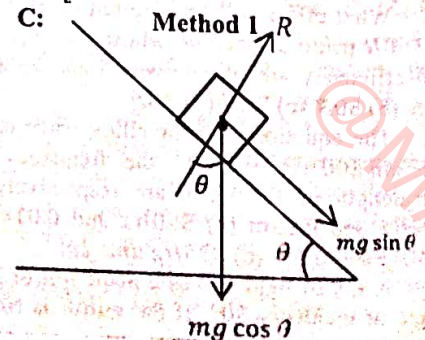
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As can be seen, the component of the weight that drags the body down the plane is $mg \sin \theta$ i.e.

$$F_{\text{motion}} = mg \sin \theta$$

Here, $m = 14kg, \theta = 60^\circ$

Thus, $F_{\text{motion}} = 14 \times 10 \times \sin 60^\circ = 121.244N$

Since $F = ma$, it is written that:

$$121.244 = 14 \times a$$

$$a = \left(\frac{121.244}{14}\right) m/s^2$$

$$= 8.66m/s^2$$

Method 2

The acceleration of a body that moves down a smooth (frictionless) plane inclined at angle θ to the horizontal is given by $a = g \sin \theta$

Thus, $\theta = (10 \sin 60^\circ)m/s^2 = 8.66m/s^2$

11. A: - concave mirror is used as shaving mirror

- convex mirror is used as driving mirror

- Parabolic mirror is used in the construction of a searchlight

12. B: $F = \frac{kq_1q_2}{r^2}$

$$= \frac{9 \times 10^9 \times 4 \times 10^{-6} \times 5 \times 10^{-6}}{0.02^2} = 450N$$

$$= 4.5 \times 10^2 N$$

13. A: The ebonite rod will acquire a negative charge while the glass will acquire a positive charge

14. C: The use of the iron core is to minimize eddy currents

15. C: The number of photoelectrons produced depends on the intensity of the light while the energy of the emitted electrons depends on the frequency of the light (and the work function of the surface)

16. A: $V = 5t^2 + 11$

Instantaneous acceleration $= \frac{\Delta V}{\Delta t}$

$$\frac{\Delta V}{\Delta t} = 2 \times 5t^{2-1} + 0$$

$$= 10t$$

At $t = 2s$,

$$a = \frac{\Delta V}{\Delta t} = 10t = (10 \times 2)m/s^2 = 20m/s^2$$

17. D: - A first class lever has the fulcrum between the load and the effort e.g. scissors & Pliers

- A second class lever has the load between the fulcrum and the effort e.g. wheelbarrow & nutcracker

- A third class lever has the effort between the fulcrum and the load e.g. forearm & sugar tong

18. B: - In a p-type semiconductor, holes are more than electrons. Thus, holes are the majority carriers while electrons are the minority carriers

- In an n-type semiconductor, electrons are more than holes. Therefore, electrons are the majority carriers while holes are the minority carriers

19. A: $\epsilon = \frac{M.A}{V.R} \times 100\%$

$$75\% = \frac{M.A}{5} \times 100\%$$

$$M.A = \frac{5 \times 75}{100} = 3.75$$

$$M.A = \frac{\text{Load}}{\text{Effort}}$$

$$3.75 = \frac{150N}{\text{Effort}}$$

$$\text{Effort} = \frac{150N}{3.75} = 40N$$

20. B: $y = A \sin \left(\frac{2\pi x}{\lambda} - 2\pi ft\right) \Rightarrow$ standard

$$y = 0.15 \sin 200\pi(x - 5.5t) \Rightarrow$$
 Given

Before any comparison can be made the given equation must be made to look similar to the standard equation. This is done by absorbing '200 π ' into the bracket

Then, we have:

$$y = 0.15 \sin 200\pi(x - 5.5t)$$

$$y = 0.15 \sin(200\pi x - 1100\pi t)$$

If this newly acquired equation is compared with the standard equation, it follows that:

i) $2200\pi t = 2\pi ft$

$$\therefore f = \frac{1100\pi t}{2\pi t} = 550Hz$$

ii) $200\pi x = \frac{2\pi x}{\lambda}$

$$\therefore \lambda = \frac{2\pi x}{200\pi x} = 0.01m$$

21. D: Keeping the incident ray fixed, rotating a plane mirror through an angle θ we cause the reflected ray to be rotated through 2θ

22. B: For a stretched string

$$f_0 = \frac{v}{2l}$$

$$\left(\frac{150}{2 \times}\right) Hz = 3.75Hz$$

$$f_1 = \frac{v}{l} = \left(\frac{150}{2}\right) Hz = 75Hz$$

OR

$$f_1 = 2f_0 = (2 \times 37.5) Hz = 75Hz$$

$$f_2 = \frac{3v}{2l} = \left(\frac{3 \times 150}{2 \times 2}\right) Hz = 112.5Hz$$

OR

$$f_2 = 3f_0$$

$$= (3 \times 37.5) Hz = 112.5Hz$$

23. A: $f = \frac{v}{\lambda}$

$$85.5 = \frac{342}{\lambda}$$

$$\lambda = \left(\frac{342}{85.5}\right) m$$

$$= 4m$$

Since what we have at the wall is the node, the required distance is the distance between a node and the adjacent antinode and this equals

$$\frac{1}{4} \times \lambda = \frac{1}{4} \times 4m = 1m$$

Note:

i) $N - N = \frac{1}{2} \lambda$

ii) $A - A = \frac{1}{2} \lambda$

iii) $N - A = \frac{1}{4} \lambda$

iv) $A - N = \frac{1}{4} \lambda$

v) $N - N - N = \lambda$

vi) $A - A - A = \lambda$

24. C: a driving mirror is a convex mirror. The focal length of a convex mirror is negative

$$r = 1m, f = \frac{r}{2} = \frac{1}{2}m. \text{ As the mirror is convex,}$$

$$f = -\frac{1}{2}m$$

Object distance, $u = 4m$, Image distance $= v = ?$

$$\frac{1}{v} = \frac{1}{u} + \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{4} + \frac{1}{-\frac{1}{2}}$$

$$= \frac{1}{4} - \frac{1}{2}$$

$$= -\frac{1}{4} + \frac{1}{2}$$

$$= \frac{1}{4}$$

$$-2 - \frac{1}{4} = \frac{1}{v}$$

$$\frac{1}{v} = \frac{-8-1}{4}$$

$$\frac{1}{v} = -\frac{9}{4}$$

$$v = \left(-\frac{4}{9}\right) m = -0.4444m \text{ (i.e. } 0.4444m \text{ behind the mirror)}$$

$$v = -\frac{4}{9} m = -0.4444m \text{ (i.e. } 0.4444m \text{ behind the mirror)}$$

25. A: The angle of dip is 0° at the equator and 90° at the pole

26. C: A satellite is said to be in a parking orbit when its period is equal to the period of the earth.

27. B: Since the two plane mirrors have their reflecting surfaces parallel to each other, the angle θ between the mirrors $= 0^\circ$

$$N = \frac{360^\circ}{\theta^\circ} - 1$$

$$= \frac{360^\circ}{0^\circ} - 1$$

$$= \infty \text{ (Infinite)}$$

28. C: Since parallel lines do not meet, the rays in a parallel beam will not meet. In other words, they will meet at infinity.

29. D: $V \propto \sqrt{\theta}$

$$V = k\sqrt{\theta}$$

$$k = \frac{V}{\sqrt{\theta}}$$

Then,

$$\frac{V_1}{\sqrt{\theta_1}} = \frac{V_2}{\sqrt{\theta_2}}$$

$$V_2 = 2V_1 \text{ (Given)}$$

Then;

$$\frac{V_1}{\sqrt{\theta_1}} = \frac{2V_1}{\sqrt{\theta_2}}$$

$$\sqrt{\theta_2} = \frac{\sqrt{\theta_1} \times 2V_1}{V_1}$$

$$\sqrt{\theta_2} = 2\sqrt{\theta_1}$$

square both sides

$$(\sqrt{\theta_2})^2 = (2\sqrt{\theta_1})^2$$

$$\theta_2 = 4\theta_1$$

30. B: Power (in diopters) =

$$\frac{1}{\text{focal length (in meters)}}$$

$$f = 50cm = \left(\frac{50}{100}\right) cm = 0.5m$$

$$P = \frac{1}{f}$$

$$= \left(\frac{1}{0.5}\right) D = 2.00D$$

31. C: $n = \frac{R.D_1}{A.D_1}$

$$\frac{4}{3} = \frac{80m}{A.D_1}$$

$$A.D_1 = \frac{3 \times 80m}{4} = 60m$$

$$A.D_1 = \frac{3 \times 80m}{4} = 60m$$

$$A.D_1 = \frac{3 \times 80m}{4} = 60m$$

Also,

$$n = \frac{R.D_2}{A.D_2}$$

$$\frac{4}{3} = \frac{60m}{A.D_2}$$

$$A.D_2 = \frac{3 \times 60m}{4} = 45m$$

Change in apparent depth $= 60m - 45m = 15m$

32. B: - If the liquid level rises, the liquid expands more than the containing vessel on heating

- If the liquid level falls, the containing vessel expands more than the liquid on heating

33. C: From Boyle's law

$$PV = K$$

P is measured in N/m^2 , V in m^3

Then,

$$PV = \frac{N}{m^2} \times m^3 = Nm$$

Note that Nm is equivalent to Joules (J), the unit of workdone. Thus, Boyle's law is equivalent to workdone.

34. C: i) $\beta = 2 \propto$

ii) $\gamma = 3 \propto$

From (i), we have:

$$\text{iii) } \alpha = \frac{\beta}{2}$$

from (ii), we have:

$$\text{iv) } \alpha = \frac{\gamma}{3}$$

equating iii & iv, we have:

$$\frac{\beta}{2} = \frac{\gamma}{3}$$

It follows that:

$$\text{v) } \beta = 2 \frac{\gamma}{3} \text{ and}$$

$$\text{vi) } \gamma = \frac{3}{2} \beta$$

35. D: The instrument used by designers to obtain different colour patterns is the kaleidoscope. It comprises two plane mirrors inclined at 60° to each other.

36. A: The two laws employed in electromagnetic induction are Faraday's law and Lenz's law. The former gives the magnitude of induced e.m.f while the latter gives the direction. It may be learnt that Lenz's law was not obtained as a result of any experiment but from the principle of conservation of mechanical energy

37. D: Weight of empty bottle = 2N

Weight of olive oil = 4N - 2N = 2N

Weight of equal volume of water = 5N - 2N = 3N

$$\text{R.D of olive oil} = \frac{\text{volume of olive oil}}{\text{weight of equal volume of water}}$$

38. D: The function of the short chain sometimes attached to the back of a petrol tank is to conduct excess charges to the earth

39. A: $n = 90, t = 10s$

$$F = \frac{n}{t} = \left(\frac{90}{10}\right) \text{ Hz} = 9 \text{ Hz}$$

OR

$$T = \frac{t}{n} = \left(\frac{10}{90}\right) \text{ s} = \frac{1}{9} \text{ s}$$

$$f = \frac{1}{T} = \left(\frac{1}{1/9}\right) \text{ Hz} = 9 \text{ Hz}$$

40. D: The ability to human eye to focus both near and distant objects on the retina is known as accommodation. Note that the power of accommodation is controlled by the ciliary muscles.

PHYSICS

2020 UTME MODEL PHYSICS QUESTIONS

1. A pendulum which has a mass of 200g is pulled sideways by a horizontal distance of 30cm. if the length of the pendulum is 50cm, calculate the potential energy of the bob in this position ($g = 10 \text{ m/s}^2$) (a) 0.2J (b) 2.0J (c) 2.2J (d) 20J
2. An object of mass 300kg and a density $\frac{600 \text{ kg}}{\text{m}^3}$ was suspended with a string so that half of it is immersed in paraffin of density $\frac{900 \text{ kg}}{\text{m}^3}$. What

is the tension in the string? ($g = 9.8 \frac{\text{m}}{\text{s}^2}$) (a)

2205N (b) 735N (c) 3000N (d) 2940N

3. A car accelerates uniformly from rest at $\frac{4 \text{ m}}{\text{s}^2}$. How far will it travel in the fifth second? (s)

100m (b) 50m (c) 32m (d) 18m

4. The quantity of an object which is a measure of its tendency to continue in motion with a steady velocity is its (a) volume (b) density (c) mass (d) weight

5. Which of the following combination will increase the stability of an object? (a) wide base and low centre of gravity (b) narrow base and low centre of gravity (c) wide base and high centre of gravity (d) narrow base and high centre of gravity

6. The physical quantity that has the same dimension as impulse is (a) momentum (b) pressure (c) energy (d) surface tension

7. A disc rotates on a platter at constant speed of 200 revolutions per minute. Determine the period of rotation. (a) 1.2s (b) 0.6s (c) 0.5s (d) 0.3s

8. A lorry travels 10km northwards, 5km eastwards, 4km southwards and then finally 5km westward. What is the total displacement (a) 24km due north (b) 6km due south (c) 6km due north (d) 4km due south

9. A rocket is held fixed so that it ejects material horizontally with a speed of $\frac{150 \text{ m}}{\text{s}}$. If it ejects a mass of $\frac{1.2 \text{ kg}}{\text{s}}$, calculate the force needed to hold it fixed. (a) 180N (b) 120N (c) 150N (d) 40N

10. A hygrometer is an instrument for measuring the (a) depth of water in a vessel (b) relative humidity of the air (c) relative density of a liquid by the method of flotation (d) relative density of liquid by finding the apparent loss in weight.

11. A simple pendulum has a period of 3.0s. determine the length of the pendulum, taking g as $\frac{9.8 \text{ m}}{\text{s}^2}$ (a) 5.0m (b) 4.0m (c) 3.5m (d) 2.3m

12. A uniform metre rule of weight 1.0N is pivoted at the 40cm mark. A weight of 2N is hung from the 15cm mark. Where must a weight of 2N be placed to balance the rule? (a) 20cm mark (b) 60cm mark (c) 50cm mark (d) 40cm mark

13. A wheel and axle is used to raise a load of 500N by the use of an effort of 250 N. determine the efficiency of the machine if the radii of the wheel and axle are respectively 0.4cm and 0.1cm (a) 60% (b) 50% (c) 40% (d) 20%

14. For what Celsius temperature is the reading on the Celsius scale equal to that on the Fahrenheit scale? (a) -80°C (b) 80°C (c) -40°C (d) 40°C

15. Which of these waves cannot be polarized? (a) sound waves (b) light waves (c) all longitudinal waves (d) all mechanical waves

16. A concave mirror of radius of curvature 20cm forms a real image four times as large as the object. The object distance is (a) 60cm (b) 40cm (c) 30cm (d) 12.5cm

17. What is the resistance that must be placed in parallel with a 25~ to make a

combined resistance of 15~ (a) 45~ (b) 37.5~ (c) 35.7~ (d) 35~

18. The distance between the object and the pinhole of a pinhole camera is reduced by a factor of 4. The size of the imaged (a) is quadrupled (b) is reduced to a quarter (c) is doubled (d) remains unchanged.

19. Which of the combinations will not produce white light after mixing? (a) Blue & magenta (b) Red, green & blue (c) Yellow & blue (d) Red & cyan

20. If a current of 4A is passed through a thin cable for two hours how much electrical energy will be converted to heat energy, given that the electrical resistance of the cable is 10 ohms? (a) 4.25MJ (b) 2.15MJ (c) 1.95MJ (d) 1.15MJ

21. Which of the following statements is true about the Coulomb's law? (a) states that the force of attraction or repulsion is directly proportional to the square of the distance between two charges. (b) states that the force of attraction or repulsion is directly proportional to the distance between two charges (c) is a square law (d) is an inverse square law

22. An object initially at a distance of 10cm from a plane mirror moves at a speed of $\frac{10 \text{ cm}}{\text{s}}$ away from the mirror. What would be the distance between the object and the image after 5s? (a) 1.2m (b) 60cm (c) 50cm (d) 20cm

23. Two mirrors in a barber's shop are on the walls opposite to each other. A man seated in between the mirrors will see how many images of himself? (a) 2 (b) 3 (c) 4 (d) Infinite

24. Which of the following pairs contains one vector and one scalar quantity? (a) Displacement and acceleration (b) force and kinetic energy (c) momentum and velocity (d) power and speed.

25. A vibrating string has a tension of 40N and produces a note of 200Hz when plucked in the middle. If the length of the string is unaltered and the tension is increased to 160N, the frequency becomes (a) 200Hz (b) 400Hz (c) 800Hz (d) 1600Hz

26. The equation of a travelling wave is given by $y = 2 \sin(4\pi x - 25\pi t)$ the frequency of the wave is (a) 1.25Hz (b) 4Hz (c) 12.5Hz (d) 50Hz

27. The process of adding impurity to a semi-conductor to increase its conductivity is called (a) doping (b) annealing (c) heating (d) hardening

28. A stone which is dropped into a dry well hits the bottom in 2.2s, how deep is the well? (a) 2.4m (b) 24.2m (c) 40.4m (d) 48.4m

29. A boy holds the end of a rubber cord from which hangs a solid metal ball, if the boy whirls the ball in a horizontal circle, keeping his hand still, in what direction will the ball move when the cord breaks? (a) Towards the hand of the boy (b) Away from his hand (c) In the direction of the tangent to the circle at the point of break (d) None of the above.

30. 50g of water at 20°C is added to 200g of water at 80°C . If properly stirred, determine the temperature of the mixture. (a) 40°C (b) 56°C (c) 68°C (d) 86°C

31. When a ray of light passes from water to glass, it is (a) bent away from the normal (b) broken into a pure spectrum (c) absorbed by the glass (d) bent towards the normal

32. The following frequencies are overtones of 140Hz , except (a) 760Hz (b) 420Hz (c) 560Hz (d) 840Hz

33. The quality of sound depends on (a) amplitude (b) frequency (c) vibration (d) harmonics

34. 250g of lead at 170°C is dropped into 100g of water at 0°C . If the final temperature is 12°C , the specific heat capacity of lead is (a) $\frac{39.5\text{J}}{\text{kg}^\circ\text{C}}$ (b) $\frac{50.4\text{J}}{\text{kg}^\circ\text{C}}$ (c) $\frac{127.6\text{J}}{\text{kg}^\circ\text{C}}$ (d) $\frac{154\text{J}}{\text{kg}^\circ\text{C}}$

35. (S.H.C of water = $\frac{4200\text{J}}{\text{kg}^\circ\text{C}}$)

36. A magnetic needle is suspended first at the earth's north magnetic pole and then at a point on the magnetic equator. The respective angles between the needle and the horizontal are (a) 0° and 0° (b) 90° and 90° (c) 0° and 90° (d) 90° and 0°

37. The linear expansivity of brass is $2 \times 10^{-5}^\circ\text{C}^{-1}$. If the volume of a piece of brass is 10cm^3 at 0°C , what will be its volume at 100°C (a) 10.06cm^3 (b) 10.04cm^3 (c) 10.02cm^3 (d) 10.20cm^3

38. The resistance of a wire depends on (a) the length of the wire (b) the diameter of the wire (c) the resistivity of the wire (d) all of the above

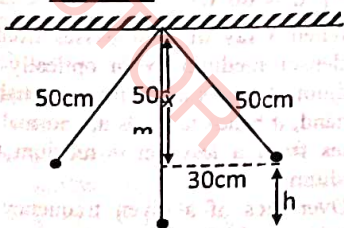
39. A given mass of an ideal gas occupies a volume V at a temperature T and under a pressure P . If the pressure is increased to $2p$ and the temperature reduced to $\frac{1}{2}T$, the percentage change in the volume of the gas is (a) 0% (b) 25% (c) 75% (d) 300%

40. When a sound wave passes from air into water its (a) speed and frequency increase but its wavelength remains the same (b) speed and wavelength increase but its frequency remains the same (c) speed decreases (d) speed remains the same but its frequency and wavelength decrease

41. A wave f frequency 10Hz forms a stationary wave pattern in a medium where the velocity is $0.2\frac{\text{m}}{\text{s}}$. Calculate the distance between adjacent nodes (a) 1.0cm (b) 2.0cm (c) 1.5cm (d) 3.0cm

SOLUTION

1. A: Method 1



Using Pythagoras theorem

$$50^2 = x^2 + 30^2$$

$$2500 = x^2 + 900$$

$$x^2 = 2500 - 900 = 1600$$

$$x = \sqrt{1600} = 40\text{cm}$$

$$x + h = 50\text{cm}$$

$$h = 50\text{cm} - x$$

$$= 50\text{cm} - 40\text{cm}$$

$$= 10\text{cm}$$

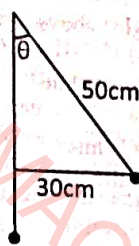
$$= \left(\frac{10}{100}\right)m = 0.1\text{m}$$

$$m = 200\text{g} = \left(\frac{200}{1000}\right)\text{kg} = 0.2\text{kg}$$

$$P.E = mgh$$

$$= (0.2 \times 10 \times 0.1)\text{J}$$

Method 2



$$\sin \theta = \frac{30\text{cm}}{50\text{cm}} = 0.6$$

$$\theta = \sin^{-1} 0.6 = 36.8699^\circ, R = 50\text{cm} = 0.5\text{m}$$

$$P.E = mgR(1 - \cos \theta)$$

$$= 0.2 \times 10 \times 0.5(1 - \cos 36.8699^\circ)$$

$$= 0.2 \times 10 \times 0.5(1 - 0.8)$$

$$= (0.2 \times 10 \times 0.5 \times 0.2)\text{J}$$

$$= 0.2\text{J}$$

2. B: Volume of the object

$$= \frac{\text{mass}}{\text{Density}} = \frac{300\text{kg}}{\frac{600\text{kg}}{\text{m}^3}} = 0.5\text{m}^3$$

$$\text{Volume immersed} = \frac{1}{2} \times 0.5\text{m}^3 = 0.25\text{m}^3$$

$$\text{Upthrust} = \rho_{\text{liq}} V_{\text{immersed}} g$$

$$= (900 \times 0.25 \times 9.8)\text{N}$$

$$= 2,205\text{N}$$

$$\text{Weight of object} = mg$$

$$= (300 \times 9.8)\text{N}$$

$$= 2,940\text{N}$$

$$\text{Tension in the string} = (2,940 - 2,205)\text{N}$$

$$= 735\text{N}$$

NB

The volume of the liquid displaced equals the volume of the object immersed.

3. D: $u = 0, a = 4\frac{\text{m}}{\text{s}^2}$

When $t = 4\text{s}$

$$s = ut + \frac{1}{2}at^2$$

$$= 0 \times 4 + \frac{1}{2} \times 4 \times 4^2$$

$$= \left(\frac{1}{2} \times 4 \times 16\right)\text{m}$$

$$= 32\text{m}$$

When $t = 5\text{s}$

$$s = ut + \frac{1}{2}at^2$$

$$= 0 \times 5 + \frac{1}{2} \times 4 \times 5^2$$

$$= \left(\frac{1}{2} \times 4 \times 25\right)\text{m}$$

$$= 50\text{m}$$

Thus, the distance covered in the fifth second =

$$50 - 32\text{m} = 18\text{m}$$

4. C: The tendency of a body to continue in motion with a steady velocity (or to continue to be at rest if it is at rest) is known as its inertia. The physical property upon which inertia depends is mass.

5. A: • The wider the base of a body, the more stable it is (and vice-versa).

• The lower the position of centre of gravity of a body, the more stable it is (and vice-versa)

6. A: Impulse = force \times time

$$= \text{mass} \times \text{acceleration} \times \text{time}$$

$$= M \times LT^{-2} \times T$$

$$= MLT^{-1}$$

Momentum = mass \times change in velocity

$$= M \times LT^{-1}$$

$$= MLT^{-1}$$

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{\text{mass} \times \text{acceleration}}{\text{Area}}$$

$$= \frac{M \times LT^{-2}}{L^2}$$

$$= ML^{-1}T^{-2}$$

Energy = workdone = force \times distance

$$= \text{mass} \times \text{acceleration} \times \text{distance}$$

$$= M \times LT^{-2} \times L$$

$$= ML^2T^{-2}$$

Thus, it is momentum that has the same dimension as impulse. Confirm by yourself that the dimension of surface tension is MT^{-2} .

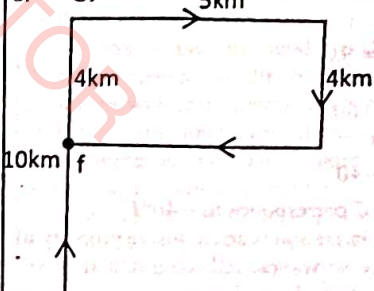
7. D: Speed = 200 revolutions per minute since frequency is the number of revolutions completed in one second,

$$F = \left(\frac{200}{60}\right)\text{Hz} = 3.3333\text{Hz}$$

$$T = \frac{1}{F}$$

$$= \left(\frac{1}{3.3333}\right)\text{s} = 0.3\text{s}$$

8. C:



Displacement = $(10\text{km} - 4\text{km})$ due north

$$= 6\text{km due north}$$

9. A: Force on the engine of a rocket = mass

(M) of

fuel per second \times Velocity (V) of exhaust gas

$$F = M \times V$$

$$= (1.2 \times 150)\text{N}$$

$$= 180\text{N}$$

10. B: A hygrometer is for measuring relative humidity while a hydrometer is for measuring the relative density of a liquid

(by the method of flotation)

11. D: $T = 3.0\text{s}, g = 9.9\frac{\text{m}}{\text{s}^2}$

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$3 = 2 \times 3.142 \times \sqrt{\frac{L}{9.9}}$$

$$3 = 6.284 \sqrt{\frac{L}{9.9}}$$

Divide both sides by 6.284

$$\sqrt{\frac{L}{9.9}} = \frac{3}{6.284}$$

$$\sqrt{\frac{L}{9.9}} = 0.4774$$

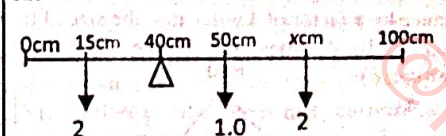
Square both sides

$$\left(\sqrt{\frac{L}{9.9}}\right)^2 = 0.4774^2$$

$$\frac{L}{9.9} = 0.2279$$

$$L = (9.9 \times 0.2279)\text{m} = 2.2562\text{m} = 2.3\text{m}$$

12. B:



Clockwise moment = Anticlockwise moment

$$1 \times (50 - 40) + 2 \times (x - 40)$$

$$= 2 \times (40 - 15)$$

$$10 + 2x - 80 = 2 \times 25$$

$$10 + 2x - 80 = 50$$

$$2x = 50 + 80 - 10 = 120$$

$$x = \frac{120}{2} = 60$$

Hence, the 2N weight must be placed at the 60cm mark

13. B: Load=500N, Effort=250N

$$M.A = \frac{\text{load}}{\text{Effort}} = \frac{500N}{250N} = 2.0$$

$$\text{Velocity ratio} = \frac{\text{Radius of wheel}}{\text{Radius of axle}}$$

$$= \frac{0.4cm}{0.1cm} = 4.0$$

$$\epsilon = \frac{M.A}{V.R} \times 100\%$$

$$= \frac{2}{4} \times 100\% = 50\%$$

14. C: $\frac{F-32}{9} = \frac{C}{5}$

Let the temperature at which the two scales give equal reading be X. then,

$$\frac{x-32}{9} = \frac{x}{5}$$

$$5(x-32) = 9x$$

$$5x - 160 = 9x$$

$$5x - 9x = 160$$

$$-4x = 160$$

$$x = \frac{160}{-4} = -40$$

Thus, $-40^\circ C$ corresponds to $-40^\circ F$

15. C: Polarization is an exclusive property of transverse waves. All longitudinal waves cannot be polarized.

16. D: $f = \frac{v}{\lambda} = \frac{20cm}{2} = 10cm$

$$M = 4$$

$$M = \frac{v}{u}, 4 = \frac{v}{u}, v = 4u$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{10} = \frac{1}{u} + \frac{1}{4u}$$

$$\frac{1}{10} = \frac{4+1}{4u}, \frac{1}{10} = \frac{5}{4u}$$

$$u = \left(\frac{10 \times 5}{4}\right) cm = 12.5cm$$

17. B: Let the required resistance be x. since the connection is in parallel,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \text{ Then}$$

$$\frac{1}{15} = \frac{1}{25} + \frac{1}{x}$$

$$\frac{1}{x} = \frac{1}{15} - \frac{1}{25}$$

$$\frac{1}{x} = \frac{5-3}{75}$$

$$\frac{1}{x} = \frac{2}{75}, x = \left(\frac{75 \times 1}{2}\right) \approx 37.5$$

OR

$$R = \frac{R_1 \times R_2}{R_1 + R_2}$$

$$15 = \frac{25 \times x}{25 + x}$$

$$25x = 375 + 15x$$

$$25x - 15x = 375$$

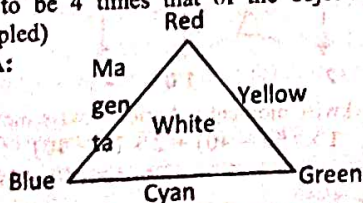
$$10x = 375$$

$$x = \frac{375}{10} = 37.5$$

18. A: $M = \frac{v}{u}$

Since magnification (M) varies inversely as the object distance (u), the reduction of the object distance by a factor of 4 will cause the size of the image to be 4 times that of the object. (i.e. quadrupled)

19. A:



From the colour triangle above, it can be deduced that:

- Red + Green + Blue = White
- Red + cyan = White
- Green + Magenta = White
- Blue + Yellow = White

20. D: $I = 4A$

$$R = 10\Omega$$

$$t = 2hrs$$

$$= (2 \times 3600)s$$

$$= 7200s$$

$$H = I^2 R t$$

$$= (4^2 \times 10 \times 7200)J$$

$$= 1152000J = \left(\frac{115200}{1000000}\right) MJ$$

$$= 1.152MJ$$

21. D: Coulomb's law states that the force of attraction or repulsion between two charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charges.

22. A: Hint: If the object is at a distance X from a plane mirror, the image will also be at distance x at the back of the mirror. If the object is moved away at $\frac{10cm}{s}$ for 5s total change in

$$\text{distance} = \frac{10cm}{s} \times 5s = 50cm$$

Since the object is initially at 10cm from the plane mirror, the object distance, $u = 50cm + 10cm = 60cm$

Also, the distance of the image from the mirror (at the back of the mirror) = 60cm.

Thus, the distance between the object and the image = 60cm + 60cm

$$= 120cm$$

$$= \left(\frac{120}{100}\right) m$$

$$= 1.2m$$

23. D: For two mirrors that are exactly opposite each other, the angle (θ) between them = 0°

(N= Number of images formed when an object is place between two mirrors inclined at θ to each other) $N = \frac{360}{\theta} - 1 = \frac{360}{0} - 1 = \infty$

24. B: Kinetic energy, power and speed are scalar quantities while displacement, acceleration, force, momentum and velocity are vector quantities.

25. B: $F = \frac{1}{21} \sqrt{T}$

From the equation above, $F \propto \sqrt{T}$

Then,

$$\frac{F_1}{\sqrt{T_1}} = \frac{F_2}{\sqrt{T_2}}$$

$$T_1 = 40N, F_1 = 200Hz, T_2 = 160N, F_2 = ?$$

$$\frac{200}{\sqrt{40}} = \frac{F_2}{\sqrt{160}}$$

$$F_2 = \frac{200 \times \sqrt{160}}{\sqrt{40}}$$

$$= 200 \times \sqrt{\frac{160}{40}}$$

$$= 200 \times \sqrt{4}$$

$$= (200 \times 2) Hz$$

$$= 400 Hz$$

26. C: $y = 2 \sin(4\pi x - 25\pi t)$

When compared to $y = A \sin\left(\frac{2\pi x}{\lambda} - 2\pi f t\right)$, it

follows that $2\pi f t = 25\pi t$

$$F = \frac{25\pi t}{2\pi t} = \left(\frac{25}{2}\right) Hz = 12.5 Hz$$

27. A: The process of adding impurity to a semi conductor to increase its conductivity is known as **doping**.

The resulting semiconductor is known as an extrinsic or impure semiconductor.

A semiconductor to which no impurity has been added is known as the intrinsic or pure conductor.

28. B: $t = 2.2s, u = 0, a = 10 \frac{m}{s^2}, s = ?$

$$s = ut + \frac{1}{2} at^2$$

$$= 0 \times 2.2 + \frac{1}{2} \times 10 \times 2.2^2$$

$$= \left(\frac{1}{2} \times 10 \times 4.84\right) m$$

$$= 24.2m$$

Method 2

$$V = u + at$$

$$= 0 + 10 \times 2.2$$

$$= 22 \frac{m}{s}$$

$$V^2 = u^2 + 2as$$

$$22^2 + 0^2 + 2 \times 10 \times s$$

$$484 = 20s$$

$$s = \left(\frac{484}{20}\right) m = 24.2m$$

Method 3

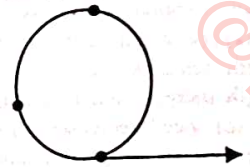
$$s = \left(\frac{u+v}{2}\right) t$$

$$= \left(\frac{0+22}{2}\right) \times 2.2$$

$$= 11 \times 2.2$$

$$= 24.2m$$

29. C: When the cord breaks, the stone will move in the direction of the tangent to the circle at the point of the break.



30. C: Let the temperature of the mixture be x. from the principle of calorimetry

$$M_1 C_1 \Delta\theta_1 = M_2 C_2 \Delta\theta_2$$

$$50 \times C_w \times (x - 20) = 200 \times C_w \times (80 - x)$$

$$50(x - 20) = 200(80 - x)$$

$$50x - 1000 = 16000 - 200x$$

$$50x + 200x = 16000 + 1000$$

$$250x = 17,000$$

$$x = \left(\frac{17,000}{250}\right)^\circ C = 68^\circ C$$

31. D: When a ray of light passes from an optically denser medium to an optically less dense medium, it bends away from normal, on the other hand, it bends towards the normal if it passes from a less dense medium to a denser medium.

32. A: Overtones of a given frequency are whole number multiples of the frequency. In other words, the overtone of a frequency must be a value that the frequency can divide, leaving no remainder.

$$\frac{840Hz}{140Hz} = 6$$

$$\frac{140Hz}{560Hz} = 4$$

$$\frac{140Hz}{420Hz} = 3$$

$$\frac{140Hz}{760Hz} = 5 \text{ Remainder } 80$$

$$\frac{140Hz}{140Hz} = 1$$

$$\frac{140Hz}{140Hz} = 1$$

$$\frac{140Hz}{140Hz} = 1$$

Thus, 750Hz is the only one that is not an overtone of 140Hz.

33. D: • The pitch of a note depends on its frequency

• The quality/timbre depends on the overtone/harmonics

• The loudness depends on the amplitude

34. C: Heat lost by lead = Heat gained by water

$$M_{lead}C_{lead}\Delta\theta_{lead} = M_{water}C_{water}\Delta\theta_{water}$$

$$M_{lead} = 250g = \left(\frac{250}{1000}\right)kg = 0.25kg$$

$$M_{water} = 100g = \left(\frac{100}{1000}\right)kg = 0.1kg$$

$$0.25 \times C_{lead} \times (170 - 12) = 0.1 \times 4200 \times (12 - 0)$$

$$0.25 \times C_{lead} \times 158 = 5040$$

$$39.5C_{lead} = 5040$$

$$C_{lead} = \left(\frac{5040}{39.5}\right)\frac{J}{kg^{\circ}C}$$

$$= 127.59\frac{J}{kg^{\circ}C}$$

$$= 127.6\frac{J}{kg^{\circ}C}$$

35. D: The angle between the direction of the earth's resultant magnetic field and the horizontal is known as the angle of dip (or inclination). The angle of dip is -90° poles and 0° at the equator

36. A: $V_2 = V_1(1 + 3 \alpha \Delta\theta)$

$$= 10cm^3(1 + 3 \times 2 \times 10^{-5} \times 100)$$

$$= 10cm^3(1.006)$$

$$= 10.06cm^3$$

37. D: From the formula $R = \frac{\rho l}{A}$, it can be deduced that the resistance of a wire depends on its resistivity (ρ), length (l) and area. Note immediately that area also depends on diameter.

NB: Resistance of a wire also depends on its temperature.

38. C: $P_1 = P, P_2 = 2p$

$$T_1 = T, T_2 = \frac{1}{2}T$$

$$V_1 = V, V_2 = ?$$

Using the general gas equation

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{P \times V}{T} = \frac{2P \times V_2}{\frac{1}{2}T}$$

$$\frac{P \times V}{T} = \frac{2P \times V_2 \times 2}{T}$$

$$V_2 = \frac{P \times V \times T}{2P \times 2 \times T} = \frac{V}{4} = 0.25V$$

$$\text{Change in volume} = V - 0.25V$$

$$= 0.75V$$

$$\% \text{ change in volume} = \frac{0.75V}{V} \times 100\%$$

$$= 75\%$$

39. B: Only the speed and the wave length of a wave change as it passes from one medium to another; the frequency remains unaltered.

$$40. A: \lambda = \frac{v}{f} = \left(\frac{0.2}{10}\right)m$$

$$= 0.02m$$

$$= (0.02 \times 100)cm$$

$$= 2cm$$

Distance between adjacent nodes,

$$\frac{\lambda}{2}$$

$$= \frac{2cm}{2} = 1.0cm$$

PHYSICS

2019 UTME MODEL PHYSICS

QUESTIONS

1. A particular metal has a work function of 2.0eV. if light of wave-length 151nm falls on it,

the maximum energy of the photo electron emitted is (a) $3.2 \times 10^{-19}J$ (b) $9.972 \times 10^{-19}J$ (c) $1.3172 \times 10^{-18}J$ (d) $1.51 \times 10^{-19}J$

2. The efficiency of a machine is 75%. If the machine can overcome a force of 6000N with another force of 2000N, what is the velocity of the machine? (a) 4 (b) 5 (c) 3 (d) 2

3. Calculate the angle of minimum deviation when light is refracted through an equilateral triangular prism of refractive index 1.5 (a) 40° (b) 37° (c) 40.2° (d) 37.2°

4. A force of 14N is applied to a spring of stiffness 220N/m. Calculate the energy stored in the spring. (a) 3080J (b) 15.71J (c) 0.4455J (d) 0.02835J

5. Two forces \vec{X} and \vec{Y} act on an object. The angle between the forces is 30° . Given that the magnitude of \vec{X} is 15N while that of the resultant is 18N, what is the magnitude of \vec{Y} ? (a) 3.375N (b) 4.47N (c) 2.0142N (d) 5.59N

6. For a body executing simple harmonic motion, it is true that (a) the velocity is maximum at the equilibrium position (b) the acceleration is maximum at the equilibrium position (c) the velocity is minimum at the equilibrium position (d) the acceleration is constant throughout.

7. A little sag is left in overhead telephone wires (a) to allow for the effect of a rise in temperature due to heating effect of current flowing through them (b) to allow for the effect of a fall in temperature of the surrounding atmosphere (c) to allow for the effect of a rise in temperature of the surrounding atmosphere (d) because tact wires do not conduct sound easily.

8. Which of the following is true about electromagnetic waves? (a) they are longitudinal (b) they can be seen (c) they travel at the same speed in vacuum (d) they have the same frequency in vacuum

9. The angle of incidence in the denser medium when the angle of refraction in the less dense medium is 90° called (a) critical angle (b) refracted angle (c) optical angel (d) emergent angle.

10. A point on a stationary wave where there is no movement of the medium is called (a) crest (b) node (c) antinode (d) amplitude

11. Which of the following properties is not common to all waves? (a) reflection (b) refraction (c) diffraction (d) polarization

12. A place progressive wave is represented by $y = 2 \sin(100\pi t - 0.2\pi x)$ where all the symbols have their usual meanings. What is the velocity of the wave? (a) 100m/s (b) 200m/s (c) 500m/s (d) 400m/s

13. The angle between the earth magnetic field and the horizontal is known as the angle of (a) dip (b) declination (c) compass (d) variation

14. An organ pipe closed at one end is 110cm. What is the frequency of the fundamental note, assuming that the speed of sound in air is 330m/s? (a) 100Hz (b) 75Hz (c) 50Hz (d) 25Hz

15. A tuning fork, a violin string and a loudspeaker cone are producing sounds. This is because they are all in a state of (a) rarefaction (b) compression (c) vibration (d) amplitude

16. Two cars of equal mass moving with a velocity of 50m/s collide head-on. Calculate the

velocity of each after the collision if they stick together (a) 50m/s (b) 30m/s (c) 10m/s (d) 0m/s

17. An object of mass 200kg hangs at the end of a rope. If a $g = 9.8m/s^2$, what is the acceleration, when the tension in the rope is 2000N? (a) $20m/s^2$ (b) $25m/s^2$ (c) $0.2m/s^2$ (d) $2m/s^2$

18. An object was launched with velocity of 50m/s at an angle of 30° to the horizontal, the maximum height reached is: (a) 55m (b) 30m (c) 31.25m (d) 11.11m

19. A dynamo converts (a) mechanical energy into electrical energy (b) electrical energy into kinetic energy (c) potential energy into kinetic energy (d) kinetic energy into potential energy

20. The quality of sound depends on (a) frequency (b) harmonics (c) velocity (d) wavelength

21. Which of the following is correct? (a) metals have forbidden band gaps while semi-conductors do not (b) metal are always harder than non-metals (c) the resistance of metals decreases with temperature while reverse is the case for semi-conductors (d) the resistance of metals increases with temperature while reverse is the case for semi-conductors.

22. Which of the following is most strongly deflected by a magnetic field? (a) gamma rays (b) X-rays (c) Beta particles (d) Alpha particle

23. Three capacitors $2\mu F$, $3\mu F$ and $6\mu F$ are connected in series. If the p.d across the system is 12v, the p.d across the $6\mu F$ capacitor is (a) 4v (b) 6v (c) 12v (d) 2v

24. The purpose of a dielectric material in a parallel plate capacitor is to (a) increase its capacitance (b) decrease its capacitance (c) increase the magnetic field between them (d) increase its potential difference.

25. A boat travels due east with a speed of 40m/s across a river flowing due south at 30m/s. what is the resultant speed of the boat? (a) 1.3m/s (b) 10m/s (c) 50m/s (d) 70m/s

26. When a plane mirror at which a ray of light is incident is rotated at angle θ , the reflected ray will be rotated through (a) $\frac{1}{2}\theta$ (b) θ (c) 2θ (d) 3θ

27. In an AC circuit that contains only a capacitor, the voltage (a) leads the current by 90° (b) lags the current by 90° (c) leads the current by 180° (d) leads the current by 45°

28. If the distance between two point charges is increased by a factor of four, the magnitude of electrostatic force between them will be (a) increased to double the initial value (b) reduced to one-sixteenth the initial value (c) decreased by a quarter (d) quadrupled.

29. Which of the following is a set of vectors (a) force, mass and momentum (b) acceleration, velocity and momentum (c) mass, weight and density (d) mass, volume and density

30. A transformer has a primary coil with 500 turns and a secondary coil with 2500 turns. When the voltage input to the primary is 120v, the output is (a) 600v (b) 600v (c) 240v (d) 60v

31. If two parallel wires carry currents flowing in the same direction, the wire will (a) attract each other (b) have no effect on each other (c) repel each other (d) both move in the same direction

32. In what range of temperature is the expansion of water anomalous? (a) +20°C to +28°C (b) -8°C to 76°C (c) +96°C to 100°C (d) 0°C to 4°C
33. A certain radioactive substance has a half life of 20 years. How long will it take the activity to become $\frac{1}{4}$ of its original? (a) 20years (b) 40years (c) 60years (d) 80years
34. Two balls of masses 5kg and 10kg were dropped from a height at the same time. If the ball with the smaller mass reached the ground after 4s, the time taken by the bigger ball to reach the ground is (a) 4s (b) 2.5s (c) 8s (d) 2s
35. The dimensions of pressure and density are respectively (a) ML^{-3} & $ML^{-1}T^2$ (b) $ML^{-1}T^2$ & ML^{-3} (c) ML^{-2} & $ML^{-1}T^2$ (d) $ML^{-1}T^2$ & ML^2
36. A conducting sphere has a net charge of $-4.8 \times 10^{17}C$. What is the approximate number of excess electrons on the sphere if the fundamental natural charge is $-1.6 \times 10^{-19}C$? (a) 100 (b) 300 (c) 200 (d) 400
37. The process of adding impurity to a semiconductor to increase its conductivity is called (a) doping (b) annealing (c) heating (d) hardening
38. The electromotive force is in such a direction as to oppose the motion or charge producing it. This is a statement of (a) Faraday's law (b) Lenz's law (c) Maxwell law (d) Ampere's law
39. The transfer of energy from the sun to the Earth's surface is known as (a) evaporation (b) convection (c) radiation (d) conduction
40. The instrument used for measuring the relative humidity is known as (a) hydrometer (b) hygrometer (c) wind vane (d) anemometer

2019 PHYSICS SOLUTION

1. **B:** $W_0 = 2.0eV$
 Since $leV = 1.6 \times 10^{-19}J$,
 $2.0eV = (1.6 \times 10^{-19} \times 2)J = 3.2 \times 10^{-19}J$
 Thus, $W_0 = 3.2 \times 10^{-19}J$
 Energy of the light, $E = hf = \frac{hc}{\lambda}$
 $h = 6.63 \times 10^{-34}Js$, $C = 3 \times 10^8m/s$
 $\lambda = 151nm = 151(10^{-9})m$
 $= 1.51 \times 10^{-7}m$
 Thus,
 $E = \left(\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.51 \times 10^{-7}}\right)J = 1.3172 \times 10^{-18}J$
 Kinetic energy of the emitted photo electron is obtained by taking the work function of the metal from the total energy available in the photons.
 Then, $K.E = 1.3172 \times 10^{-18}J - 3.2 \times 10^{-19}J$
 $= 9.972 \times 10^{-19}J$
2. **A:** **KEY** \Rightarrow A machine is a device which uses a force (known as the effort) to overcome another force (known as the load). Therefore, the effort is 2000N while the load is 6000N.
 Mechanical Advantage (M.A) = $\frac{Load}{Effort}$
 $= \frac{6000N}{2000N} = 3$
 $\epsilon = \frac{M.A}{V.R} \times 100\%$
 $75\% = \frac{3}{V.R} \times 100\%$
 $V.R = \frac{3 \times 100\%}{75\%} = 4$
3. **D:** Since the prism is equilateral, the angle of prism (A) = 60°

$$n = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$1.5 = \frac{\sin\left(\frac{60+D_m}{2}\right)}{\sin\left(\frac{60}{2}\right)}$$

$$1.5 = \frac{\sin\left(\frac{60+D_m}{2}\right)}{\sin 30}$$

$$\sin\left(\frac{60+D_m}{2}\right) = 1.5 \sin 30^\circ$$

$$\sin\left(\frac{60+D_m}{2}\right) = 0.75$$

$$\frac{60+D_m}{2} = \sin^{-1}0.75 = 48.59$$

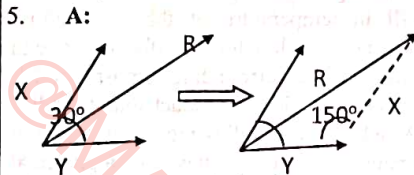
Then,
 $D_m = (2 \times 48.59) - 60 = 37$

4. **C:** $F = 14N, K = 220N/m$
 Let us find the extension using Hooke's law:
 $F = Ke$
 $e = \frac{F}{K} = \frac{14N}{220N/m} = 0.06364m$
 Energy stored in an elastic material
 $= \frac{1}{2}Fe = \frac{1}{2}Ke^2 = \frac{1}{2} \frac{F^2}{K}$

Method 1
 $E = \frac{1}{2}Fe = \left(\frac{1}{2} \times 14 \times 0.06364\right)J$
 $= 0.4455J$

Method 2
 $E = \frac{1}{2}Ke^2 = \left(\frac{1}{2} \times 220 \times 0.06364\right)J$
 $= 0.4455J$

Method 3
 $E = \frac{1}{2} \frac{F^2}{K} = \left(\frac{1}{2} \times \frac{14^2}{220}\right)J$
 $= 0.4455J$



5. **A:**
 Why is the new angle 150°? we employed the fact that the base angles of the quadrilateral are supplementary i.e. their sum must be 180°. Using cosine rule, we have:
 $R^2 = X^2 + Y^2 - 2(XY) \cos 150^\circ$
 $18^2 = 15^2 + Y^2 - 2(15Y) \cos 150^\circ$
 $324 = 225 + Y^2 - 30Y(-0.8660)$
 $324 = 225 + Y^2 + 25.98Y$
 If re-arranged, we have:
 $Y^2 + 25.98Y + 225 - 324 = 0$
 $Y^2 + 25.98Y - 99 = 0$
 Using the quadratic formula, we have:
 $Y = \frac{-25.98 \pm \sqrt{25.98^2 - 4 \times 1 \times -99}}{2(1)}$
 $Y = \frac{1.2598 \pm 32.73}{2}$
 $Y = \frac{-25.98 + 32.73}{2}$ OR $\frac{-25.98 - 32.73}{2}$
 $Y = 3.375N$ as Y cannot be negative
6. **A:** With the formulae in mind [$a = -w^2x$, and $v = w\sqrt{A^2 - x^2}$], it can be correctly deduced that:
 (i) At the equilibrium position, the acceleration is zero while the velocity is maximum
 (ii) At the extreme end, the acceleration is maximum while the velocity is zero
7. **B:** This is to allow for the effect of a fall in temperature of the surrounding atmosphere. Note well that rise in temperature causes expansion while fall in temperature causes contraction
8. **C:**

- Electromagnetic waves are transverse waves, not longitudinal waves
- They cannot be seen
 - They travel at the same speed in vacuum.
 - They have different frequencies and wavelength
- Radio wave, Infra-red, Visible light, ultra-violet X-ray, Gamma ray. Increasing frequencies decreasing wavelength.
9. **A:** The angle of incidence in the dense medium when the angle of refraction in the less dense medium is 90° is called the critical angle. Note that for total internal reflection to occur, light must travel from denser medium to a less dense medium and the angle of incidence must exceed the critical angle.
10. **B:** A point on a stationary wave where there is no movement of the medium is the *node* while a point of maximum movement is called the *antinode*.
11. **D:** Longitudinal waves cannot be polarized. Polarization is an exclusive property of transverse waves.
12. **C:** $2\pi ft = 100t$, $f = \frac{100\pi t}{2\pi t} = 50Hz$
 $\frac{2\pi x}{\lambda} = 0.2\pi x$, $\lambda = \frac{2\pi x}{0.2\pi x} = 10m$
 $V = F\lambda = (50 \times 10)m/s = 500m/s$
13. **A:**
 - The angle between the earth's magnetic field and the horizontal is the angle of *dip* or angle of *inclination*.
 - The angle between the magnetic meridian and the geographic meridian is known as the angle of *declination* or *variation*
14. **B:** For a closed pipe, the fundamental frequency,
 $f_0 = \frac{v}{4L}$
 $V = 330m/s$
 $L = 110cm = \left(\frac{110}{100}\right)m = 1.10m$
 Then,
 $f_0 = \left(\frac{330}{4 \times 1.10}\right)Hz = 75Hz$
15. **C:** They all produce sound because they are in a state of vibration. Sound is produced when there is vibration of a material medium.
16. **D:** **KEY** \Rightarrow For the cars to collide head-on; they must be travelling in opposite directions. Thus, if the cars are taking as A & B, we write:
 $M_A U_A - M_B U_B = (M_A + M_B)V$
 Where M_A & M_B refer to the masses of the cars. U_A & U_B refer to their initial speed and V refers to their common velocity after impact. Since they have equal mass, we can write:
 $M_A = M_B = x$
 Then,
 $(x \times 50) - (x \times 50) = (x + x)V$
 $50x - 50x = (2x)V$
 $0 = (2x)V$
 $V = \frac{0}{2x} = 0$
17. **C:**
-
- Resultant force = $T - mg$

$$= 2000 - 200(9.8)$$

$$= 40N$$

$$F = ma$$

$$40 = 200a, \quad a = \left(\frac{40}{200}\right)m/s^2$$

$$= 0.2m/s^2$$

18. C: Method 1

$$\Rightarrow \text{Time to reach maximum height, } t = \frac{u \sin \theta}{g}$$

$$\Rightarrow \text{Total time of flight, } T = \frac{2u \sin \theta}{g}$$

$$\Rightarrow \text{Range} = \frac{u^2 \sin 2\theta}{g}$$

$$\Rightarrow \text{Maximum height, } H_{max} = \frac{u^2 \sin^2 \theta}{2g}$$

$$= \frac{50^2 \times (\sin 30^\circ)^2}{2(10)}$$

$$= 31.25m$$

Method 2

Since the velocity is at 30° to the horizontal, the vertical component $U_y = u \sin 30^\circ = 50 \sin 30^\circ = 25m/s$.

For upward motion under gravity,

$$a = -g = -10m/s^2$$

$$s = H_{max} = ?$$

At the maximum height, $V = 0$

$$V^2 = u^2 + 2as; \quad 0^2 = 25^2 + 2(-10)H_{max}$$

$$0 = 625 - 20H_{max}$$

$$20H_{max} = 625, \quad H_{max} = \left(\frac{625}{20}\right)m = 31.25m$$

19. A: Simply put, a dynamo is a generator which converts mechanical energy into electrical energy.

20. B:

- Pitch of a sound depends on frequency
- Quality depends on overtone or harmonics
- Loudness depends on amplitude

21. D:

The resistance of metals increases with temperature while that of semi-conductors decreases.

- As temperature rises, electrical conductivity of metal decreases while that of semi-conductors increases.

22. C: Since gamma rays are not charged, they are not deflected by electric or magnetic field. Alpha particles and beta particles are deflected since they are electrically charged. However, beta particles are more deflected since they are far lighter than alpha particles.

23. D: $2\mu F \quad 3\mu F \quad 6\mu F$



$$\frac{1}{C_T} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} \quad 12V$$

$$\frac{1}{C_T} = \frac{3+2+1}{6}$$

$$\frac{1}{C_T} = \frac{6}{6}, \quad C_T = \left(\frac{6}{6}\right)\mu F = 1\mu F = 1 \times 10^{-6}F$$

$$Q_T = V_T C_T = (12 \times 1 \times 10^{-6})C$$

$$= 1.2 \times 10^{-5}C$$

For the $6\mu F$, $C = 6 \times 10^{-6}F$

$$V_6 = \frac{Q_T}{C_6} \quad (\text{Since } Q_T = Q_2 = Q_3 = Q_6)$$

$$= \frac{(1.2 \times 10^{-5})}{(6 \times 10^{-6})}V$$

$$= 2V$$

24. A: The purpose of a dielectric material is to increase the capacitance. This can be seen from the formula.

$$C = \frac{A \epsilon_0}{d}$$

C = Capacitance

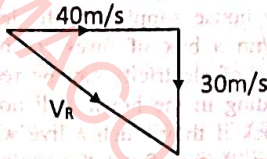
A = Area of overlap of the plates

ϵ_0 = Permittivity of free space

K = Dielectric constant

d = Separation of the two plates

25. C:



Using Pythagoras Theorem

$$V_R^2 = 40^2 + 30^2$$

$$= 1600 + 900$$

$$= 2500$$

$$V_R = \sqrt{2500} = 50m/s$$

26. C: When a plane mirror is rotated through a particular angle, with the incident ray fixed, the reflected ray will be rotated through twice the angle.

27. B:

- In an A.C circuit containing the capacitor only, the current leads the voltage by 90° or $\frac{\pi}{2}$. In other words, the voltage lags the current by 90° or $\frac{\pi}{2}$.

- In an A.C.circuit containing the inductor only, the current lags the voltage by 90° or $\frac{\pi}{2}$. In other words, the voltage leads the current by 90° or $\frac{\pi}{2}$.

28. B: From the formula $F = \frac{Kq_1q_2}{r^2}$, it follows that:

$$F \propto \frac{1}{r^2}$$

$$\text{Then, } F_1 r_1^2 = F_2 r_2^2$$

If the distance is increased to four times the initial, $r_2 = 4r_1$. Then,

$$F_1 r_1^2 = F_2 (4r_1)^2$$

$$F_1 r_1^2 = F_2 \times 16r_1^2$$

$$F_2 = \frac{F_1 r_1^2}{16r_1^2} = \frac{F_1}{16}$$

i.e. the force is reduced to one-sixteenth the original.

29. B: Scalar quantities require only magnitude for their description while vector quantities require both magnitude and direction for their description. Mass, volume and density are scalar quantities while force, weight, velocity, acceleration and momentum are vector quantities.

$$30. \quad B: \quad \frac{N_p}{N_p} = \frac{V_s}{V_p} = \frac{I_p}{I_s}$$

Then,

$$\frac{2500}{500} = \frac{V_s}{120}, \quad V_s = \left(\frac{2500 \times 120}{500}\right)V = 600V$$

31. A: When two parallel wires which are stationed close to each other have current passed through them, they exert force on each other. This is because a magnetic field is created around each wire and each lies in the magnetic field of the other. The force between the two wires will be *attractive* if the current flows in the *same* direction. If, however, the current flows in *opposite* direction, the force will be *repulsive*.

32. D: The anomalous behaviour of water occurs between $0^\circ C$ and $4^\circ C$. What is anomalous about water within this temperature range? Recall that when most liquids are heated, they

expand and when they are cooled they contract. If water is heated from $0^\circ C$ to $4^\circ C$, it contracts (instead of expansion) and when water is cooled from $4^\circ C$ to $0^\circ C$, it expands (instead of contraction). The behaviour of water is thus said to be anomalous within the temperature range.

$$33. \quad B: \quad A_0 \xrightarrow{20yrs} \frac{A_0}{2} \xrightarrow{40yrs} \frac{A_0}{4}$$

Method 2

$$A_t = A_0 - e^{-\lambda t}$$

Where, A_t = Activity at a given instant

A_0 = Original activity

$$\lambda = \text{decay constant} = \frac{0.693}{t_{1/2}}$$

$$= \frac{0.693}{20yrs} = 0.034651yr$$

When the activity becomes one-quarter of the original, it means $\frac{A_t}{A_0} = \frac{1}{4}$.

Thus,

$$\frac{A_t}{A_0} = e^{-\lambda t}, \quad \frac{1}{4} = e^{-\lambda t}$$

$$\frac{1}{4} = e^{-0.03465 \times t}$$

$$\ln \left(\frac{1}{4}\right) = -1.3863$$

$$t = \left(\frac{-1.3863}{-0.03465}\right)yrs = 40years$$

34. A: Neglecting air resistance, all objects released from the same height at the same time will reach the ground at the same time. This is because the objects experience the same acceleration (acceleration due to gravity).

$$35. \quad B: \quad \text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{\text{mass} \times \text{acceleration}}{\text{Area}}$$

$$= \frac{M \times L T^{-2}}{L^2}$$

$$= M L^{-1} T^{-2}$$

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{M}{L^3} = M L^{-3}$$

36. B: Number of electrons =

$$\frac{\text{Total charge}}{\text{Charge on an electron}} \\ = \frac{-4.8 \times 10^{-17}C}{-1.6 \times 10^{-19}C} \\ = 300$$

37. A: The process of adding impurity to a semi-conductor to increase its conductivity is called *doping*. The semi-conductor created is known as an extrinsic semi-conductor.

38. B: This is a statement of Lenz's law. It must be noted that while Faraday's law gives the magnitude of the induced emf, Lenz's law gives the direction.

39. C: The mode of heat transfer from the sun to the earth is by radiation. It must be noted that radiation is the only method of heat radiation that does not require a material medium.

40. B: Hydrometer \Rightarrow Relative density

Hygrometer \Rightarrow Relative humidity

Wind vane \Rightarrow Direction of wind

Anemometer \Rightarrow Speed of wind

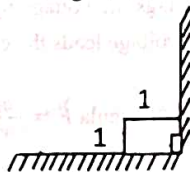
2018 UTME MODEL PHYSICS QUESTIONS

1. The coefficient of viscosity is defined as force per unit area per unit velocity. Given that the dimension of the coefficient of viscosity is $M^2 L^{-1} T^{-2}$, the values of x, y and z are (a) 1, -1, 1 (b) 0, 1, -1 (c) 1, -1, -1 (d) 1, 0, 1

2. A string is attached to a nail in the floor. A force of 20N is exerted on the nail at an angle of 30° with the horizontal, the force tending to

- bend the nail over is (a) 20N (b) 17.32N (c) 5.77N (d) 4.22N
3. A ship travels 200km to the south and then 400km to the west. Calculate the magnitude of the ship's displacement from its starting point (a) 600km (b) 200km (c) 447km (d) 401km
4. A man starts with a velocity of 15m/s and moves with a uniform acceleration of 2m/s². What distance does he cover in the fifth second (a) 100m (b) 76m (c) 176m (d) 24m
5. Which of the following is not a component of an A.C generator? (a) carbon brushes (b) commutator (c) slip rings (d) commutator
6. Calculate the instantaneous velocity at 7s of a rocket undergoing uniformly accelerated motion if the position is given by $s = 5t + 12t^2$
7. An object weighing 0.6N is hung on a spiral spring and causes it to extend by 6.0cm. The object is removed and a log of wood replacing it causes the spring to extend by 10cm. What is the weight of the wood? (a) 0.6N (b) 0.4N (c) 0.67N (d) 1.0N
8. A force of magnitude 500N is applied to the free end of a spiral spring of force constant $1.0 \times 10^4 \text{ Nm}^{-1}$, the energy stored in the stretched spring is (a) 12.5J (b) 25J (c) $5 \times 10^6 \text{ J}$ (d) $2.5 \times 10^6 \text{ J}$
9. A solid metal cube of side 10cm is heated from 10°C to 60°C. If the linear expansivity of the metal is $1.2 \times 10^{-5} \text{ K}^{-1}$, calculate the increase in its volume /C (a) 1000cm³ (b) 1.8cm³ (c) 1001.8cm³ (d) 998.2cm³
10. A body of mass 5kg is held at a height of 10m above the ground, what is its potential energy (a) 1000J (b) 600J (c) 500J (d) 250J
11. If a body of mass m is thrown vertically upwards with velocity v, at what height will the potential energy be equal to the kinetic energy (a) $h = \frac{v^2}{g}$ (b) $h = \frac{v^2}{4g}$ (c) $h = \frac{2v^2}{g}$ (d) $h = \frac{v^2}{2g}$
12. A cell whose internal resistance is 0.5Ω delivers a current of 4A to an external resistor. The lost voltage of the cell is (a) 2v (b) 1.25v (c) 9v (d) 11v
13. A cell supplies current of 0.6A and 0.2A through 1.0Ω and 4.0Ω resistors respectively. What is the internal resistance of the cell (a) 4Ω (b) 2Ω (c) 1Ω (d) 0.5Ω
14. On which physical property does the inertia of a body depend? (a) mass (b) distance (c) gravity (d) velocity
15. An electric lamp is rated 240v, 40W. What is the cost of running the lamp for 72hrs if electricity costs ₦2.50 per kwh (a) ₦3.6 (b) ₦720 (c) ₦7.20 (d) ₦360
16. The period of oscillation of a particle executing simple harmonic motion is 4π seconds. If the amplitude of oscillation is 3.0m, calculate the maximum speed of the particle (a) 4.5m/s (b) 1.5m/s (c) 6m/s (d) 0.17m/s
17. Which of the following can stop gamma ray? (a) paper (b) aluminium (c) copper (d) lead
18. The change in frequency of sound due to the motion of the source or/and the observer is known as (a) reflection (b) reverberation (c) Doppler's effect (d) total internal reflection
19. The pitch of a sound depends on (a) frequency (b) quality (c) overtone (d) loudness
20. An immersion heater rated 400W, 220V is used to heat a liquid of mass 0.5kg. If the temperature of the liquid increases uniformly at

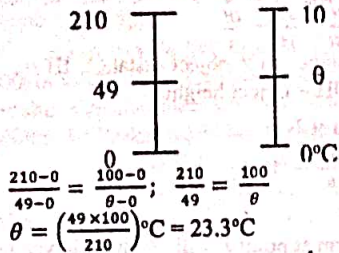
- the rate of 2.5°C per second, calculate the specific heat capacity of the liquid (a) 5.1Jkg⁻¹K⁻¹ (b) 320Jkg⁻¹K⁻¹ (c) 400Jkg⁻¹K⁻¹ (d) 111Jkg⁻¹K⁻¹
21. The amount of heat required to raise the temperature of a body is Δ . thermal energy B. thermal conduction C. heat lost D. specific heat capacity E. thermal capacity.
22. Every house supplied with electricity is provided with a box of fuses so that A. the consumption of electricity can be recorded B. people residing in the house will not have an electric shock if they touch a live wire C. the total current drawn from the mains can be limited D. the voltage supply can be stabilised E. it serves as a standby supply when there is a power failure.
23. A herdsman yelling out to fellow herdsman heard his voice reflected by a cliff 4s later: What is the velocity of sound in air if the cliff is 680m away? A. 170ms⁻¹ B. 136ms⁻¹ C. 340ms⁻¹ D. 680ms⁻¹ E. 510ms⁻¹.
24. An object 1cm high placed on the axis 15cm from a converging lens forms an image 30cm from the lens. The size of the image is A. 0.5 cm B. 1.5 cm C. 3 cm D. 2.5 cm E. 2 cm.
25. An object is positioned between two plane mirrors inclined at right angles to each other. The object is 1 unit distance from each mirror. The number of images formed is A. 1 B. 2. C. 3 D. 4 E. 5.



26. Suppose a car travelling at a uniform speed, sounds its horn at point Y while moving towards X in the above figure. Assuming there is no wind, which of the following observations is correct? A. The man at point X will receive a lower pitch B. The driver at point Y will receive a lower pitch C. The man at point Z will receive a lower pitch D. The pitch will be the same at points X and Z E. None of the above.
27. A magnet is similar to a bipolar charged system in that A. it consists of two opposite poles — the north and south poles B. the earth's magnetic field has a south pole near the geographic north pole and a north pole near the geographic south pole C. the force of attraction and repulsion between opposite and between like poles obeys a law identical in form to Coulomb's law for electrostatic charges D. A and B only E. A and C only
28. A given quantity of heat increases the temperature of 150grams of water from 9°C to 15°C and increases the temperature of an equal volume of oil weighing 100 grams from 9°C to 25°C. The ratio of the specific heat of oil to that of water is A. 0.36 B. 0.46 C. 0.56 D. 0.76 E. 0.86
29. The motion of the moving skin of a talking drum can rightly be described as A. translational B. random C. rotational D. oscillatory E. transitory
30. Which of the following statements is NOT true of the image in a plane mirror? The image is A. the same size as the object B. laterally inverted C. virtual D. magnified E. the same

- distance behind the mirror as the object is in front.
31. A man stands on a spring scale placed in a lift. The lift descends at constant velocity. As a result, the scale reads a weight A. greater than the weight of the man B. the same as the weight of the man C. of zero D. less than the weight of the man E. greater than the weight of the man by 1kg.
32. One of the following readings represents the measurement of the length of a metal rod using vernier callipers. Taking the reading accuracy into consideration, the most likely one is A. 5.16cm B. 5.165cm C. 5.0cm D. 5.160cm E. 5cm
33. The tyre pressure of a car was found to be 150cm Hg in the morning at a temperature of 27°C. Hard driving in the afternoon raised the temperature of the tyres to 57°C. The tyre pressure had by the afternoon A. increased by 15.0cm Hg B. decreased by 15.0cm Hg C. increased by 22.50cm Hg D. decreased by 22.50cm Hg E. remained constant.
34. Which of the following machines does NOT apply the lever principle? A. Claw hammer B. Wheel barrow C. Single moving pulley D. Sugar tongs E. Nutcrackers
35. Which of the following statements is NOT true of γ -rays? A. γ -rays belong to the electromagnetic spectrum B. γ -rays do not carry an electron charge C. γ -rays obey the inverse cube law in air D. The thickness of aluminium which stops β -particles has a negligible effect on γ -radiation. E. The difference between γ -rays and X-rays is that γ -rays originate from energy changes in the nuclei of atoms, while X-rays come from energy charges associated with the electron structure of atoms.
36. The distance travelled by a particle starting from rest is plotted against the square of the time elapsed from the commencement of motion. The resulting graph is linear, the slope of this graph is a measure of A. initial displacement B. initial velocity C. acceleration D. half the acceleration E. half the initial velocity
37. The lower and upper fixed points marked on a mercury-in-glass thermometer are 210mm apart. The end of the mercury column in the tube is 49mm above the lower fixed point in a room. What is the temperature of the room in degrees Celsius? A. 55.3°C B. 23.3°C C. 49.0°C D. 16.1°C E. 76.7°C
38. A given mass of an ideal gas occupies a volume V at a temperature T and under a pressure P. If the pressure is increased to 2P and the temperature reduced to $\frac{1}{2}T$, then the percentage change in the volume of the gas is A. 0% B. 25% C. 75% D. 300% E. 400%
39. Normal atmospheric pressure at sea-level is 10^5 Nm^{-2} and the acceleration due to gravity is approximately 10ms⁻². If the atmosphere has a uniform density of 1kg m⁻³, its height is A. 100m B. 1000m C. 10000m D. 100 000m E. 1000 000m
40. Radio waves have a velocity of $3 \times 10^8 \text{ ms}^{-1}$. A radio station sends out a broadcast on a frequency of 800KHz. The wavelength of the broadcast is A. 375.0 m B. 267.0m C. 240.0m D. 37.5m E. 26.7m

37. B:



38. C: $V_2 = \frac{P_1 V_1 T_2}{P_2 T_1} = \frac{P \times V \times \frac{1}{2} T}{2P \times T} = \frac{V \times \frac{1}{2}}{2} = \frac{V}{4}$

Change in volume = $v - \frac{V}{4} = \frac{3V}{4}$
 % change in volume = $\frac{\frac{3V}{4}}{V} \times 100\%$
 $= \frac{3}{4} \times 100\% = 75\%$

39. C: $P = h\rho g$

$h = \frac{P}{\rho g} = \frac{10^5}{1 \times 10} = 10^4 \text{m}$

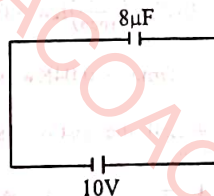
40. A: $\lambda = \frac{v}{f} = \left(\frac{3 \times 10^8}{800 \times 10^3}\right) \text{m} = 375 \text{m}$

2017 UTME MODEL PHYSICS QUESTIONS

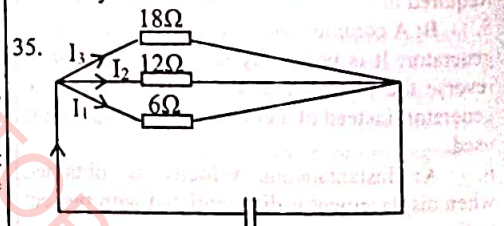
- A waterfall is 42m high, calculate the difference in temperature of the water between the top and bottom of the waterfall assuming no heat is lost. [specific heat capacity of water = $4.20 \times 10^3 \text{Jkg}^{-1}\text{K}^{-1}$, $g = 10 \text{m/s}^2$] A. 1.0°C B. 42.0°C C. 4.2°C D. 0.1°C
- A body When slightly displaced is said to be in neutral equilibrium only if it tends to A. come to rest in a new position with centre of gravity and height remaining unchanged B. return to its original position C. remain in its displaced position D. move further away from its original position while its centre of mass changes.
- A string of length 5m is extended by 0.04m when a load of 0.8kg is suspended at the end. How far will it extend if a force of 16N is applied? [$g = 10 \text{m/s}^2$] A. 0.04m B. 0.12 C. 0.01m D. 0.08m
- Which of the following has negligible mass? A. Protons B. Gamma rays C. Beta particles D. Alpha particles
- How can energy loss be minimized through Eddy-current? A. By using high resistance wire B. By using insulated soft iron wires C. By using low resistance wires D. By using turns of wires
- Calculate the upthrust on an object of volume 50cm^3 which is immersed in liquid of density 10^3kgm^{-3} . [$g = 10 \text{m/s}^2$] A. 0.8N B. 2.5N C. 0.5N D. 1.0N
- Which of the following would appear when a white screen is illuminated by red and green light? A. Red B. Purple C. Yellow D. Green
- I. Refraction II. Interference III. Diffraction. Which of the above properties are common to all waves? A. II and III only B. I, II and III C. I and II only D. I and III only
- Calculate the electric field intensity between two plates of potential difference 6.5V when separated by a distance of 35cm A. 18.57NC^{-1} B. 53.06NC^{-1} C. 2.28NC^{-1} D. 0.80NC^{-1}
- The distance between the image and the object in a plane mirror is 40cm, if the distance

- of the object is reduced by 9.2cm, what is the distance of the object from the mirror? A. 17.50m B. 15.50m C. 18.50m D. 16.50m
- Find the potential energy of an object of mass 10kg placed on a building floor 10m above the ground level. [$g = 10 \text{m/s}^2$] A. 10,000J B. 5,000J C. 100J D. 1,000J
 - The volume of a fixed mass of gas is 10cm^3 when its pressure is 400cmHg. Determine the volume of the gas when its pressure is 200cmHg. A. 30cm^3 B. 40cm^3 C. 50cm^3 D. 20cm^3
 - The product PV where P is pressure and V is volume has the same unit as A. impulse B. power C. force D. work
 - What is the cost of running seven 40W lamps and five 80W lamps for 12 hours if the electrical energy cost ₦7.00kWhr? A. ₦80.000 B. ₦45.36 C. ₦65.00 D. ₦57.12
 - The thermal expansion of a solid is an advantage in A. Balance wheel of a watch B. Construction of steel rail lines C. Construction of large steel bridges D. Fitting of tyres on wheels
 - Calculate the specific latent heat of vapourization of steam if $1.13 \times 10^6 \text{J}$ of heat energy is required to convert 15kg of it to water A. $7.53 \times 10^3 \text{Jkg}^{-1}$ B. $7.53 \times 10^2 \text{Jkg}^{-1}$ C. $7.53 \times 10^4 \text{Jkg}^{-1}$ D. $7.53 \times 10^3 \text{Jkg}^{-1}$
 - A stationary wave pattern is formed by a wave of frequency 401Hz and velocity 60cms^{-1} . What is the distance between adjacent nodes? A. 0.33cm B. 1.50cm C. 0.67cm D. 0.75cm
 - Calculate the height of the image formed by a pinhole camera of length 12cm used to photograph an object 60cm away from the hole and 70cm high A. 10cm B. 16cm C. 5cm D. 14cm
 - From the diagram above, calculate the energy stored in the capacitor A. $4.0 \times 10^{-2} \text{J}$ B. $4.0 \times 10^{-4} \text{J}$ C. $8.0 \times 10^{-4} \text{J}$ D. $8.0 \times 10^{-2} \text{J}$
 - Which of the following is a scalar quantity A. Tension B. Weight C. Impulse D. Mass
 - Calculate the time taken for a mango fruit that fall from the tree 20m to the ground. [$g = 10 \text{m/s}^2$] A. 5s B. 10s C. 4s D. 2s
 - Which of the following instruments is most appropriate in the measurement of the thickness of a piece of paper? A. Spherometer B. Metre rule C. Micrometer screw gauge D. Vanier calipers
 - What is the energy of a radiation that has the frequency of $8.2 \times 10^{16} \text{Hz}$, [$h = 6.63 \times 10^{-34} \text{Js}$] A. $5.44 \times 10^{-17} \text{J}$ B. $1.24 \times 10^{18} \text{J}$ C. $5.44 \times 10^{-18} \text{J}$ D. $1.24 \times 10^{17} \text{J}$
 - Under what conditions are cathode rays produced in a discharge tube? A. High pressure and low voltage B. High pressure and high voltage C. Low pressure and low voltage D. Low pressure and high voltage
 - Why do soldiers march disorderly while crossing a bridge A. To prevent resonance on the bridge B. To set the bridge into resonance C. To

- make the bridge collapse D. To spread their weight evenly on the bridge
- In a pure inductive and capacitive circuit, where is all the energy stored when the current is at the peak? A. In both the inductor and the capacitor B. In the capacitor C. In the entire circuit D. In the inductor
 - Calculate the voltage across a $5 \mu\text{F}$ capacitor connected to an ac source of frequency $50/\pi \text{Hz}$ when a current of 0.25A flows through the circuit. A. 1591.3V B. 2000.0V C. 500.0V D. 397.8V
 - If silicon is doped with phosphorous, what type of semiconductor material will be formed? A. Zener material. B. p-n junction C. n-type D. p-type
 - A block and tackle pulley arrangement has 6 pulleys in which an effort of 50N supports a load of 200N, calculate the efficiency of the machine. A. 80.0% B. 76.6% C. 66.7% D. 60.7%
 - Which of the following is an advantage of a thermoelectric thermometer? A. It is no suitable for measurement of rapid changes in temperature B. It is sensitive C. It is very fragile D. It is not very accurate.
 - Determine the focal length of thin converging lens if the power is 5.0 dioptries A. 0.1m B. 0.2m C. 2.0m D. 2.5m
 - Which of the following statements about magnetism is true? A. iron fillings will concentrate mainly round the ends of a bar magnet. B. Loadstone is a nonmagnetic materials C. Like poles attract D. A freely suspended bar magnet comes to rest in the geographic north-south direction
 - Calculate the force on a 5m long stiff wire carrying a current of 8A and lying in a direction at 30° to a magnetic field of magnetic flux density 0.6T? A. 30N B. 10N C. 12N D. 15N
 - Which of the following is correct about an electric cell? A. Primary cell produces a large current for a long time B. Secondary cell has a very high internal resistance C. Primary cell has a very low internal resistance D. Secondary cell has a very low internal resistance



From the diagram above, calculate the energy stored in the capacitor A. $4.0 \times 10^{-2} \text{J}$ B. $4.0 \times 10^{-4} \text{J}$ C. $8.0 \times 10^{-4} \text{J}$ D. $8.0 \times 10^{-2} \text{J}$



From the diagram $\epsilon = 12 \text{V}$, calculate the total current in the circuit. A. 5.0A B. 3.7A C. 4.5A D. 4.0A

- Calculate the angle of minimum deviation of a 60° prism of a refractive index 1.5 [$\sin^{-1} 0.75 = 49^\circ$] A. 38.00° B. 19.47° C. 16.25° D. 49.00°
- Which of the following statements is NOT correct? A. Molecules of a liquid are stationary B. Brownian motion is an evidence of particle nature matter C. Matter is made up of molecules D. The molecules of matter are in constant motion
- Which of the following is NOT part of the electromagnetic spectrum? A. Alpha particle B. Gamma ray C. Infrared ray. D. Radio wave

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2 \times \pi \times \frac{50}{\pi} \times 5 \times 10^{-6}} = 2000 \Omega$$

$$V = IX_C = (0.25 \times 2000)V = 500V$$

28. C: When a pentavalent atom (such as phosphorus) is added to a pure semi-conductor, a negative type (n-type) semi-conductor will be formed. On the other hand, if a trivalent atom (such as boron) is added to a pure semi-conductor, a positive type (p-type) semi-conductor is formed.

29. C: V.R = Number of pulleys = 6

Effort = 50N, Load = 200N

$$M.A. = \frac{\text{Load}}{\text{Effort}} = \frac{200N}{50N} = 4$$

$$\epsilon = \frac{M.A.}{V.R} \times 100\%$$

$$= \frac{4}{6} \times 100\% = 66.7\%$$

30. B: A thermoelectric thermometer is very sensitive.

$$31. B: P = \frac{1}{f}$$

$$\text{Then, } f = \frac{1}{P} = \frac{1}{5} = 0.2m$$

32. A: Iron filling will concentrate mainly round the ends of a bar magnet.

Lodestone is a magnetic material.

Like poles repel, unlike poles attract.

A bar magnet suspended about its centre comes to rest with its axis aligned in the N-S direction.

33. C: B = 0.6T

$$I = 8A$$

$$L = 5m$$

$$\phi = 30^\circ C$$

$$F = BIL \sin\phi = (0.6 \times 8 \times 5 \times \sin 30^\circ)N$$

$$= 12N$$

34. D: Primary cells have large internal resistance while secondary cells have low internal resistance. This is why a secondary cell can deliver a very large current while a primary cell cannot.

Primary cells cannot be recharged while secondary cells can be recharged.

Examples of primary cells are the Daniel cell and the Leclanche cell.

Examples of secondary cells are the lead-acid accumulator and the alkaline or Nickel-Iron accumulator.

35. B: The resistors are connected in parallel.

Thus,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{18} + \frac{1}{12} + \frac{1}{6} = \frac{2+3+6}{36} = \frac{11}{36}$$

$$\frac{1}{R} = \frac{11}{36}, R = \frac{36}{11} = 3.273 \Omega$$

$$V = 12V$$

$$I = \frac{V}{R} = \left(\frac{12}{3.273}\right) A = 3.7A$$

$$36. A: n = \frac{\sin\left(\frac{A+Dm}{2}\right)}{\sin\left(\frac{A}{2}\right)}; \quad 1.5 = \frac{\sin\left(\frac{60+Dm}{2}\right)}{\sin\left(\frac{60}{2}\right)}$$

$$1.5 = \frac{\sin\left(\frac{60+Dm}{2}\right)}{\sin 30}$$

$$\sin\left(\frac{60+Dm}{2}\right) = 1.5 \sin 30 = 0.75$$

$$\frac{60+Dm}{2} = \sin^{-1} 0.75 = 49$$

$$60 + Dm = 2 \times 49 = 98$$

$$Dm = 98 - 60 = 38^\circ$$

37. A: The molecules of a liquid are not stationary; they are in a state of constant motion.

38. A: The main components of the electromagnetic spectrum are radio waves, infrared rays, visible light, ultra-violet rays, x-rays and gamma ray.

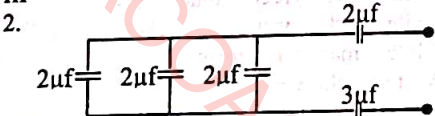
39. C: This represents half-wave rectification.

40. D: It is simply the air conditioner.

2016 UTME MODEL PHYSICS QUESTIONS

I. Change of state. II. Diffusion. III. Radiation. IV Osmosis.

1. Which of the processes above can be explained using the kinetic theory? A. I, II, III and IV B. I, III and IV C. I, II and IV D. I, II and III

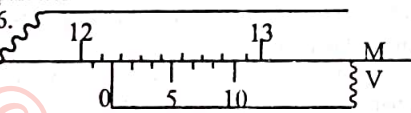


Calculate the effective capacitance of the circuit above A. 4mF B. 2mF C. 3mF D. 1mF

3. A tennis ball is projected horizontally from the top of a vertical cliff 50 m high with a velocity of $10ms^{-1}$. Find the time it will take the ball to reach the ground. [$g = 10ms^{-2}$] A. 3.02s B. 4.01s C. 4.15s D. 3.16s

4. The magnitude of the angle of dip at the equator is A. 0° B. 180° C. 360° D. 90°

5. A circuit has a resistance of 200Ω . The resistance of the circuit can be reduced to 120Ω when A. an 80Ω resistor is connected to it in series B. a 240Ω resistor is connected to it in series C. a 300Ω resistor is connected to it in parallel D. a 150Ω resistor is connected to it in parallel



From the diagram above, the reading on the main scale M is A. 12.20 mm B. 12.18 mm C. 12.19mm D. 12.17mm

7. The inertia of a body is defined as the A. reluctance to keep moving if already in motion B. readiness to start moving if in a state of rest C. reluctance to start moving if in a state of rest D. ability to overcome the earth's gravitational pull

8. A radioactive isotope has a decay constant of $10^{-8}s^{-1}$, calculate its half-life. A. 5.93×10^6s B. 6.93×10^7s C. 6.93×10^9s D. 5.93×10^7s

9. The transverse wave with the longest wavelength is A. x-rays B. infrared ray C. radio wave D. ultra-violet rays

10. When $^{210}_{82}Pb$ decays to $^{206}_{80}Pb$, it emits A. two alpha and two beta particles B. a beta particle C. one alpha and one beta particle D. an alpha particle

11. Satellite that circles round the earth are held by a force called A. gravitational potential B. earth's rotational pull C. earth's gravitational field D. gravitational constant

12. Calculate the force acting on an electron of charge $1.5 \times 10^{-19}C$ placed in an electric field of intensity 10^5Vm^{-1} . A. $1.5 \times 10^{-14}N$ B. $1.5 \times 10^{-12}N$ C. $1.5 \times 10^{-13}N$ D. $1.5 \times 10^{-11}N$

13. What is the best method of demagnetizing a steel bar magnet? A. Hammering. B. Rough handling it C. Solenoid method D. Heating it

14. Calculate the mass of silver deposited in a silver nitrate electrolysis in which a current of 6A passes through the electrolyte for 3hours. [e.c.e of silver = $1.12 \times 10^{-4}kgC^{-1}$] A. $7.2 \times 10^{-2}kg$ B. $7.2 \times 10^{-4}kg$ C. $7.2 \times 10^{-3}kg$ D. $7.2 \times 10^{-6}kg$

15. If a metal wire 4m long and cross-sectional area $0.8mm^2$ has a resistance of 6Ω , find the resistivity of the wire. A. $5.3 \times 10^{-7}\Omega m$ B. $1.2 \times 10^{-6}\Omega m$ C. $3.2 \times 10^{-6}\Omega m$ D. $3.0 \times 10^{-6}\Omega m$

16. A system performs simple harmonic motion with a period of 10s and amplitude of 2m. Calculate its maximum velocity. A. $1.26 ms^{-1}$ B. $7.60 ms^{-1}$ C. $12.00 ms^{-1}$ D. $2.25 ms^{-1}$

17. A body of mass m_1 moving with a velocity of u collides with a stationary body of mass m_2 . Both bodies will move together after collision with a velocity of A. $\frac{m_2 u}{m_1 - m_2}$ B. $\frac{m_1 u}{m_1 + m_2}$ C. $\frac{m_2 u}{m_1 + m_2}$ D. $\frac{m_1 u}{m_1 - m_2}$

18. If a charge of $2\mu C$ is situated in a field of intensity $400NC^{-1}$, the force on the charge is A. $8 \times 10^{-9}N$ B. 4×10^6NC C. $8 \times 10^{-4}N$ D. 4×10^8N

19. Shortsightedness occurs if the A. focal length of the eye is at infinity B. parallel rays are brought to a focus behind the retina C. eyeball is too short D. eyeball is too long

20. Myopic defects in the human eye can be corrected through the use of a A. concave mirror B. concave lens C. prism D. convex lens

21. A charged particle is moving in a uniform magnetic field. If the direction of motion of the charged particle is parallel to the magnetic field, the path of the charge will A. be a straight line B. curve inwards C. be a parabola D. curve outwards

22. What happens to a water pool on a day when the humidity of the air is very low? A. Temperature decreases B. Slow evaporation C. Temperature increases D. Rapid evaporation

23. A satellite moves in a circular orbit of radius $4R$ round the earth. The acceleration of the satellite in terms of g is A. $\frac{g}{16}$ B. $\frac{g}{4}$ C. $\frac{4}{g}$ D. $\frac{16}{g}$

24. I. Chemical II. Sound III. Electricity. Which of the above forms of energy can directly be converted to light energy? A. I and II only B. II and III only C. I, II and III D. I and III only

25. An object is placed 15cm in front of a plane mirror. If the mirror is moved further 5cm away from the object, the distance between the object and the image is A. 80cm B. 40cm C. 50cm D. 70cm

26. Which of the following statements is correct about a machine? A. Efficiency of a machine is always greater than 1 B. Efficiency decreases with an increase in friction. C. Velocity ratio depends on friction D. Mechanical advantage increases with an increase in friction

27. The instrument used to view stars is the A. prism binoculars B. telescope C. film project D. microscope

28. The frequency of the beats produced when two tuning forks of frequencies 258Hz and 270Hz are sounded close to each other is A. 6Hz B. 264Hz C. 528Hz D. 12Hz

29. What is the angular magnification of a telescope having objective and eyepiece lenses of focal lengths 30cm and 3cm respectively? A. 60 B. 10 C. 30 D. 90

30. When an athlete perspires after running, he loses heat through A. evaporation B. conduction C. radiation D. convection

31. The heat required to raise a mass of a substance through 1K is known as A. specific heat capacity B. specific latent heat of

vaporization C. capacity latent heat of fusion D. heat capacity

32. A boy in a barber's shop sits between two parallel mirrors. The number of images observed by him will be A. infinite B. ten C. eight D. forty

33. Semiconductor is a class of solid whose conductivity increases with an increase in A. pressure B. temperature C. current D. voltage

34. A dynamo primarily converts A. mechanical energy into electrical energy B. electrical energy into kinetic energy C. potential energy into kinetic energy D. kinetic energy into potential energy

35. A saturated vapour pressure of a liquid increases when the A. temperature of the liquid increases B. volume of the liquid increases C. volume of the liquid decreases D. temperature of the liquid decreases

36. What force has to be exerted on a mass 60kg to give it an acceleration of 10ms^{-2} vertically upwards? [$g = 10\text{ms}^{-2}$] A. 300N B. 600N C. 1200 D. 400N

37. A metre rule is pivoted at its mid-point with a vertical force of 10N hanging from the distance 30cm from the mid-point. At what distance must a 15N force hang to balance the ruler horizontally? A. 30cm B. 10cm C. 20cm D. 25cm

38. A projectile is fired from the ground level with a velocity of 300ms^{-1} at an angle of 30° to the horizontal. Calculate the time taken to reach the maximum height. [$g = 10\text{ms}^{-2}$] A. 30s B. 20s C. 25s D. 15s

39. A train with an initial velocity of 20ms^{-1} is subjected to a uniform deceleration of 2ms^{-2} . The time required to bring the train to a complete halt is A. 40s B. 10s C. 20s D. 5s

40. Which of the following electromagnetic waves has the shortest wavelength? A. Visible light B. Ultraviolet rays C. Infrared rays D. Gamma rays

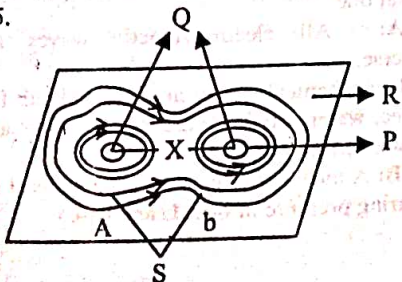
41. A radioactive isotope has a decay constant of 10^{-8} . Calculate its half-life A. $5.93 \times 10^6\text{s}$ B. $6.93 \times 10^7\text{s}$ C. $6.93 \times 10^9\text{s}$ D. $5.93 \times 10^7\text{s}$

42. Which of the following waves is both transverse and mechanical? A. Water waves B. Radios waves C. Sound waves D. X-rays

43. The relative density of a liquid is the ratio of the A. mass of water to the mass of an equal volume of liquid B. upthrust in the liquid the upthrust in water C. density of water to density of the liquid D. upthrust in water to the upthrust in the liquid

44. What happens to the pressure of a gas if temperature is reduced to -273°C ? A. It will decrease B. It will drop to zero C. It will increase D. It will remain constant

45.



In the diagram above, the neutral point is at A. R B. X C. S D. P

46. Which of the following does NOT use magnetic effect of current to function? A. Lead acid accumulator B. An electric bell C. A moving coil galvanometer D. A telephone receiver

47. Vapour is said to be saturated on top of an enclosed liquid if A. the rate of condensation is greater than that of vaporization B. the rate of condensation is equal to that of vaporization C. there is neither condensation nor vaporization of the liquid D. the rate of condensation is less than that of vaporization

48. Shadows and eclipse result from the A. reflection of light B. rectilinear propagation of light C. diffraction of light D. refraction of light

49. Which of the following statements about wave motion is correct? A. Electromagnetic waves are transverse B. Transverse wave do not require a medium for propagation C. Longitudinal waves vibrate perpendicular to the direction of travel D. All mechanical waves are longitudinal

50. A manometer is an instrument used for measuring A. relative density of liquid B. pressure in liquids and gases C. humidity C. atmospheric pressure

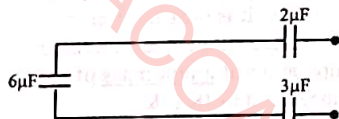
2016 PHYSICS SOLUTION

1. C: Change of state, diffusion and osmosis can be explained using the kinetic theory of matter; radiation cannot be so explained. Remember that radiation does not involve material medium.

2. - The three $2\mu\text{F}$ are connected in parallel. Thus, for the three $2\mu\text{F}$, the combined capacitance

$$= 2\mu\text{F} + 2\mu\text{F} + 2\mu\text{F} = 6\mu\text{F}$$

The arrangement can therefore be reduced to:



As can be seen, the diagram above depicts a series arrangement.

Therefore,

$$\frac{1}{C} = \frac{1}{6} + \frac{1}{2} + \frac{1}{3}; \frac{1}{C} = \frac{1+3+2}{6}$$

$$\frac{1}{C} = \frac{6}{6}; C = 1\mu\text{F}$$

It must be keenly noted that the effective capacitance, $C = 1\mu\text{F}$ not 1mF . Students are advised not to pick any option in a case like this.

3. D: KEY \Rightarrow The time taken to reach the ground can be calculated with even only the height of the cliff known. Note that, the velocity, 10ms^{-1} given here is purely u_x . The vertical component of the velocity, $u_y = 0$

$$H = S_y = 50\text{m}$$

$$u_y = 0$$

$$a_y = 10\text{m/s}^2$$

$$t = ?$$

$$\text{Using } S = ut + \frac{1}{2}at^2$$

$$50 = (0 \times t) + \frac{1}{2} \times 10t^2$$

$$50 = 5t^2$$

$$t^2 = \frac{50}{5} = 10; t = \sqrt{10} = 3.16\text{s}$$

4. A: The angle of declination or variation is the angle between the geographic and magnetic meridians at a place. It varies from place to place.

The angle of dip or inclination is the angle between the direction of earth's resultant magnetic field and the horizontal. It also varies from place to place. For instance, the angle of dip at the equator is 0° while its value at the poles is 90° .

5. C: If you were to guess out the answer, what would the correct option be? NO! You should not even think of options A and B as the two options depict connections in series. If you want the resistance to reduce, you connect an appropriate resistor in parallel with the existing one; series connection will always lead to an increase in resistance value.

Let the required resistance be x

$$\frac{1}{120} = \frac{1}{200} + \frac{1}{x}$$

$$\frac{1}{120} - \frac{1}{200} = \frac{1}{x}$$

$$\frac{5-3}{600} = \frac{1}{x}; \frac{2}{600} = \frac{1}{x}; 2x = 600; x = 300\Omega$$

6. - The main scale reading is the reading that can be clearly recorded before the interception of the vernier scale. This value is exactly 12.1cm (note that the marker has not reached the 12.2cm mark). Since it's the seventh line on the vernier that coincides with a line on the main scale the most and the reading accuracy of a vernier caliper is 0.01cm, the reading of a vernier = $7 \times 0.01\text{cm} = 0.07\text{cm}$. The total reading (if demanded; here it is not) = $12.\text{cm} + 0.07\text{cm} = 12.17\text{cm}$.

STOP! Don't pick option D; you are to calculate the main reading, not the total reading.

7. C: The inertia of a body is its reluctance to stop moving if already in motion or to start moving if at rest.

8. B: $T_{\frac{1}{2}} = \frac{0.693}{\lambda}$
Where $T_{\frac{1}{2}}$ = half life; λ = decay constant, $t = 10^8\text{s}^{-1}$

Thus, $T_{\frac{1}{2}} = \frac{0.693}{10^{-8}} = 6.93 \times 10^7\text{s}$.

9. C: The transverse wave with the longest wavelength is radio wave. Please note that the radio wave has the least frequency.

Radio wave \rightarrow Infra-red ray \rightarrow visible light \rightarrow ultraviolet ray \rightarrow x-ray \rightarrow gamma ray \rightarrow

Increasing Frequency

← Increasing Wavelength

10. D: ${}_{82}^{210}\text{P} \rightarrow {}_{80}^{206}\text{Pb} + {}_2^4\text{He}$ (alpha particle)

11. B: Satellite that circles round the earth are held by a force called the earth's gravitational pull given by the formula $F_g = \frac{GM_eM_s}{R^2}$

Where F_g = Gravitational Pull (or gravitational force) M_e = Mass of the earth; M_s = Mass of the satellite and R = Distance of the satellite from the centre of the earth.

12. A: $F = Eq$
 E = Electric field intensity = 10^5Vm^{-1}
 q = charge = $1.5 \times 10^{-19}\text{C}$
 $F = (10^5 \times 1.5 \times 10^{-19}) = 1.5 \times 10^{-14}\text{N}$

13. C: The electrical (solenoid) method is the best way to demagnetize a magnet. It is interesting to note that the best method of producing a magnet is still the electrical method.

14. A: $M = Zit$
 $Z = \text{Electrochemical equivalent} = 1.12 \times 10^{-6} \text{KgC}^{-1}$
 $I = \text{Current} = 6\text{A}; t = \text{time} = 3\text{hrs} = (3 \times 3600)\text{s}$
 $M = (1.12 \times 10^{-6} \times 6 \times 10800)\text{kg} = 7.26 \times 10^{-2}\text{Kg}$

15. B: $R = 6\ \Omega, L = 4\ \text{m}, A = 0.8\ \text{mm}^2 = 8 \times 10^{-7}\text{m}^2$
 $R = \frac{\rho l}{A}$; where $\rho = \text{resistivity}$.
 $\rho = \frac{RA}{l} = \left(\frac{6 \times 8 \times 10^{-7}}{4}\right) = 1.2 \times 10^{-6}\ \Omega\text{m}$

16. A: Period, $T = 10\text{s}$
 Amplitude, $A = 2\text{m}$
 $V = \omega A, \omega = 2\pi F = \frac{2\pi}{T}$
 Thus,
 $\omega = \frac{2 \times 3.142}{10} = 0.6284\text{rad/s}$
 Now,
 $V = (0.6284 \times 2)\text{m/s} = 1.26\text{m/s}$

17. B: $M_1 U_1 + M_2 U_2 = (M_1 + M_2) V$
 (Conservation of linear momentum)
 Since the second body is stationary, $U_2 = 0$
 Thus,
 $M_1 U_1 = M_2 (0) + (M_1 + M_2) V$
 $(M_1 + M_2) V = M_1 U_1$
 $V = \frac{M_1 U_1}{M_1 + M_2} = \frac{M_1 U_1}{M_1 + M_2}$

18. C: $E = 400\text{Nc}^{-1}; q = 2\mu\text{C} = 2 \times 10^{-6}\text{C}$
 $F = Eq = (400 \times 2 \times 10^{-6}) = 8 \times 10^{-4}\text{N}$

19. D: Short sightedness (or myopia) is the inability of an eye to see distant objects clearly. This is because the eye ball is too long or the crystalline lens is so converging that rays from distant objects are brought to a focus in front of the retina instead of on the retina.

20. B: Myopia is corrected through the use of a diverging or concave lens. Hypermetropia (long sightedness), on the other hand, is corrected with the use of a converging or convex lens.

21. A: KEY \Rightarrow A charged particle moving in a direction parallel to a magnetic field will experience no force and this implies that its original direction of motion will not be affected.

22. D: Humidity refers to the amount of water vapour present in the atmosphere. When a large amount of water vapour is present in the atmosphere, we say that the humidity of the air is high and vice versa. Low humidity promotes rapid evaporation from water bodies while high humidity promotes slow evaporation.

23. A: Key \Rightarrow The force for the motion of the satellite round the earth is provided by the pull of the earth on it (gravitational force)
 $F_g = \frac{GM_e M_s}{r^2} = \frac{GM_e M_s}{(4R)^2} = \frac{GM_e M_s}{16R^2}$
 From Newton's second law of motion, $F = ma$
 Since the satellite is the one moving under the influence of the gravitational force, we can write:
 $F_g = M_s a$
 Then, it follows that:
 $M_s a = \frac{GM_e M_s}{16R^2}$
 $a = \frac{GM_e}{16R^2}; a = \frac{GM_e}{R^2} \times \frac{1}{16}$
 Also, the acceleration due to gravity, g is given by $g = \frac{GM_e}{R^2}$
 Thus,
 $a = g \times \frac{1}{16} = \frac{g}{16}$

24. D: Chemical every and electrical energy can directly be converted to light energy.

25. B: Initial $U = 15\text{cm}$; moving it 5cm away makes U to become 20cm . Don't forget that in a plane mirror, U and V are equal i.e. $U = V = 20\text{cm}$. Required distance = $U + V = 20\text{cm} + 20\text{cm} = 40\text{cm}$

26. B: The efficiency of a machine is always less than 1 (if expressed to unity) and less than 100% (if expressed in percentage). Efficiency decreases with an increase in friction as friction causes the force required to overcome a given load to increase. Velocity ratio does not depend on any force (not even friction). It depends solely on the geometry of the machine. Mechanical advantage decreases with an increase in friction
 Normally, $M.A = \frac{l}{L}$
 It has been explained earlier that friction causes the effort needed to overcome a given load to increase. From the formula above, it is crystal-clear that the relationship between M.A and E is an inverse one. Thus, friction will cause the effort required to increase and consequently cause the efficiency to decrease.

27. B: The instrument used to view distant objects (like stars) is the telescope.

28. D: Beat frequency = $f_2 - f_1$; where $f_2 > f_1$
 $= (270 - 250)\text{Hz} = 12\text{Hz}$

29. B: Magnification, $M = \frac{f_o}{f_e} = \frac{30\text{cm}}{3\text{cm}} = 10$

30. A: The athlete loses heat through evaporation. This is how it happens: The energy required (heat energy) to evaporate the sweat is extracted from the body and as the sweat evaporates progressively, more and more heat is extracted from the body.

31. D: The heat required to raise the temperature of a body by 1K is known as the heat or thermal capacity. It is measured in JK^{-1}
 The specific heat capacity is the heat required to raise the temperature of a unit mass of the body by 1K. It is measured in $\text{JKg}^{-1}\text{K}^{-1}$

32. A: $N = \frac{360}{\theta} - 1$
 $N = \text{Number of images formed}; \theta = \text{angle between the mirrors}$
 The angle between two parallel mirrors = 0
 Thus,
 $N = \frac{360}{0} - 1 = \infty$

33. B: The conductivity of a semi-conductor increases with an increase in temperature while that of a metal decreases with an increase in temperature.

34. A: A dynamo (generator) converts mechanical energy into electrical energy.

35. A: As the temperature increases, more and more of a liquid is converted into the gaseous (vapour) form. Thus, it follows that the saturated vapour pressure increases as the temperature increases.

36. C: Resultant force = $ma = (60 \times 10)\text{N} = 600\text{N}$
 $600 = F_u - F_d$
 $F_u = \text{upward force applied}$
 $F_d = \text{downward drag on the object} = mg = (60 \times 10)\text{N} = 600\text{N}$
 Then, $600 = F_u - 600$
 $F_u = (600 + 600)\text{N} = 1200\text{N}$

37. C:
 $C.M = A.C.M$
 $15 \times x = 10 \times 30$
 $x = \left(\frac{10 \times 30}{15}\right)\text{cm} = 20\text{cm}$

38. D: $t = \frac{U \sin \theta}{g} = \frac{300 \sin 30^\circ}{10} = 15\text{s}$, Note that the formula $T = \frac{2U \sin \theta}{g}$ is to calculate the time required to return to the original level of projection.
 $H_{\max} = \frac{U^2 \sin^2 \theta}{2g} \Rightarrow \text{Maximum height attained}$
 $R = \frac{U^2 \sin 2\theta}{g} \Rightarrow \text{for the horizontal range covered}$

39. B: Since the train will eventually stop, $V = 0$
 $U = 20\text{ms}^{-1}, a = -2\text{ms}^{-2}, t = ?$
 $V = U + at$
 $t = \frac{V - U}{a} = \frac{0 - 20}{-2} = \frac{-20}{-2} = 10\text{s}$

40. D: Gamma rays have the shortest wavelength but the highest frequency. Please, refer to the solution to question 9 for better explanation.

41. B: Same as question 8

42. A: Water wave is both transverse and mechanical. Sound wave is also mechanical but longitudinal. Radio waves and x-rays are both electromagnetic radiations.

43. B: $R.D = \frac{\text{Mass of substance}}{\text{Mass of equal volume of water}} = \frac{\text{Weight of substance}}{\text{Weight of equal volume of water}} = \frac{\text{Density of substance}}{\text{Density of Water}}$
 For a liquid, the relative density can also be given by
 $R.D = \frac{\text{Upthrust on an object in a liquid}}{\text{Upthrust on the same object in water}}$

44. B: OK or -273°C is known as the absolute zero temperature. It is the temperature at which both the volume and pressure of a given gas will theoretically drop to zero.

45. B: The neutral point is at X

46. A: An electric bell, a telephone receiver and a moving coil galvanometer use the magnetic effect of current to function while a lead-acid accumulator (car battery) does not.

47. B: This occurs when both evaporation and condensation are occurring at the same rate.

48. B: Shadows and eclipse result from the rectilinear propagation of light.
 NB: The pin-hole camera is also a proof for the rectilinear propagation of light, albeit an artificial one.

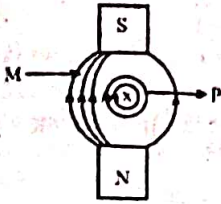
49. A: All electromagnetic waves are transverse.
 Not all mechanical waves are longitudinal. For instance, water wave is a mechanical wave and it is transverse.

50. B: A manometer is an instrument used for measuring pressure in liquids and gases.

2015 UTME MODEL PHYSICS
QUESTIONS

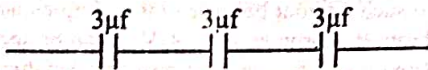
COMPUTER BASED TEST (CBT)

1. A satellite moves in a circular orbit of radius $4R$ round the earth. The acceleration of the satellite in terms of g is A. $\frac{4}{g}$ B. $\frac{g}{4}$ C. $\frac{g}{16}$ D. $\frac{16}{g}$



In the diagram above, the direction of the force between N and S in the magnetic field is A. NS B. SN C. MP D. PM

2. Calculate the inductance of a coil of resistance $30\ \Omega$ connected to a $100V$ a.c source if the coil draws an r.m.s current of $2A$. A. $1.25H$ B. $2.50H$ C. $0.60H$ D. $0.04H$
3. What force has to be exerted on a mass $60kg$ to give it an acceleration of $10ms^{-2}$ vertically upwards? [$g = 10ms^{-2}$] A. $600N$ B. $1200N$ C. $400N$ D. $300N$
4. A satellite revolving around the earth is kept on its orbit by A. centrifugal forces only B. centripetal forces only C. centripetal and frictional forces D. centripetal and centrifugal forces.
5. The plates of a $0.5\mu F$ uncharged capacitor are connected to a $10V$ battery. The charge on the capacitor after a long time is A. $20.0\mu C$ B. $50.0\mu C$ C. $10.0\mu C$ D. $5.0\mu C$
6. If a document is to be produced using a duplicating camera, where should the document be placed in order to obtain an exact copy? A. At the point which is twice the focal length of the lens of the camera. B. At the optical centre of the lens of the camera. C. Between the principal focus and a point twice the focal length of the lens of the camera. D. Beyond a point twice the focal length of the lens of the camera.
7. The efficiency of a machine is 70% . Calculate the work done using this machine to raise a load of $10kg$ through a vertical height of $2.0m$. [$g = 10ms^{-2}$] A. $2000J$ B. $3000J$ C. $1500J$ D. $1000J$
8. Which of the following statement is NOT true about atoms? A. An atom is made up of a nucleus and a number of electrons. B. The mass of an atom is concentrated in the nucleus. C. Atoms of different elements have different atomic weights. D. Atoms of all elements are identical.
9. A current of $20A$ flows through a cable whose resistance is 5Ω . Calculate the electric power dissipated. A. 2×10^3W B. 2×10^4W C. 1×10^3W D. 1×10^2W



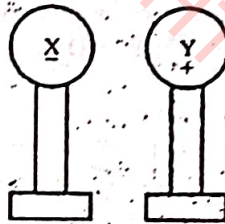
From the diagram above, the equivalent capacitance of the three capacitors is A. $\frac{1}{3}\mu F$ B. $\frac{1}{9}\mu F$ C. $1\mu F$ D. $3\mu F$

12. Calculate the temperature of moles of an ideal gas at a pressure of $7.6 \times 10^6 Nm^{-2}$ with a

volume of $10^{-3}m^3$ [$R = 8.3Jmol^{-1}K^{-1}$] A. $185^\circ C$ B. $201^\circ C$ C. $153^\circ C$ D. $126^\circ C$

13. A piece of cork floats in water because A. the upthrust on it when completely immersed in water is greater than its weight in air B. the surface of the water acts like an elastic skin C. the upthrust on it when completely immersed in water is equal to its weight in air D. there is no upthrust on it when it is completely immersed in water.

14. A block of aluminium of mass m is heated electrically by a $25W$ heater. If the temperature rises by $10^\circ C$ in 5 minutes, calculate the heat capacity of the aluminium A. $750JK^{-1}$ B. $1250JK^{-1}$ C. $125JK^{-1}$ D. $50JK^{-1}$



In the diagram above, the charges on X and Y are opposite. What happens when they are in contact? A. X and Y become negatively charged. B. X and Y attract each other. C. X and Y become positively charged. D. X and Y repel each other.

16. If the speed of light in water is $2.26 \times 10^8ms^{-1}$ and the velocity of light in air is $3.0 \times 10^8ms^{-1}$. Calculate the refractive index of water. A. 1.33 B. 1.23 C. 1.45 D. 1.56

17. I. Thermometer must be kept vertical II. Top of the mercury meniscus is read III. Air use must be dry. Which of the following precautions are common in verification of Boyle's law, Charles' law and pressure law? A. I and II only B. I, II and III C. II and III only D. I and III only

18. Which of the following does NOT use magnetic effect of current to function? A. A telephone receiver B. Lead acid accumulator C. A moving coil galvanometer D. An electric bell

19. What are the charge carriers in semiconductors? A. Electrons and holes B. Holes only C. Ion and electrons. D. Ion and holes.

20. When a capacitor is charged to $20C$ on each plate the energy stored by it is $40J$, at what charge will it store half of this energy? A. $10.0C$ B. $5.0C$ C. $14.4C$ D. $20.0C$

21. What is the energy with which an incident light of wavelength $10^{-7}m$ falls on a metal and electrons are emitted? [$c = 3.0 \times 10^8ms^{-1}$; $h = 6.63 \times 10^{-34}Js$] A. $1.99 \times 10^{-19}J$ B. $1.99 \times 10^{-16}J$ C. $1.99 \times 10^{-19}J$ D. $1.99 \times 10^{-20}J$

22. Which of the following will be applied when a metal Y is used to electroplate another metal X in electrolysis? A. Y is the cathode and X is the anode B. Y is the anode and very high current is used C. X is the anode and very high current is used D. X is the anode and Y is the cathode.

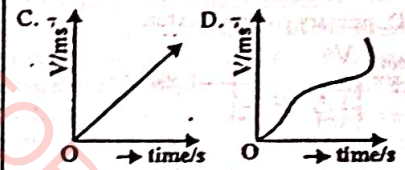
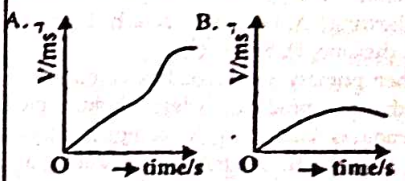
23. A progressive wave is represented by $y = 10 \sin(1000t - \frac{\pi x}{34})$. Two layers of the wave separated by $153cm$ have a phase difference of A. 270° B. 45° C. 90° D. 180°

24. X-rays can be used in the study of crystal structures because they A. have an extremely

short wavelength B. have a very long-reaching wavelength. C. are very fast. D. are invisible.

25. From the generating station to each substation, power is transmitted at a very high voltage so as to reduce. A. eddy current loss B. hysteresis loss C. heating in the coils D. magnetic flux leakage

26. Which of the velocity-time graphs shows uniform acceleration of a body from rest?



27. An empty relative density bottle has a mass of $30g$. When filled with paraffin, its mass is $70g$. Calculate the mass of the bottle when it is filled with water. [Relative density of paraffin = 0.8] A. $40g$ B. $20g$ C. $60g$ D. $80g$

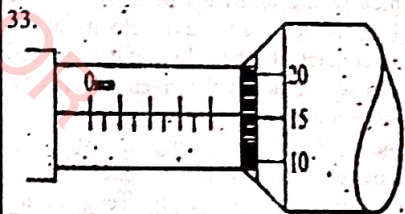
28. A projectile is fired from the ground level with a velocity of $300ms^{-1}$ at an angle of 30° to the horizontal. Calculate the time taken to reach the maximum height. [$g = 10ms^{-2}$] A. $25s$ B. $30s$ C. $20s$ D. $15s$

29. An electric bulb is labeled $260V$, $80W$. How much current is taken by the bulb? A. $0.46A$ B. $0.82A$ C. $0.40A$ D. $0.31A$

30. A metre rule is pivoted at its mid-point with a vertical force of $10N$ hanging from the distance $30cm$ from the mid-point. At what distance must a $15N$ force hang to balance the ruler horizontally? A. $25cm$ B. $30cm$ C. $20cm$ D. $10cm$

31. ${}^2_1X + {}^2_1X \rightarrow {}^4_2Y + {}^1_0n + \text{Energy}$. What type of reaction is represented by the equation above? A. Chain B. Ionization C. Fission D. Fusion.

32. Calculate the period of vibration of a spring system of force constant $200Nm^{-1}$ when loaded with a mass of $2kg$. A. $0.53s$ B. $0.63s$ C. $0.33s$ D. $0.23s$

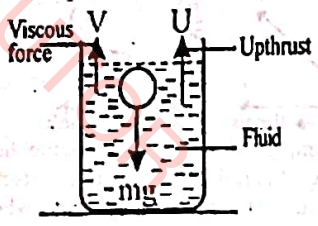


From the diagram above, the measuring accuracy of the micrometer screw gauge is A. $4.70mm$ B. $4.78mm$ C. $4.66mm$ D. $4.16mm$

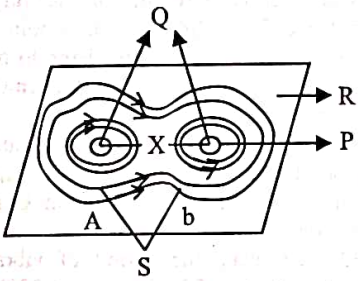
34. The impulse of a force is deduced from Newton's second law as A. $F = mg$ B. $F = m(\frac{v-u}{t})$ C. $F = ma$ D. $F = mv - mu$

35. A charged particle is moving in a uniform magnetic field. If the direction of motion of the charged particle is parallel to the magnetic field, the path of the charge will A. curve inwards B. be a parabola C. curve outwards D. be a straight line.

36. Which of the following is NOT affected by friction in machines? A. Efficiency B. Effort C. Velocity ratio D. Mechanical advantage.
37. Which of the following waves is both transverse and mechanical? A. Sound waves. B. Radio waves. C. Water waves. D. X-rays.
38. Which of the following is a semiconductor material? A. Copper B. Silicon C. Steel D. Iron.
39. Chemical energy is used to power which of the following? A. Leclanche cell. B. Electric cell C. A dynamo. D. Solar cell.
40. When primary and secondary colours are combined; to produce white light, the phenomenon is known as A. complementary colours mixture B. subtractive mixtures of colours C. secondary and primary colours mixture D. primary colours mixture.



41. From the diagram above, at terminal velocity, the three forces are related by the expression. A. $v + u = mg$ B. $mg + v - u = 0$ C. $v - u = mg$ D. $mg + v = u$
42. The different time rates of flow of fluids is due to A. cohesive force B. adhesive force C. viscous force D. surface tension
43. If a current of 4.6A was passed through a wire of resistance 6.5 c, the potential difference across the wire is A. 1.4V B. 0.7V C. 29.9V D. 48.5V.



44. In the diagram above, the neutral point is at A. S B. R C. X D. P
45. Which of the following does NOT affect frictional force? A. The relative velocity of the surfaces in contact B. The colour of the surfaces C. The area of contact of the given surfaces D. The nature of the surfaces in contact
46. Which of the following is NOT an application of expansion in metals? A. Bimetallic strip thermometer B. Temperature control in an electric iron C. Compensated balance wheel of a watch D. Sagging of telegraph wires.
47. Vapour is said to be saturated on top of an enclosed liquid if A. the rate of condensation is equal to that of vapourization B. there is neither condensation nor vapourization of the liquid C. the rate of condensation is less than that of vapourization D. the rate of condensation is greater than that of vapourization.
48. A body which weighs 50N in air displaces 3.7kg of water when partially immersed in water. Calculate the upthrust on the body. A. 37.0N B. 87.0N C. 13.0D. 8.7N.

49. If the distance between the object and the pinhole of a pinhole camera is reduced by half, the size of the image of the object A. is doubled B. is quadrupled C. remains the same D. is halved.
50. A train with an initial velocity 20ms⁻¹ is subjected to a uniform deceleration of 2ms⁻². The time required to bring the train to a complete halt is A. 20s B. 40s C. 10s D. 5s.

2015 PHYSICS SOLUTION

1. C: This is the same as question 23, 2016.
2. A: The magnetic field lines always point from north (N) to south (S).
3. $-V_L = I_L X_L$ (Just how one would write $V = IR$ in the common case of resistance)
 $X_L = \frac{V_L}{I_L} = \left(\frac{100}{2}\right)\Omega = 50\Omega$
 But
 $X_L = 2\pi fL$
 The inductance, $L = \frac{X_L}{2\pi f}$
 The actual numerical value of L cannot be obtained since f is not given.
 $L = \frac{50}{2\pi f} = \frac{50}{2 \times 3.142 \times f} = \left(\frac{50}{6.284f}\right)H$
 Where f = frequency
4. B: This is same as question 36, 2016.
5. D: The satellite is kept on its orbit by centripetal and centrifugal forces. The centripetal force is directed towards the centre of the orbit while the centrifugal force is directed away from it.
6. D: $C = 0.5\mu F = 5 \times 10^{-7}F$, $V = 10V$
 Charge, $Q = VC = (10 \times 5 \times 10^{-7})C = 5 \times 10^{-6} = 5\mu C$
7. A: The document should be placed at a point which is twice the focal length of the lens of the camera (2F). This is because the magnification here is 1 i.e. both the object (the document) and the image (the photocopy) will be same size.
8. $\text{Efficiency} = \frac{\text{Work output}}{\text{Work input}} \times 100\%$
 $= \frac{\text{Work done by the load}}{\text{Work done by the effort}} \times 100\%$
 $= \frac{\text{Load} \times \text{load distance}}{\text{Work done by the effort}} \times 100\%$
 Then, we can write:
 $70\% = \frac{100 \times 2}{\text{Work done by the effort}} \times 100\%$
 $0.7 = \frac{\text{Work done by the effort}}{200}$
 Work done by the effort = $\left(\frac{200}{0.7}\right)J = 285.7J$
9. D: Atoms of different elements are not identifiable. They are always different in many perspectives like mass, number of protons, number of neutrons, number of electrons, type of ion formed etc.
10. A: the electric power is given by the following:
 $\text{Power} = \frac{\text{Electrical energy}}{\text{time}}$
 $= \frac{IVt}{t} = IV$
 $= \frac{V^2 t}{R} = \frac{V^2}{R}$
 $= \frac{I^2 Rt}{t} = I^2 R$
 The appropriate equation here is the last one
 $P = I^2 R = 20 \times 5 = 2000W = 2 \times 10^3 W$
11. C: When capacitors are connected in parallel, the effective capacitance is the sum of the individual capacitances. When, however, the

- capacitors are connected in series, the effective capacitance C is related to other capacitances by:
 $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \dots$
 Note that the reverse is the case for the arrangement of resistors
 Since the capacitors are connected in series
 $\frac{1}{C} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{3}{3} = 1$
 $C = 1\mu F$
12. $-PV = nRT$
 $T = \frac{PV}{nR} = \left(\frac{7.6 \times 10^6 \times 10^{-3}}{6 \times 8.3}\right)K = 152.6K$
 $T(^{\circ}C) = T(K) - 273$
 $= (152.6 - 273)^{\circ}C = -120.4^{\circ}C$
13. C: For an object to float in a liquid, the upthrust of the liquid on the object (when the object is totally immersed in the liquid) must at least be equal to the weight of the object in air.
14. A: Electrical energy = $(25 \times 5 \times 60)J = 7500J$
 The electrical energy is converted to heat energy to raise the temperature of the block.
 Thus, we can write
 $7500 = C\Delta\theta$ (where C = thermal capacity, not specific heat capacity).
 Then,
 $C = \frac{7500}{\Delta\theta} = \left(\frac{7500}{10}\right)Jk^{-1} = 750Jk^{-1}$
15. B: Since like poles repel while unlike poles attract, X and Y must attract (Note that X & Y are oppositely charged)
16. A: $n_w = \frac{\text{Speed of light in air (or vacuum)}}{\text{Speed of light in water}}$
 $= \frac{3.0 \times 10^8 ms^{-1}}{2.26 \times 10^8 ms^{-1}} = 1.33$
17. C: KEY \Rightarrow Boyle's law investigates the relationship between pressure and volume. Hence, the positioning of the thermometer (to measure temperature) is not related to Boyle's law as the law does not involve temperature measurement.
18. B: Same as question 46, 2016
19. A: The charge carriers in electrolytes are free mobile ions.
 The charge carriers in conductors (metals) are free mobile electrons
 The charge carriers in semi-conductors are holes and electrons.
20. A: Energy stored in a capacitor = $\frac{1}{2}QV$
 $= \frac{1}{2} \frac{Q^2}{C}$
 $= \frac{1}{2} CV^2$
 The related equation is the first one
 $E = 40J$, $Q = 20C$
 $E = \frac{1}{2}QV$; $40 = \frac{1}{2} \times 20 \times V$; $40 = 10V$; $V = 4V$
 For half of the initial energy, $E = 20J$
 $20 = \frac{1}{2}Q \times 4$
 $20 = 2Q$
 $Q = \frac{20}{2} = 10C$
 But honestly, you don't have to subject yourself to such a rigour because of this simple question. From the formula, $E = \frac{1}{2}QV$. it can be seen that energy and charge vary directly. Anything that happens to the energy happens to the charge. Thus, if the energy is halved, the charge will also be halved.
 Thus, new charge = $\frac{1}{2} \times \text{old charge}$
 $= \frac{1}{2} \times 20C = 10C$
21. A: $E = hf = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{10^{-7}} = 1.99 \times 10^{-18}J$

22. B: to use a metal Y to electroplate another metal X, you make Y the anode and make X the cathode.

23. - Phase difference = $\frac{\pi x}{34}$ $x = 153\text{cm} = 1.53\text{m}$

$$= \left(\frac{3.142 \times 1.53}{34} \right) \text{rad} = 0.14139 \text{rad}$$

$$\pi \text{rad} = 180^\circ \text{C}$$

$$\text{Then, } 0.14139 \text{rad} = \frac{180^\circ}{3.142} \times 0.14139 = 8.1^\circ$$

24. A: The use of X-ray in the study of crystal structures is known as X-ray crystallography. X-rays are so used because they have extremely short wavelength.

25. C: Power can be transmitted at low current and high voltage or at high current and low voltage. It must be acknowledged that the metal cables through which the power is transmitted have a certain amount of electrical resistance. Thus, transmitting power at high current will lead to loss of energy in the form of heat in the cables. To avoid this, power is therefore transmitted at high voltage and low current.

26. C: The graph in "C" depicts uniform acceleration.

27. D: Relative density of paraffin = $\frac{\text{mass of paraffin}}{\text{mass of equal vol. of water}}$

$$\text{Mass of paraffin} = 70\text{g} - 30\text{g} = 40\text{g}$$

$$0.8 = \frac{40\text{g}}{\text{mass of equal volume of water}}$$

Thus,

$$\text{Mass of water} = \frac{40\text{g}}{0.8} = 50\text{g}$$

$$\text{Mass of the bottle when filled with water} = 50\text{g} + 30\text{g} = 80\text{g}$$

$$28. \text{ D: } t = \frac{U \sin \theta}{g} = \frac{300 \sin 30^\circ}{10} = 15\text{s}$$

This is the same as question 38, 2016

29. D: Power = IV (current \times voltage)

$$I = \frac{\text{Power}}{\text{Voltage}} = \frac{80\text{W}}{260\text{V}} = 0.31\text{A}$$

30. C: Same as question 37, 2016

31. D: Since two nuclei are joining to form a heavier nucleus, the reaction is nuclear fusion.

$$32. \text{ B: } T = 2\pi \sqrt{\frac{m}{K}}; m = 2\text{kg}, K = 200\text{Nm}^{-1}$$

$$= 6.284 \sqrt{\frac{2}{200}} = 0.6284\text{s} = 0.63\text{s}$$

33. D: the main reading = 4.0mm

The main reading coincides with the thimble reading on the 16th line and the reading accuracy of micrometer screw gauge is 0.01mm. Thus, thimble reading = $16 \times 0.01 = 0.16\text{mm}$

$$\text{Total reading} = (4 + 0.16)\text{mm} = 4.16\text{mm}$$

34. D: From Newton's second law of motion,

$$F = m \left(\frac{v-u}{t} \right)$$

$$Ft = m(v - u)$$

Impulse = change in momentum.

35. D: This is the same as question 21, 2016

36. C: Velocity ratio = $\frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$

Since velocity ratio is a ratio of distances, friction (which is a force) will not affect it

37. C: Same as question 42, 2016.

38. B: Steel, iron and copper are pure conductors while silicon is a semi-conductor.

39. A: A leclanche cell is an electrochemical cell. Electrochemical cells convert chemical energy into electrical energy.

40. A: When a primary colour is added to an appropriate secondary colour, white colour (which is a tertiary colour) will be produced.

Note that you can't pick a primary colour and a secondary colour at random to generate white colour. The colours that combine to give white colour are called complementary colour.

Yellow + Blue (primary) \rightarrow White

Magenta (secondary) + Green (primary) \rightarrow White

Cyan (secondary) + Red (primary) \rightarrow White

You may refer to the solution to question 7, 2017 for further illustration.

41. A: Normally,

$$v + u - mg = ma$$

But at the terminal velocity, $a = 0$

Then,

$$v + u - mg = m(0) = 0$$

$$v + u = mg$$

42. C: The different time rates of flow of fluids is due to viscous force. Viscosity is the name given to the internal friction between layers fluid. If a fluid (liquid or gas tends to prevent motion of objects through it while another fluid does not, the first fluid is said to be viscous while the second is non-viscous.

43. C: $I = 4.6\text{A}$

$$R = 6.5\Omega$$

$$V = IR = (4.6 \times 6.5)\text{V} = 29.9\text{V}$$

44. C: the neutral point is located at X. At the neutral point, the effect of magnetism is zero.

45. B: The colour of the surfaces does not, in anyway, affect frictional force.

46. D: Sagging of telegraph wires is a disadvantage rather than an application of expansion in metals.

47. A: When the rate of evaporation equals that of condensation, the vapour on top of an enclosed liquid is said to be saturated.

48. A: Mass of water displaced = 3.7kg

$$\text{Weight of water displaced} = (3.7 \times 10)\text{N} = 37\text{N}$$

Upthrust in water = weight of water displaced = 37N

49. A: The closer the object to the pin-hole, the bigger the image. Thus, if the distance between the object and the pinhole camera is reduced by half, the size of the image is doubled. ALTERNATIVELY, we can use the relation:

$$M = \frac{v}{u} = \frac{H_i}{H_o} \quad (v = \text{image distance, } u = \text{object distance, } H_i = \text{image height, } H_o = \text{object height}).$$

Thus,

$$H_i = \frac{H_o \times v}{u}$$

For better illustration, let the product $H_o \times v$ be K.

Then,

$$H_i = \frac{K}{u}$$

Let U be 1 unit

Thus, $H_i = K$

Now, let half of U be used i.e. $\frac{1}{2}$ unit

$$H_i = \frac{K}{\frac{1}{2}} = 2K$$

Thus, the image size is doubled

$$50. \text{ C: } U = 20\text{ms}^{-1}, a = -\text{ms}^{-2}, t = ? \quad V = 0$$

$$V = U + at$$

$$0 = 20 + (-2t)$$

$$0 = 20 - 2t$$

$$2t = 20$$

$$t = \frac{20}{2} = 10\text{s}$$

2014 UTME MODEL PHYSICS QUESTIONS PAPER TYPE F

1. Which Question Paper Type of Physics is given to you? A. Type FB. Type E C. Type LD. Type S.

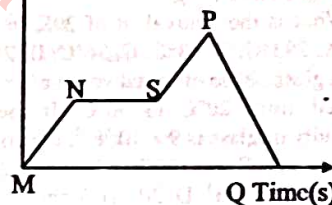
2. What is the least possible error encountered when taking measurement with a meter rule? A. 1.0mm. B. 0.5 mm. C. 0.2 mm. D. 0.1 mm.

3. A quantity which requires magnitude and direction to be specified is A. distance B. displacement. C. mass. D. temperature.

4. I. Electrical potential II. Torque III. Kinetic energy IV. Momentum. Which of the quantities listed above are vectors? A. I and II. B. I and III C. II and III D. II and IV.

5. Which type of motion do the wheels of a moving car undergo? A. Random and translational motion. B. Rotational and oscillatory motion C. Translational and rotational motion D. Vibratory and translational motion.

6. V(m⁻¹) \uparrow



From the diagram above, the region of zero acceleration is A. MN B. NS C. SP D. PQ.

7. A car accelerates uniformly from rest at 3ms^{-2} , its velocity after travelling a distance of 24m is A. 144ms^{-1} B. 72ms^{-1} C. 36ms^{-1} D. 12ms^{-1}

8. Calculate the escape velocity of a satellite launched from the earth's surface if the radius of the earth is $6.4 \times 10^6\text{m}$. A. 4.2kms^{-1} B. 4.0kms^{-1} C. 11.3kms^{-1} D. 25.3kms^{-1} . [$g = 10\text{ms}^{-2}$]

9. An object of weight 80kg on earth is taken to a planet where the acceleration due to gravity is one-third of its value on earth. The weight of the object on the planet is A. 12N . B. 27N . C. 36N . D. 48N . [$g = 10\text{ms}^{-2}$]

10. One of the conditions necessary for an object to be in equilibrium when acted upon by a number of parallel forces is that the vector sum of the forces is A. zero. B. negative. C. positive D. average.

11. What happens when three coplanar non-parallel forces are in equilibrium? A. They are represented in magnitude only. B. They are represented in direction only. C. Their lines of action meet at a point. D. Their lines of action are parallel.

12. An object of mass 20kg is released from a height of 1Om above the ground level. The kinetic energy of the object just before it hits the ground is A. 4000J . B. 2000J . C. 500J . D. 200J . [$g = 10\text{ms}^{-1}$]

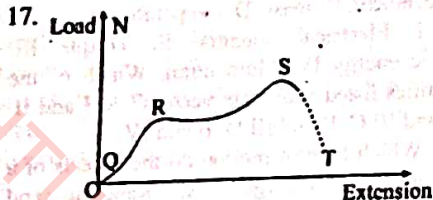
13. The energy in the nucleus of atoms produce heat which can be used to generate A mechanical energy. B. electrical energy. C. potential energy. D. kinetic energy.

14. A machine whose efficiency is 75% is used to lift a load of 1000N . Calculate the effort put in to the machine if it has a velocity ratio of

4. A. 233.33 N. B. 333.33 N. C. 334.33 N. D. 343.32 N.

15. A wheel and axle is used to raise a load whose weight is 800 N when an effort of 250 N is applied. If the radii of the wheel and axle are 800 mm and 200 mm respectively, the efficiency of the machine is A. 80%. B. 85%. C. 87%. D. 90%.

16. A force of 500N is applied to a steel wire of cross-sectional area 0.2m^2 the tensile stress is A. $1.0 \times 10^3\text{Nm}^{-2}$ B. $1.0 \times 10^4\text{Nm}^{-2}$ C. $2.5 \times 10^3\text{Nm}^{-2}$ D. $2.5 \times 10^4\text{Nm}^{-2}$



17. From the diagram above, the point that represents the elastic limit is A. Q. B. R. C. S. D. T.

18. The small droplets of water that form on the grass in early hours of the morning is A. hail. B. mist. C. dew. D. fog.

19. What is the equivalent of 20K in Celsius scale? A. 293°C . B. 68°C . C. 36°C . D. 20°C .

20. A glass bottle of initial volume $2 \times 10^4\text{cm}^3$ is heated from 20°C to 50°C . If the linear expansivity of glass is $9 \times 10^{-6}\text{K}^{-1}$, the volume of the bottle at 50°C is A. $20\ 005.4\text{cm}^3$. B. $20\ 008.1\text{cm}^3$. C. $20\ 013.5\text{cm}^3$. D. $20\ 016.2\text{cm}^3$.

21. The equation $P^a V^b T^c = \text{constant}$ reduces to Charles Law if A. $a=1, b=0$ and $c=-1$. B. $a=0, b=1$ and $c=1$. C. $a=0, b=1$ and $c=-1$. D. $a=1, b=1$ and $c=0$.

22. The quantity of heat needed to raise the temperature of a body by 1K is the body's A. internal energy. B. specific heat capacity C. latent heat of fusion. D. heat capacity.

23. The melting point of a substance is equivalent to its A. solidification temperature B. liquidification temperature C. solidification pressures. D. vapour pressure.

24. The temperature at which the water vapour present in the air just sufficient to saturate the air is A. ice point. B. saturation point C. dew point. D. boiling point.

25. Heat transfer by convection in a liquid is due to the A. increased vibration of the molecules of the liquid about their mean position B. variation of density of the liquid C. expansion of the liquid as it is heated D. latent heat of vaporization of the liquid.

26. The distance between two successive crests of a wave is 15 cm and the velocity 300ms^{-1} . Calculate the frequency. A. $4.5 \times 10^5\text{Hz}$ B. $2.0 \times 10^3\text{Hz}$ C. $4.5 \times 10^2\text{Hz}$ D. $2.0 \times 10^4\text{Hz}$.

27. A boy receives the echo of his clap reflected by a nearby hill 0.8s later. How far is he from the hill? A. 66m B. 136m C. 264m D. 528m [speed of sound in air = 340ms^{-1}]



The diagram above shows a stationary wave of wavelength 40 cm in a closed tube. The length L of the resonating air column is A. 10 cm B. 20 cm C. 30 cm D. 40 cm.

29. An object is placed 10 m from a pinhole camera of length 25 cm. Calculate the linear magnification A. 2.5×10^{-2} B. 2.5×10^{-1} C. 2.5×10^1 D. 2.5×10^2 .

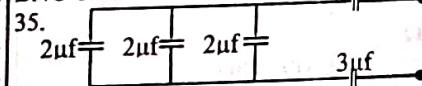
30. The focal length of a concave mirror is 2.0 cm. If an object is placed 8.0 cm from it, the image is at A. 2.0 m. B. 2.3 m. C. 2.5 m. D. 2.7 m.

31. In a compound microscope, the objective and the eyepiece focal lengths are A. long. B. short. C. the same. D. at infinity

32. When a telescope is in normal use, the final image is at A. the focus. B. the radius of curvature. C. the near point. D. infinity.

33. When a negatively-charged rod is brought near the cap of a charged gold leaf electroscope which has positive charges, the leaf A. collapses B. collapses and diverges again C. Diverges D. remains the same.

34. What charge is stored in a 0.1F capacitor when a 10V supply is connected across it? A. 5C B. 4C C. 2C D. 1C



35. Calculate the effective capacitance of the circuit above. A. $1\mu\text{f}$. B. $2\mu\text{f}$. C. $3\mu\text{f}$. D. $4\mu\text{f}$.

36. The maximum power transfer occurs in a cell when the external resistance is A. the same as the internal resistance of the cell B. greater than the internal resistance of the cell C. less than the internal resistance of the cell. D. twice the internal resistance of the cell.

37. If a metal wire 4 m long and cross-sectional area 0.8mm^2 has a resistance of 6Ω , find the resistivity of the wire. A. $3.0 \times 10^{-6}\Omega\text{m}$ B. $1.2 \times 10^{-6}\Omega\text{m}$. C. $3.2 \times 10^{-6}\Omega\text{m}$. D. $53 \times 10^{-7}\Omega\text{m}$

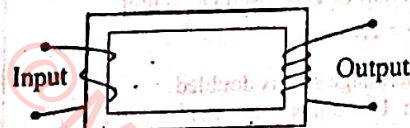
38. A circuit has a resistance of 200Ω . The resistance of the circuit can be reduced to 120Ω when A. an 80Ω resistor is connected to it in series B. a 150Ω resistor is connected to it in parallel C. a 240Ω resistor is connected to it in series D. a 300Ω resistor is connected to it in parallel.

39. PHCN measures its electrical energy in A. kWh B. Wh C. J D. W.

40. What is the best method of demagnetizing a steel bar magnet? A. Heating it. B. Rough handling it C. Solenoid method. D. Hammering.

41. The magnitude of the angle of dip at the equator is A. 0° B. 90° . C. 180° D. 360° .

Use the diagram below to answer questions 42 and 43



42. The diagram above is that of A. a step-up transformer. B. a step-down transformer. C. an auto transformer D. an oil transformer.

43. The electromotive force in the secondary winding is A. increasing. B. reducing. C. stabilizing. D. varying.

44. What type of reaction is represented by the V equation ${}_Z^AX + {}_Z^AX \rightarrow {}_Z^AY + {}_0^1n + \text{Energy}$? A. Fusion. B. Fission. C. Chain. D. Ionization.

45. When an atom undergoes a beta decay, the atomic number of the nucleus A. decreases by one. B. increases by one. C. becomes zero. D. remains unchanged.

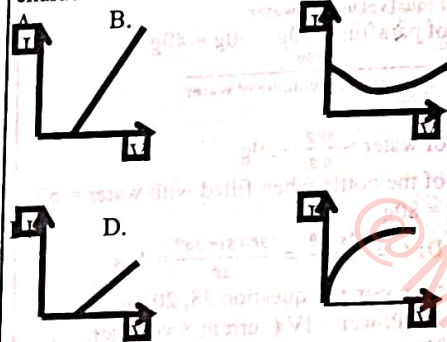
46. Calculate the mass of the copper deposited during electrolysis when a current of 4A passes through a copper salt for 2 hours. A. $9.5 \times 10^{-7}\text{kg}$ B. $9.5 \times 10^{-3}\text{kg}$ C. $2.9 \times 10^{-4}\text{kg}$ D. $2.9 \times 10^6\text{kg}$ [e of copper = $3.3 \times 10^{-7}\text{kgC}^{-1}$]

47. Which gas produces a pink coloured light in a discharge tube? A. Argon. B. Air. C. Neon D. Mercury.

48. When ${}_{82}^{210}\text{Pb}$ decays to ${}_{80}^{206}\text{Pb}$, it emits A an alpha particle B. one beta particle C. one alpha and two beta particle D. two alpha and two beta particles.

49. In a common emitter configuration, the output voltage is through A. base B. collector C. emitter D. resistor.

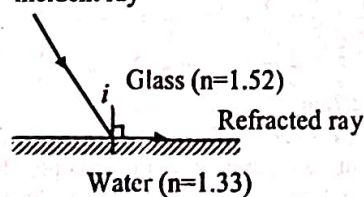
50. Which of the graphs below shows the characteristics of an I-V transistor?



2014 PHYSICS SOLUTION

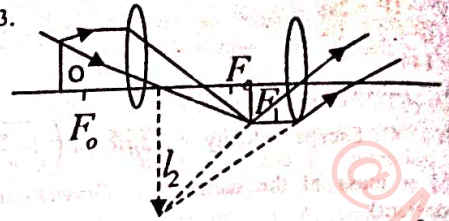
- A: the question paper type is F
- B: The least possible error encountered while using a measuring instrument is half of its smallest division. Note that the smallest division on a measuring instrument is known as its accuracy. The reading accuracy of a metre rule is 0.1cm or 1mm. Thus, the least possible error = $\frac{1}{2} \times 1\text{mm} = 0.5\text{mm}$
- B: A quantity that can be described only with the magnitude is a scalar quantity while the one that requires both the magnitude and direction is a vector quantity. Distance, mass and temperature are scalar quantities while displacement is a vector quantity.
- D: Torque and momentum are vectors while electric potential and energy are scalars.
- C: The wheel of a moving car undergo translational and rotational motion. The centre of the wheel undergoes translational motion while any other point on the wheel undergoes rotational motion around the centre.
- B: The region NS indicates zero acceleration as there is no change of velocity. The regions MN and SP indicate acceleration since the velocity is increasing. The region PQ indicates deceleration since the velocity is decreasing.
- D: $U = 0$ (Since it starting from rest)
 $a = 3\text{ms}^{-2}$, $S = 24\text{m}$, $V = ?$

3. The resultant of two forces is 50N. If the forces are perpendicular to each other and one of them makes an angle of 30° with the resultant, find its magnitude. A. 100.0N. B. 57.7N. C. 43.3N. D. 25.0N.
4. The pair of physical quantities that are scalar only are A. volume and area. B. moment and momentum. C. length and displacement. D. impulse and time.
5. A simple pendulum of length 0.4m has a period of 2s. What is the period of a similar pendulum of length 0.8m at the same place? A. 8s. B. 4s. C. $2\sqrt{2}$ s. D. $\sqrt{2}$ s.
6. A train with an initial velocity of 20ms is subjected to a uniform deceleration of 20m/s. The time required to bring the train to a complete halt is A. 5s. B. 10s. C. 20s. D. 40s.
7. Calculate the apparent weight loss of a man weighing 70kg in an elevator moving downwards with an acceleration of 1.5ms^{-2} . A. 686N. B. 595N. C. 581N. D. 105N. [$g = 10\text{ms}^{-2}$]
8. A piece of cork floats in a liquid. What fraction of its volume will be immersed in the liquid? A. 0.8. B. 0.5. C. 0.2. D. 0.1. [Density of the cork = $0.25 \times 10^3\text{kg}^{-3}$, density of the liquid = $1.25 \times 10^3\text{kg}^{-3}$]
9. An object is moving with a velocity of 5ms^{-1} . At what height must a similar body be situated to have a potential energy equal in value with kinetic energy of the moving body? A. 25.0m. B. 20.0m. C. 1.3m. D. 1.0m.
10. If a pump is capable of lifting 5000 kg of water through a vertical height of 60 m in 15 mm, the power of the pump is A. $2.5 \times 10^5\text{Js}^{-1}$. B. $2.5 \times 10^4\text{Js}^{-1}$. C. $3.3 \times 10^3\text{Js}^{-1}$. D. $3.3 \times 10^2\text{Js}^{-1}$
11. The coefficient of friction between two perfectly smooth surfaces is A. infinity. B. one. C. half. D. zero.
12. What effort will a machine of efficiency 90% apply to lift a load of 180N if its effort arm is twice as long as its load arm? A. 80N. B. 90N. C. 100N. D. 120N.
13. Calculate the work done when a force of 20N stretches a spring by 50mm. A. 0.5J. B. 1.5J. C. 2.0J. D. 2.5J.
14. At what depth below the sea-level would one experience a change of pressure equal to one atmosphere? A. 0.1m. B. 1.0m. C. 10.0m. D. 100.0m. [Density of sea water = 10^3kg^{-3} , one atmosphere = $0.01 \times 10^5\text{Nm}^{-2}$, $g = 10\text{ms}^{-2}$]
15. What volume of alcohol will have same mass as 4.2m^3 of petrol? A. 0.8m^3 . B. 1.4m^3 . C. 3.6m^3 . D. 4.9m^3 . [Density of alcohol = $8.4 \times 10^2\text{kgm}^{-3}$, density of petrol = $7.2 \times 10^3\text{kgm}^{-3}$]
16. Calculate the length which corresponds to a temperature of 20°C if the ice and steam points of an ungraduated thermometer are 400 mm apart. A. 20mm. B. 30mm. C. 60mm. D. 80mm.
17. A wire of length 100.0m at 30°C has linear expansivity of $2 \times 10^{-5}\text{K}^{-1}$. Calculate the length of the wire at a temperature of -10°C . A. 100.08m. B. 100.04m. C. 99.96m. D. 99.92m.
18. A gas at a pressure of 10^5Nm^{-2} expands from 0.6m^3 to 1.2m^3 at constant temperature, the work done is A. $7.0 \times 10^5\text{J}$. B. $6.0 \times 10^5\text{J}$. C. $6.0 \times 10^4\text{J}$. D. $6.0 \times 10^4\text{J}$.
19. Two liquids X and Y having the same mass are supplied with the same quantity of heat. If the temperature rise in X is twice that of Y, the ratio of specific heat capacity of X to that of Y is A. 2:1. B. 1:2. C. 4:1. D. 1:4.
20. Foods cook quicker in salt water than in pure water because of the effect of A. dissolved substances on the boiling point. B. atmospheric pressure on the boiling point. C. food nutrients on the thermal energy. D. salts on the thermal conductivity of water.
21. Steam from boiling water causes more damage on the skin than does boiling water because A. water has a high specific heat. B. steam has latent heat of fusion. C. the steam is at a higher temperature than the water. D. steam brings heat more easily by convection.
22. What will happen to the boiling point of pure water when it is heated in a place 30m below sea level? A. It will be more than 100°C . B. It will be less than 100°C . C. It will still be at 100°C . D. It will be fluctuating.
23. The rise or fall of a liquid in a narrow tube is because of the A. viscosity of the liquid. B. surface tension of the liquid. C. friction between the walls of the tube and the liquid. D. osmotic pressure of the liquid.
24. The mechanism of heat transfer from one point to another through the vibration of the molecules of the medium is A. convection. B. conduction. C. radiation. D. diffusion.
25. A wave that travels through stretched strings is known as A. electromagnetic wave. B. micro wave. C. mechanical wave. D. seismic wave.
26. A transverse wave and a longitudinal wave travelling in the same direction in a medium differ essentially in their A. frequency. B. amplitude. C. direction of vibration of the particles of the medium. D. period of vibration of the particles of the medium.
27. What is the velocity of sound at 100°C if the velocity of sound at 0°C is 340ms^{-1} ? A. 497ms^{-1} . B. 440ms^{-1} . C. 397ms^{-1} . D. 240ms^{-1}
28. If a sonometer has a fundamental frequency of 450Hz, what is the frequency of the fifth overtone? A. 2700Hz. B. 456Hz. C. 444Hz. D. 75Hz.
29. A man 1.5m tall is standing 3m in front of a pinhole camera whose distance between the hole and the screen is 0.1 m. What is the height of the image of the man on the screen? A. 0.05m. B. 0.15m. C. 0.30m. D. 1.00m.
30. A ray of light passing through the centre of curvature of a concave mirror is reflected by the mirror at A. 0° . B. 45° . C. 90° . D. 180°
31. Incident ray



From the diagram above, calculate the incident angle i . A. 41° . B. 49° . C. 55° . D. 61°

32. Total internal reflection will not occur when light travels from A. water to air. B. water into glass. C. glass to air. D. glass into water.



What does the diagram above represent? A. telescope in normal use. B. microscope in normal use. C. telescope in abnormal use. D. microscope in abnormal use.

34. If the linear magnification of the objective and eyepiece convex lenses of a compound microscope are 4 and 7 respectively, calculate the angular magnification of the microscope. A. 2. B. 3. C. 11. D. 28.
35. The angle of deviation of light of various colours passing through a triangular prism increases in the order A. red \rightarrow green \rightarrow blue. B. green \rightarrow violet \rightarrow blue. C. blue \rightarrow red \rightarrow green. D. blue \rightarrow green \rightarrow red.
36. Calculate the force acting on an electron of charge $1.5 \times 10^{-19}\text{C}$ placed in an electric field of intensity 10^5Vm^{-1} . A. $1.5 \times 10^{-11}\text{N}$. B. $1.5 \times 10^{-12}\text{N}$. C. $1.5 \times 10^{-13}\text{N}$. D. $1.5 \times 10^{-14}\text{N}$.
37. Capacitors are used in the induction coil to A. control circuits. B. dissipate energy. C. prevent electric sparks. D. prevent distortion of electric fields.
38. A cell of emf 1.5V is connected in series with a 1Ω resistor and a current of 0.3A flows through the resistor. Find the internal resistance of the cell. A. 4.0Ω . B. 3.0Ω . C. 1.5Ω . D. 1.0Ω .
39. Which of the following obeys ohm's law? A. electrolytes. B. metals. C. diode. D. glass.
40. A house has ten 40W and five 100W bulbs. How much will it cost the owner of the house to keep them lit for 10 hours if the cost of a unit is ₦5? A. ₦90. B. ₦50. C. ₦45. D. ₦60.
41. An electric device is rated 2000V, 250V. Calculate the maximum current it can take. A. 9A. B. 13A. C. 7A. D. 6A.
42. When a charge moves through an electric circuit in the direction of an electric force, it A. gains both potential and kinetic energy. B. gains potential energy and loses kinetic energy. C. loses potential energy and gains kinetic energy. D. loses both potential and kinetic energy.
43. To convert a galvanometer to a voltmeter A. high resistance is connected to it in series. B. high resistance is connected to it in parallel. C. low resistance is connected to it in series. D. low resistance is connected to it in parallel.
44. Induced emfs are best explained using A. Ohm's law. B. Faraday's law. C. Coulomb's law. D. Lenz's law.
45. If a current of 2.5A flows through an electrolyte for 5 hours and 1.8g of a substance is deposited, what is the mass of the substance that will be deposited if a current of 4A flows through it for 4.8 hours? A. 2.4g. B. 3.2g. C. 4g. D. 4.8g.
46. Calculate the energy of the third level of an atom if the ground state energy is -24.8eV . A. -9.20eV . B. -8.20eV . C. -2.75eV . D. -1.75eV .
47. In photo-emission the number of photo electrons ejected per second depends on the A. frequency of the beam. B. work function of the

metal C. threshold frequency of the metal D. intensity of the beam.

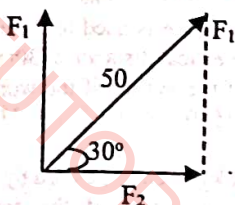
48. The particle nature of light is demonstrated by the A. photoelectric effect B. speed of light C. colours of light D. diffraction of light.

49. The energy of a photon having a wavelength of 10^{-10}m is A. $2.0 \times 10^{-15}\text{J}$ B. $1.7 \times 10^{-13}\text{J}$ C. $2.0 \times 10^{-12}\text{J}$ D. $17 \times 10^{-12}\text{J}$. ($h = 6.63 \times 10^{-34}\text{Js}$, $c = 3.0 \times 10^8\text{ms}^{-1}$)

50. The bond between silicon and germanium is A. dative. B. covalent. C. trivalent. D. ionic.

2013 UTME PHYSICS SOLUTION

1. A: The question paper type is D
2. A: The mass of an object is constant while its weight varies from place to place.
3. C:



$$\cos 30^\circ = \frac{F_2}{50}$$

$$F_2 = 50 \cos 30^\circ$$

$$= 43.3\text{N}$$

4. A: Volume, area, length and time are scalar quantities while moment, momentum, displacement and impulse are vector quantities.

$$5. \text{ C: } \frac{T_1}{\sqrt{L_1}} = \frac{T_2}{\sqrt{L_2}}; T_2 = \frac{T_1 \times \sqrt{L_2}}{\sqrt{L_1}} = \frac{2 \times \sqrt{0.8}}{\sqrt{0.4}} = 2\sqrt{2}\text{s}$$

6. B: $U = 20\text{m/s}$
 $V = 0$ (since the train is finally coming to rest)
 $a = -2\text{m/s}^2$; $t = ?$
 $V = U + at$

$$0 = 20 + (-2)t; \implies = 20 - 2t$$

$$2t = 20; t = \frac{20}{2} = 10\text{s}$$

7. D: Since the elevator is moving down, the apparent weight of the man = $mg - ma$
 $= 70(10) - 70(1.5)$
 $= (700 - 105)\text{N}$
 $= 595\text{N}$

Students must note that the above is the reading of the man while in the elevator. His normal weight, $w = mg = (70 \times 10)\text{N} = 700\text{N}$
 Loss in weight = $700\text{N} - 595\text{N} = 105\text{N}$

8. C: Fraction of cork submerged in a fluid
 $= \frac{\text{Density of cork}}{\text{Density of fluid}} = \frac{0.25 \times 10^3}{1.25 \times 10^3} = 0.2$

9. C: P.E = K.E
 $mgh = \frac{1}{2}mv^2$

$$\text{Then, } h = \frac{\frac{1}{2}mv^2}{mg} = \frac{1}{2} \frac{v^2}{g} = \frac{1}{2} \times \frac{5^2}{10} = 1.25\text{m}$$

10. C: $\rho = \frac{m}{V} = \frac{mgh}{t} = \frac{(5000 \times 60 \times 10)}{15 \times 60} = 3333.33\text{Js}^{-1}$
 $= 3.33 \times 10^3\text{W}$

11. D: The coefficient of friction between two perfectly smooth surface is zero. Motion on such a surface will be unhindered

12. C: $V.R = \frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$

$\frac{\text{Effort arm}}{\text{Load arm}}$
 Since the effort arm is twice as long as the load arm, we can write:
 Effort arm = $2 \times$ load arm
 $V.R = \frac{2 \times \text{load arm}}{\text{load arm}} = 2$

$$\epsilon = \frac{M.A}{V.R} \times 100\%$$

$$90\% = \frac{M.A}{2} \times 100\%$$

$$M.A = \frac{\text{Load}}{\text{Effort}}; 1.8 = \frac{180}{\text{Effort}}; \text{Effort} = \frac{180}{1.8} = 100\text{N}$$

13. A: $F = 20\text{N}$, $e = 50\text{mm} = 50(10^{-3})\text{m} = 0.05\text{m}$

$$\text{Workdone} = \frac{1}{2}Fc = \frac{1}{2} \times 20 \times 0.05 = 0.5\text{J}$$

14. C: $P = h\rho g$
 $P =$ fluid pressure
 $h =$ depth in the fluid
 $\rho =$ density of the fluid

$g =$ acceleration due to gravity
 $1\text{atm} = 101325\text{Nm}^{-2} \approx 10^5\text{Nm}^{-2}$
 $10^5 = h \times 1013 \times 10$

$$h = \frac{10^5}{10130} = 9.87\text{m} = 10\text{m}$$

15. C: Let us first calculate the mass of the petrol

$$\text{Mass} = \text{density}_{\text{petrol}} \times \text{volume}_{\text{petrol}} = 7.2 \times 10^2 \times 4.2 = 3024\text{kg}$$

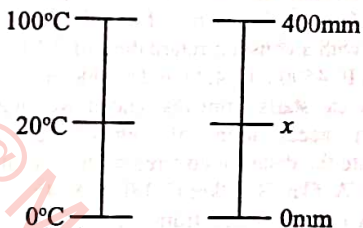
Mass of the alcohol must be equal to that of petrol. Thus, we can write:

$$\text{Density}_{\text{alcohol}} \times \text{volume}_{\text{alcohol}} = 3024\text{kg}$$

$$840\text{kgm}^{-3} \times \text{volume}_{\text{alcohol}} = 3024\text{kg}$$

$$\text{Volume}_{\text{alcohol}} = \frac{3024\text{kg}}{840\text{kgm}^{-3}} = 3.6\text{m}^3$$

16. D:



$$\frac{100-0}{20-0} = \frac{400-x}{400-0}$$

$$\frac{100}{20} = \frac{400-x}{400}$$

$$x = \frac{20 \times 400}{100} = 80\text{mm}$$

17. D: $L_1 = 100\text{m}$

$\theta_1 = 30^\circ\text{C}$

$$\alpha = 2 \times 10^{-5}\text{K}^{-1}$$

$\theta_2 = -10^\circ\text{C}$

$$\Delta\theta = \theta_2 - \theta_1 = -10^\circ\text{C} - 30^\circ\text{C} = -40^\circ\text{C}$$

$$L_2 = L_1(\alpha\Delta\theta + 1)$$

$$= 100(2 \times 10^{-5} \times -40 + 1)$$

$$= 100(0.9992) = 99.92\text{m}$$

18. D: Workdone = $P\Delta V$

$$= 10^5(1.2 - 0.6)$$

$$= 10^5(0.6) = 6 \times 10^4\text{J}$$

19. B: Since they are supplied with the same quantity of heat, we can write:

$$M_x C_x \Delta\theta_x = M_y C_y \Delta\theta_y$$

Since they have the same mass, the equation reduces to:

$$C_x \Delta\theta_x = C_y \Delta\theta_y \text{ (the mass cancels out)}$$

Since the temperature rise in x is twice that of y i.e. $\Delta\theta_x = 2\Delta\theta_y$, we have:

$$C_x \times 2\Delta\theta_y = C_y \times \Delta\theta_y$$

Then,

$$\frac{C_x}{C_y} = \frac{\Delta\theta_y}{2\Delta\theta_y} = \frac{1}{2}$$

Thus, $C_x : C_y = 1 : 2$

20. A: This is due to the effect of dissolved substances on the boiling point. It must be generally noted that impurities raise boiling points and lower melting points.

21. B: It is because the steam has latent of vaporization while liquid water does not.

22. A: The pressure below the sea level is higher than that at the sea level and that above the sea level. Note that the variation of boiling point and melting point with impurity is similar to that with pressure. In other words, boiling point increases as pressure increases and vice-versa. The opposite is the case for melting point.

23. C: Capillarity is the tendency of a liquid to rise or fall in a narrow tube. The friction between the walls of the tube and the liquid accounts for capillarity.

24. B: The method of heat transfer that involves the vibration of the molecules of the medium is known as conduction. Convection of the medium while radiation does not require material medium at all.

25. C: A wave that requires a material medium for its propagation is known as a mechanical wave. Here, the stretched string is the medium through which the wave is propagated.

26. C: Transverse waves travel in a direction perpendicular to the vibration producing them while longitudinal waves travel in a direction that is parallel to the direction of vibration of the medium.

27. C: $V \propto \sqrt{T}$

$$V = K\sqrt{T}$$

$$K = \frac{v_1}{\sqrt{T_1}} = \frac{v_2}{\sqrt{T_2}}$$

Thus,

$$v_2 = \frac{v_1 \times \sqrt{T_2}}{\sqrt{T_1}} = \frac{340 \times \sqrt{373}}{\sqrt{273}} = 397\text{m/s}$$

28. A: Fundamental frequency = $f_0 = 450\text{Hz}$
 Fifth overtone = sixth harmonic = $6f_0 = 6 \times 450\text{Hz} = 2700\text{Hz}$

$$29. \text{ A: } \frac{H_1}{H_0} = \frac{v}{u}; \frac{H_1}{15} = \frac{0.1}{3}$$

$$H_1 = \frac{15 \times 0.1}{3} = 0.05\text{m}$$

30. D: A ray of light through the centre of curvature strikes the mirror normally and is reflected back along the same line or path. Note that the incident ray and the reflected ray are anti-parallel.

$$31. \text{ D: } n_w = \frac{\sin r}{\sin i} = \frac{1.33}{1.52} = 0.875$$

$$n_w = \frac{\sin i \text{ (the angle in glass)}}{\sin r \text{ (the angle in water)}}$$

$$0.875 = \frac{\sin 90^\circ}{\sin i}$$

$$\sin i = 0.875 \times \sin 90^\circ = 0.875 \times 1 = 0.875$$

$$i = \sin^{-1} 0.875 = 61.04^\circ = 61^\circ$$

32. B: Total internal reflection occurs only when light travels from denser medium to a less dense medium. If light travels from less dense medium to a denser medium, total internal reflection will not occur.

Water \rightarrow Air \checkmark

Glass \rightarrow Air \checkmark

Glass \rightarrow Water \checkmark

Water \rightarrow Glass \times

33. B: The diagram represents a compound microscope in normal use. NB: the eyepiece lens always has a longer focal length than the objective lens in a compound microscope.

34. D: The magnifying power of the compound microscope is the product of the magnification due to the objective lens and that

due to the eyepiece lens. Hence, magnification = $4 \times 7 = 28$.

35. A: Red → Orange → Yellow → Green → Blue → Indigo → Violet

Increasing angle of deviation

36. D: $F = Eq = 10^5 \times 1.5 \times 10^{-19} = 1.5 \times 10^{-14} \text{N}$

37. C: Capacitor has many uses other than to store electric charge. One of such is the use in induction coil to prevent electric sparks.

38. B: $I = \frac{E}{R+r}$; $0.3 = \frac{1.5}{1+r}$; $1+r = \frac{1.5}{0.3} = 5$;

$r = 5 - 1 = 4\Omega$

39. B: Metals obey Ohm's law and are therefore referred to as Ohmic conductors.

40. C: Total power = $10 \times 40\text{W} + 5 \times 100\text{W} = 900\text{W}$

= 0.9Kw

Time = 10hrs

Energy = Power × Time = $0.9\text{Kw} \times 10\text{hrs} = 9\text{Kwh}$

If 1 unit (1Kwh) costs = ₦5, 9kwh will cost ₦(9 × 5) = ₦45

41. B: $P = IV$; $I = \frac{P}{V} = \frac{2000}{250} = 8\text{A}$

42. C: It loses potential energy but gains kinetic energy.

43. A: To convert a galvanometer to a voltmeter, a high resistance (known as the multiplier) is connected to it in series. To convert a galvanometer to an ammeter, a low resistance (known as the shunt) is connected to it in parallel.

44. D: Lenz's law gives the direction of the induced emf.

45. C: $Q_1 = I_1 t_1 = (2.5 \times 3 \times 3600)\text{C} = 27,000\text{C}$

$Q_2 = I_2 t_2 = (4 \times 4.8 \times 3600)\text{c} = 69,120\text{C}$

$M \propto Q$, then, $\frac{M_1}{Q_1} = \frac{M_2}{Q_2}$

$M_2 = \frac{(M_1 \times Q_2)}{Q_1} = \frac{(1.89 \times 69120)}{27,000} = 4.6\text{g}$

46. C: $n = 3$; $E = \frac{-24.8\text{eV}}{n^2} = \frac{-24.8\text{eV}}{3^2} = -2.756\text{eV}$

47. D: The number of photoelectrons ejected in a photoemission depends on the intensity of light while the energy of the emitted photoelectrons depends on the frequency of the light and the work function.

48. A: Photoelectric effect supports the particle nature of light while reflection, refraction, diffraction polarization and interference support the wave nature.

49. A: $E = \frac{hc}{\lambda} = \left(\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{10^{-10}}\right)\text{J} = 2 \times 10^{-15}\text{J}$

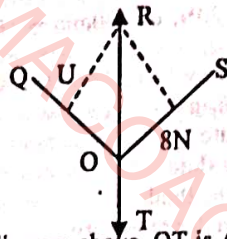
50. B: Both silicon and germanium have four valence electrons. Thus, neither will be 'willing' to donate electron. They can only share electrons. This is covalency.

2012 UTME PHYSICS QUESTIONS PAPER TYPE: PURPLE

- Which Question Paper Type of Physics as indicated above is given to you? A. Type Green. B. Type Purple C. Type Red. D Type Yellow.
- In order to remove the error of parallax when taking measurements with a metre rule, the eye should be focused A. slantingly towards the left on the markings B. slantingly towards the

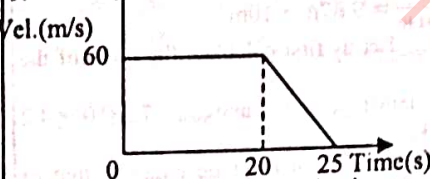
right on the markings C. vertically downwards on the markings D. vertically upwards on the markings.

3. A load is pulled at a uniform speed along a horizontal floor by a rope at 45° to floor. If the force in the rope is 1500N, what is the frictional force on the load? A. 1524N B. 1350N C. 1260N D. 1061N.



From the diagram above, OT is A. 18N B.14N C.5N D.2N

5.



From the velocity-time graph shown above, which of the following quantities CANNOT be determined? A. Deceleration B. Initial velocity C. Total distance travelled D. Initial acceleration.

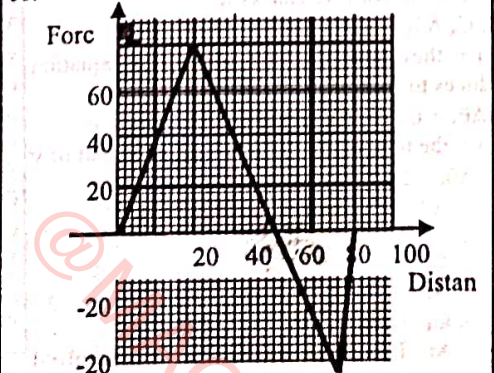
6. Calculate the total distance covered by a train before coming to rest if its initial speed is 30ms^{-1} with a constant retardation of 0.1ms^{-2} . A. 550Cm B. 4500m C. 420Cm D. 300Cm.

7. A car starts from rest and moves with a uniform acceleration of 30ms^{-2} for 20s. Calculate the distance covered at the end of the motion. A. 6km B. 12km C. 18km D.24km

8. A rocket is fired from the earth's surface to a distant planet. By Newton's law of universal gravitation, the force F will A. increase as r reduces B. increase as G varies C. remains constant D. increases as r increases.

9. If a freely suspended object is pulled to one side and released, it oscillates about the point of suspension because the A. acceleration is directly proportional to the displacement B. motion is directed away from the equilibrium point C. acceleration is directly proportional to the square of the displacement D. velocity is minimum at the equilibrium point.

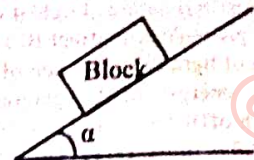
10. An object moves in a circular path of radius 0.5m with a speed of 1ms^{-1} . What is its angular velocity? A. 8 rads^{-1} B. 4 rads^{-1} C.2 rads^{-1} D. 1 rads^{-1}



11.

From the diagram above, calculate the work done when the particle moves from $x = 0\text{m}$ to $x = 80\text{m}$. A. 1200J B. 2400J C. 6000J D. 7000J.

12.



The diagram above shows a wooden block just about to slide down an inclined plane whose inclination to the horizontal is α . The coefficient of frictional force between the block and the plane is A. $\sin \alpha$ B. $\tan \alpha$ C. $\cot \alpha$ D. $\cos \alpha$.

13. An object of mass 20kg slides down an inclined plane at an angle of 30° to the horizontal. The coefficient of static friction is A. 0.2 B. 0.3 C. 0.5 D. 0.6. [$g = 10\text{ms}^{-2}$]

14. A block and tackle is used to raise a load of 250N through a vertical distance of 30m. What is the efficiency of the system if the work done against friction is 1500J? A. 62.5% B. 73.3% C. 83.3% D. 94.3%.

15. If a load of 1 kg stretches a cord by 1.2cm, what is the force constant of the cord? A. 866Nm^{-1} B. 833Nm^{-1} C. 769Nm^{-1} D. 667Nm^{-1} . [$g \approx 10\text{ms}^{-2}$]

16. An object of volume 1m^3 and mass 2kg is totally immersed in a liquid of density 1kgm^{-3} . Calculate its apparent weight. A. 20N B. 10N C. 2N D. 1N. [$g \approx 10\text{ms}^{-2}$]

17. The pressure at any point in a liquid at rest depends only on the A. depth and the density B. mass and the volume C. quantity and the surface area D. surface area and the viscosity.

18. A balloon whose volume is 300m^3 is filled with hydrogen. If the density of air is 1.3kgm^{-3} , find the upthrust on the balloon. A. 3000NB. 3800N C. 3900N D. 4200N. [$g \approx 10\text{ms}^{-2}$]

19. Clinical thermometers are examples of A. pressure gas thermometer B. resistance thermometer C. alcohol thermometer D. mercury-in-glass thermometer.

20. Two metals P and Q are heated through the same temperature difference. If the ratio of the linear expansivities of P to Q is 2 : 3 and the ratio of their length is 3 : 4 respectively, the ratio of the increase in lengths of P to Q is A. 1 : 2 B. 2 : 1 C. 8 : 9 D. 9 : 8.

21. 2000cm^3 of a gas is collected at 27°C and 700mmHg . What is the volume of the gas at standard temperature and pressure? A. 1896.5cm^3 B. 1767.3cm^3 C. 1676.3cm^3 D. 1456.5cm^3 .

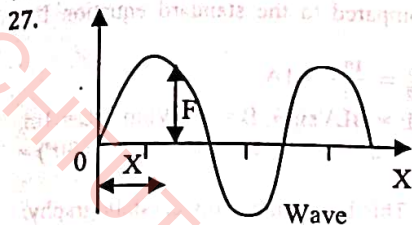
22. Calculate the temperature change when 500 J of heat is supplied to 100g of water. A. 12.1°C B. 2.1°C C. 1.2°C D. 0.1°C . [specific heat capacity of water = $4200\text{Jkg}^{-1}\text{K}^{-1}$]

23. Which of the following is NOT a factor that can increase the rate of evaporation of water in a lake? A. Increase in the pressure of the atmosphere. B. Rise in temperature. Increase in the average speed of the molecules of water D. Increase in the kinetic energy of the molecules of water.

24. The quantity of heat energy required to melt completely 1 kg of ice at -30°C is A. $4.13 \times 10^6\text{J}$ B. $4.13 \times 10^7\text{J}$ C. $3.56 \times 10^6\text{J}$ D. $3.56 \times 10^7\text{J}$ [latent heat of fusion = $3.5 \times 10^5\text{Jkg}^{-1}$, specific heat capacity of ice = $2.1 \times 10^3\text{Jkg}^{-1}\text{K}^{-1}$]

25. I. It is a rapid, constant and irregular motion of tiny particles. II. It gives evidence that tiny particles of matter called molecules exist. III. It takes place only in gases. IV. It gives evidence that molecules are in a constant state of random motion. Which of the combinations above is correct about Brownian motion? A. I, II and III only B. II, III and IV only C. I, III and IV only D. I, II and IV only.

26. The equation of a wave travelling in a horizontal direction is expressed as $y = 15\sin\frac{2}{5}(60t - x)$. What is its wave length? A. 60m B. 15m C. 5m D. 2m.



From the diagram above, if the particle F is at a distance X from 0 to the right, the phase of the vibration will be different from that at O by A. $\frac{2\pi x}{\lambda}$ B. $\frac{\pi x}{\lambda}$ C. $\frac{\lambda}{2\pi x}$ D. $\frac{\lambda}{\pi x}$

28. Which of the following factors will affect the velocity of sound? A. An increase in the pitch of the sound. B. An increase in the loudness of the sound. C. Wind travelling in the same direction of the sound D. A change in the atmospheric pressure constant temperature.

29. The characteristic of a vibration that determines its intensity is the A. frequent B. overtone C. wavelength D. amplitude.

30. Where can a man place his face to get an enlarged image when using a concave mirror to shave? A. Between the centre of curvature and the principal focus. B. At the principal focus C. Between the principal focus and the pole D. At the centre of curvature.

31. A pinhole camera is placed 300m in front of a building so that the image is formed on a screen 5cm from the pinhole. If the image is 2.5cm high, the height of the building will be A. 25m B. 50m C. 100m D. 150m.

32. The magnification of an object 2 cm tall when placed 10cm in front of a plane mirror is A. 6.0 B. 1.0 C. 0.7 D. 0.6

33. After reflection from the concave mirror, rays of light from the sun converges A. at the radius of curvature B. at the focus C. beyond the radius of curvature D. between the focus and radius of curvature.

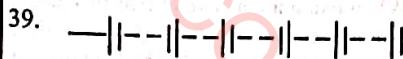
34. A glass block of thickness 10cm is placed on an object. If an observer views the object vertically, the displacement of the object is A. 3.33cm B. 5.00cm C. 6.67cm D. 8.50cm. [glass = 1.5]

35. I. Rays of light travel from a less dense medium to a denser medium. II. The Angle of incidence is greater than critical angle. III. Rays of light travel from a denser medium to a less dense medium. Which of the statements above are conditions for total internal reflection to occur? A. I & II only B. I & III only C. II & III only D. II only.

36. The use of lenses is NOT applicable in the A. projector B. human eye C. periscope D. telescope.

37. Dispersion of white light is the ability of white light to A. penetrate air, water and glass B. move in a straight line C. move around corners D. separate to its component colours.

38. A newly charged 12V accumulator can easily start a car whereas eight new dry cells in series with an effective e.m.f. of 12V cannot start the same car because A. the current capacity is high B. the current capacity is low C. it cannot be re-charged D. it cannot easily be connected to a car.

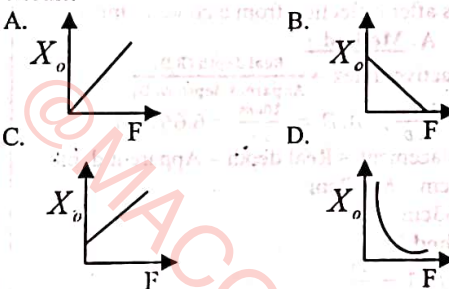


Six identical cells, each of e.m.f. 2V, are connected as shown above. The effective e.m.f. of the cell is A. 0V B. 4V C. 6V D. 12V.

40. The fuse in an electric device is always connected to the A. neutral side of an electric supply B. earth side of an electric supply C. live side of an electric supply D. terminal side of an electric supply.

41. A particle carrying a charge of $1.0 \times 10^{-8}C$ enters magnetic field at $3.0 \times 10^2 ms^{-1}$ at right angles to the field. If the force on this particle is $1.8 \times 10^{-8}N$ what is the magnitude of the field? A. $26.0 \times 10^{-1}T$ B. $6.0 \times 10^{-2}T$ C. $6.0 \times 10^{-3}T$ D. $6.0 \times 10^{-4}T$.

42. Which of the following is the correct shape of the graph of capacitive reactance X_c versus frequency F for a pure capacitor in an a.c. circuit?



43. The current output form of an a.c. source is given as $I = 10 \sin \omega t$. The d.c. equivalent of the current is A. 5.0A B. 7.1A C. 10.0A D. 14.1A

44. A conductor of length 1 m moves with a velocity of $50ms^{-1}$ at an angle of 30° to the direction of a uniform magnetic field of flux density $1.5Wbm^{-2}$. What is the e.m.f. induced in the conductor? A. 37.5V B. 50.5V C. 75.0V D. 80.5V.

45. The process of detecting a pin mistakenly swallowed by a child is x - ray A. diagnosis B. therapy C. crystallography D. mammography.

46. Which of the following particles CANNOT be deflected by both electric and magnetic fields? A. Gamma rays. B. Alpha particles. C. Wave particles. D. Beta particles.

47. A piece of radioactive material contains 1000 atoms. If its half-life is 20 seconds, the time taken for 125 atoms to remain is A. 20 seconds B. 40 seconds C. 60 seconds D. 80 seconds.

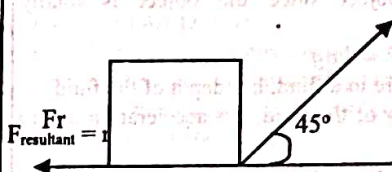
48. The p-n junction diodes can act as rectifiers because they A. conduct current when forward-biased B. conduct current when reverse-biased C. block current when forward-biased D. conduct current in both directions.

49. If a reverse-biased voltage is applied across a p-n junction, the depletion layer width is A. increased B. decreased C. constant D. halved.

50. I. Small size .II. Low power requirement III. Not easily damaged by high temperature IV. Highly durable. Which of the above are the advantages of semiconductors? A. I, II and III only B. II, III and IV only C. I, II and IV only D. I, II, III and IV.

2012 UTME PHYSICS SOLUTION

- B: The question paper type is purple
- C: The eye should be focused vertically downwards on the markings.
- D: 1500N



$1500\cos 45 - Fr = ma$
The load is said to be pulled at a uniform speed i.e. $a = 0$. Then, we have $1500\cos 45 - Fr = m \times 0 = 0$

Thus,
 $Fr = 1500\cos 45 = 1061N$

4. A: INCOMPLETE DIAGRAM
5. D: The horizontal part of the graph indicates the region of uniform velocity while the downward slanting line indicates deceleration. The initial acceleration cannot be determined since the acceleration region is not included.

6. B: $U = 30m/s, V = 0, A = -0.1m/s^2, S = ?$
 $V^2 = U^2 + 2aS; S = \frac{v^2 - U^2}{2a} = \frac{0^2 - 30^2}{2(-0.1)} = 4500m$

7. A: $U = 0, a = 30m/s^2, t = 20s, S = ?$
 $S = Ut + \frac{1}{2}at^2 = (0 \times 20) + \frac{1}{2} \times 30 \times 20^2 = 6000m = 6km$

8. A: From Newton's law of universal gravitation:
 $F = \frac{GM_1M_2}{r^2}$

$F =$ Gravitational force, m_1 & $m_2 =$ masses
 $r =$ the distance between the masses.

As can be seen, the force (F) and the separation (r) maintain an inverse relationship i.e. as 'r' increases, 'F' decreases and as 'r' decreases, 'F' increases.

9. A: This is simple harmonic motion. A body is said to be undergoing simple harmonic motion if its acceleration towards a fixed point is directly proportional to the displacement from the fixed point.

10. C: $V = wr; w = \frac{v}{r} = \left(\frac{1}{0.5}\right)rad/s = 2rad/s$
11. B: The workdone equals the area under the graph and this equals the area of the big triangle + area of the small triangle. This equals: $\frac{1}{2} \times (60 - 0) \times 70 + \frac{1}{2} \times (80 - 60) \times 30 = (2100 + 300)J = 2400J$

12. B: Whenever the giving body is about to slide down or is already sliding down (but at a uniform velocity), the coefficient of friction, $\mu = \tan \theta$. Where θ (known as the angle of friction) is the angle the inclined plane makes with the horizontal at this point.

13. D: As already explained above, $\mu = \tan \theta$
 $\theta = \tan 30^\circ = 0.5774 = 0.6$

14. C: Workdone by the load = $(250 \times 30)J = 7500J$. Since 1500J of work is done against

friction, total workdone by the effort = (7500 + 15000)J = 9000J

$$\epsilon = \frac{\text{Workdone by load}}{\text{Workdone by effort}} \times 100\%$$

$$= \frac{7500}{9000} \times 100\% = 83.3\%$$

15. B: Mass = 1kg; weight = (1 × 10)N = 10N
Extension = 1.2cm = 0.012m

$$F = Ke; K = \frac{F}{e} = \frac{10N}{0.012m} = 833.33Nm^{-1}$$

16. B: Upthrust = $\rho Vg = (1 \times 1 \times 10)N = 10N$

Weight of the solid in air = $mg = 20N$

Apparent weight = 20N - 10N = 10N

NB: The volume of the liquid displaced equals that of object since the object is totally immersed.

17. A: $P = h\rho g$

P = Pressure in a fluid, h = depth of the fluid

ρ = density of the fluid, g = acceleration due to gravity.

18. C: $U = \rho Vg = (1.3 \times 300 \times 10) = 3900N$

19. D: Clinical thermometers are good examples of liquid-in-glass thermometers. To be specific, they are mercury-in-glass thermometers.

20. A:

	P	Q
$\Delta\theta$	x	x
α	2y	3y
l	3z	4z

$$\Delta L_P = \alpha_P L_P \Delta\theta_P; \Delta L_Q = \alpha_Q L_Q \Delta\theta_Q$$

Thus,

$$\frac{\Delta L_P}{\Delta L_Q} = \frac{2y \times 3z \times x}{3y \times 4z \times x} = \frac{2 \times 3}{3 \times 4} = \frac{2}{4} = \frac{1}{2}$$

Then, $\Delta L_P : \Delta L_Q = 1 : 2$

21. C: $V_1 = 2000cm^3, T_1 = 27^\circ C = 300K, P_1 = 700mmHg, V_2 = ? T_2 = 273K, P_2 = 760mmHg$

Using the general gas equation

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}; V_2 = \frac{P_1 V_1 T_2}{P_2 T_1}$$

$$= \left(\frac{700 \times 2000 \times 273}{760 \times 300} \right) cm^3$$

22. C: $Q = mc\Delta\theta$

$$m = \left(\frac{100}{1000} \right) kg = 0.1kg$$

$$500 = 0.1 \times 4200 \times \Delta\theta$$

$$\Delta\theta = \frac{500}{420} = 1.2^\circ C$$

23. A: Decrease in pressure, rise in temperature, increase in the average speed of water molecules and increase in the kinetic energy of water molecules cause the rate of evaporation to increase. An increase in pressure reduces the rate of evaporation.

24. B: $Q = mL_{\text{fusion}} + mc\Delta\theta$
 $= (1 \times 3.5 \times 10^5) + (1 \times 2.1 \times 10^3 \times 30)$
 $= 413000J = 4.13 \times 10^5 J$

Note that only 'mL_{fusion}' will be required if the solid is already at its melting point (which is 0°C for ice).

25. D: All the statements except the one in 'III' are correct about the Brownian motion. This is because Brownian motion occurs in both gases and liquids. The movement of pollen grains in water as observed under a microscope exemplifies the occurrence in liquid while the movement of smoke in air is an example for its occurrence in gases.

26. C: $y = 15 \sin \frac{2\pi}{5} (60t - x)$

$$y = A \sin \left(2\pi ft - \frac{2\pi x}{\lambda} \right)$$

If the derived equation is compared with the general equation above, we have that:

$$\frac{2\pi x}{\lambda} = \frac{2\pi x}{\lambda}$$

$$\text{Thus, } \lambda = 5m$$

27. A: The phase difference $\frac{2\pi x}{\lambda}$

28. C: If wind travels in the same direction as the sound will increase. Also, the velocity increases as temperature increases.

29. D: The characteristics of a vibration that determines its intensity is the amplitude.

30. C: When using a concave mirror to shave, the user should place his face between the principal focus and the pole to obtain a magnified and erect image.

31. D: $H_1 = 2.5cm, H_0 = ? V = 5cm, U = 300m$

$$\frac{H_1}{H_0} = \frac{V}{U}$$

$$\frac{2.5cm}{H_0} = \frac{5cm}{300m}; H_0 = \frac{2.5cm \times 300m}{5cm} = 150m$$

32. B: The magnification of an image produced by a plane mirror is always 1. This is because the object distance and the image distance are equal for a plane mirror, remember that magnification (M) = $\frac{\text{Image distance (V)}}{\text{Object distance (U)}}$. So, if object distance is x, image distance will also be x.

$$\text{Then, } M = \frac{V}{U} = \frac{x}{x} = 1$$

33. B: Rays of light from an object at infinity (such as the sun) will converge at the principal focus after reflection from a concave mirror.

34. A: **Method 1**

$$\text{Refractive index} = \frac{\text{Real depth (R.D.)}}{\text{Apparent depth (A.D.)}}$$

$$1.5 = \frac{10cm}{A.D.}; A.D. = \frac{10cm}{1.5} = 6.667cm$$

Displacement = Real depth - Apparent depth
 $= 10cm - 6.667cm = 3.33cm$

Method 2

$$D = t \left(1 - \frac{1}{\mu} \right)$$

D = Displacement, t = thickness, μ = Refractive index

$$D = 10cm \left(1 - \frac{1}{1.5} \right) = 3.33cm$$

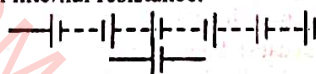
35. C: For total internal reflection to occur: Light must travel from a denser medium to a less dense medium.

The angle of incidence must be greater than the critical angle.

36. C: A periscope essentially consists of two parallel plane mirrors fixed facing each other and inclined at 45° to the horizontal. The periscope is an instrument for looking over obstacles.

37. D: Dispersion of white light is the ability of white light to be separated to its component colours.

38. B: It is because the current capacity is low. It must always be remembered that primary cells have high internal resistance.

39. B: 

To understand this, we need to know that the longer line depicts (+) while the shorter (-).

Let have 2V (as given) then

has -2V (since their directions are opposite). Thus, we have: $E = 2V - 2V + 2V - 2V + 2V + 2V = 4V$.

40. C: The fuse must always be connected to the live side of an electric supply.

41. C: $F = qVB \sin\theta$

$$B = \frac{F}{qv \sin\theta} = \frac{1.8 \times 10^{-8}}{1 \times 10^{-8} \times 3 \times 10^2 \times \sin 90^\circ} = 6.0 \times 10^{-3} T$$

42. B: The graph of X_C against F for a pure capacitor is always an inverse graph. This can be seen from the formula $X_C = \frac{1}{2\pi fC} (X_C \propto \frac{1}{f})$

43. B: The d.c equivalent of an a.c is simply the rms value (I_{rms}). From $I = 10 \sin \omega t, I_0 = 10A$ (when compared to the standard equation $I = I_0 \sin \omega t$)

$$I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 7.1A$$

44. A: $A = BLV \sin\theta; B = 1.5Wbm^{-2}, L = 1m, V = 50m/s, \theta = 30^\circ = (15 \times 1 \times 50 \times \sin 30^\circ) = 37.5V$

45. C: This is through x-ray crystallography.

46. A: Gamma rays are not charged. This is why they cannot be deflected by an electric or magnetic field.

47. C: $N_t = N_0 \left(\frac{1}{2} \right)^{\frac{t}{T_{1/2}}}; 125 = 1000 \left(\frac{1}{2} \right)^{\frac{t}{20}}$

$$\left(\frac{1}{2} \right)^{\frac{t}{20}} = \frac{125}{1000} = \frac{1}{8}$$

$$\left(\frac{1}{2} \right)^{\frac{t}{20}} = \frac{1}{8} = \left(\frac{1}{2} \right)^3; \left(\frac{1}{2} \right)^{\frac{t}{20}} = \left(\frac{1}{2} \right)^3. \text{ The, } \frac{t}{20} = 3$$

$$t = (20 \times 3)_s = 60s$$

48. A: The p-n junction diodes can act as rectifier because they conduct current when forward biased.

49. A: If a reverse-biased voltage is applied across a p-n junction, the depletion layer width is increased.

50. D: All the given statements correctly represent the advantages of semi-conductors.

2011 UTME PHYSICS QUESTIONS PAPER TYPE C

1. Which Question Paper Type of Physics is given to you? A. Type A. B. Type B. C. Type C. D. Type P.

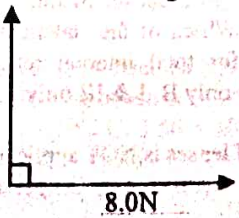
2. A carpenter on top of a roof 20.0 m high dropped a hammer of mass 1.5kg and it fell freely to the ground. The kinetic energy of the hammer just before hitting the ground is A. 300 J B. 450 J C. 600 J D. 150 J. [$g = 10 ms^{-2}$]

3. Two balls X and Y weighing 5 g and 50 g respectively were thrown up vertically at the same time with a velocity of 100 ms⁻¹. How will their positions be one second later? A. X will be 500m ahead of Y B. X and Y will both be 500m from the point of throw C. X and Y will be 500m from each other D. Y will be 500m ahead of X.

4. A man standing on a lift that is descending does not feel any weight because A. there is no reaction from the floor of the lift B. there is no gravitational pull on the man in the lift C. the inside of the lift is airtight D. the lift is in vacuum.

5.

6.0N



8.0N

The diagram above shows two vectors at right angles to each other. The value of the resultant vector is A. 12.0N B. 13.0N C. 14.0N D. 10.0N.

6. An object of mass 2 kg moves with a velocity of 10 ms^{-1} round a circle of radius 4 m. Calculate the centripetal force on the object. A. 50 N B. 40 N C. 25 N D. 100N

7. If it takes an object 3s to fall freely to the ground from a certain height, what is the distance covered by the object? A. 45 m B. 60 m C. 90m D. 30m [$g = 10\text{ms}^{-2}$]

8.



The diagrams above show the positions of a cone. The position which can be described as neutral equilibrium is represented as A. Y and Z B. Y and X C. Z only D. X only.

9. If a tube of small radius opened at both ends is placed in a liquid, the liquid will A. fall below the liquid level if the liquid does not wet the glass B. rise above the liquid level if the liquid does not wet the glass C. remain at the same level irrespective of whether the liquid wets the glass or not D. fall below the liquid level if the liquid wets the glass.

10. I. Density of the liquid. II. Depth below the surface of the liquid. III. Surface area of the liquid. In which of the statements above will pressure be dependent? A. I, II and III B. I and III only C. I and II only D. II and III only

11. I. High thermal capacity. II. High sensitivity. III. Easy readability. IV. Accuracy over a wide range of temperatures. From the statements above, the qualities of a good thermometer are A. I, III and IV B. II, III and IV C. I and II D. I, II, III and IV

12. A machine is used to lift a load of 20 N through a height of 10m. If the efficiency of the machine is 40%, how much work is done? A. 300 J B. 120 J C. 80 J D. 500 J

13. Which of the following could be effectively used to reduce friction? A. Water. B. Petrol C. Kerosene. D. Grease.

14. A copper wire was subjected to a tensile stress of $7.7 \times 10^7 \text{ Nm}^{-2}$. Calculate the tensile strain of the wire A. 7.0×10^{-4} B. 2.2×10^{-4} C. 2.0×10^{-5} D. 7.0×10^{-3} [Young modulus = $1.1 \times 10^{11} \text{ Nm}^{-2}$]

15. An object weighs 22kg in water and 30kg in air. What is the upthrust exerted by the liquid on the object? A. 220 N B. 80 N C. 50 N D. 520 N [$g \approx 10\text{ms}^{-2}$]

16. A block of aluminium is heated electrically by a 30W heater. If the temperature rises by 10°C in 5 minutes, the heat capacity of the aluminium is A. 100 JK^{-1} B. 200 JK^{-1} C. 9003 K^{-1} D. 90 JK^{-1} .

17. A perfect emitter or absorber of radiant energy is a A. white body B. red body C. conductor D. black body.

18. The phenomenon that shows that increase in pressure lowers the melting point can be observed in A. coagulation B. regelation C. sublimation D. condensation

19. If the volume of a gas increases steadily as the temperature decreases at constant pressure,

the gas obeys A. pressure law B. Charles' law C. Graham's law D. Boyle's law.

20. Steam burn is more severe than that of boiling water because A. water boils at a higher temperature B. steam burn is dependent on relative humidity C. steam burn is independent of relative humidity D. steam possesses greater heat energy per unit mass.

21. Which of the following types of waves needs a medium for preparation? A. Radio waves. B. X-rays. C. Sound waves. D. Light wave.

22. The ground is always cold at night because the A. sun no longer shines at night B. atmosphere reflects the sun's energy at night C. atmosphere absorbs the sun's energy at night D. earth radiates heat to the atmosphere at night.

23. A metal of volume 40cm^3 is heated from 30°C to 90°C , the increase in volume is A. 1.20cm^3 B. 0.40cm^3 C. 0.12cm^3 D. 4.00cm^3 [Linear expansivity of the metal = $2.0 \times 10^{-5} \text{ K}^{-1}$]

24. I. Change of state II. Diffusion III. Radiation IV. Osmosis. Which of the processes above can be explained using the kinetic theory? A. I, III and IV B. I, II and IV C. I, II, III and IV D. I, II and III

25. When the human eye loses its power of accommodation, the defect is known as A. astigmatism B. long-sightedness C. short-sightedness D. presbyopia.

26. A length of wire has a frequency of 255 Hz when stretched by a force of 225 N. If the force increases to 324 N, what is the new frequency of vibration? A. 488 Hz B. 356 Hz C. 306 Hz D. 512 Hz

27. A certain far-sighted person cannot see objects that are closer to the eye than 50 cm clearly. Determine the power of the converging lens which will enable him to see at 25cm A. 0.03 D B. 0.04 D C. 0.06 D D. 0.02 D

28. Which of the following electromagnetic waves has the highest frequency? A. Infrared-rays. B. X-ray C. Ultra-violet rays D. Radio waves.

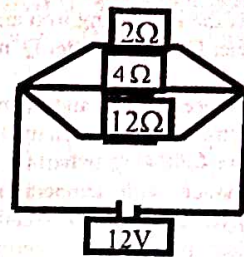
29. When a red rose flower is observed in blue light, what colour does the observer see? A. Magenta B. Yellow. C. Red. D. Blue.

30. The eclipse of the sun occurs when the A. moon is not completely hidden in the earth's shadow B. moon's umbra falls on some part of the earth C. moon is between the sun and the earth D. earth is between the sun and the moon.

31. A cannon is fired from town X. After how long is the sound heard at a town Y 4.95 km away? A. 12s B. 15s C. 30s D. 10s [Velocity of sound in air = 330ms^{-1}]

32. An image in a convex lens is upright and magnified 3 times. If the focal length of the lens is 15 cm, what is the object distance? A. 16cm B. 14cm C. 10cm D. 25cm

33. The capacitance of a parallel plate capacitor is $20 \mu\text{F}$ in air and $60 \mu\text{F}$ in the presence of a dielectric. What is the dielectric constant? A. 3.0 B. 2.0 C. 0.3 D. 6.0



In the circuit above, three resistors, 2Ω , 4Ω and 12Ω are connected in parallel and a 12V battery is connected across the combination. The current flowing through the 120Ω resistor is A. 3.2A B. 9.6A C. 14.4A D. 1.0A

35. If the charge of electricity per kWh is ₦4, what is the cost of operating an electrical appliance rated 250V, 2A for 6 hours? A. ₦16 B. ₦24 C. ₦28 D. ₦12

36. The correct expression for the potential at a point, distance r from a charge q in an electric field is A. $\frac{q}{4\pi\epsilon_0 r^2}$ B. $\frac{q^2}{4\pi\epsilon_0 r^2}$ C. $\frac{q}{4\pi\epsilon_0 r}$ D. $\frac{q^2}{4\pi\epsilon_0 r}$

37. Three similar cells each of e.m.f 2 V and internal resistance 20 are connected in parallel, the total e.m.f and total internal resistance are respectively A. 2V, 6.0Ω B. 6V, 0.7Ω C. 6V, 6.0Ω D. 2V, 0.7Ω.

38. In homes, electrical appliances and lamps are connected in parallel because A. less current will be used B. less voltage will be used C. parallel connection does not heat up the wires D. series connection uses high voltage.

39. Two resistors 5Ω and 10Ω are arranged first in series and later in parallel to a 24 V source. The ratio of total power dissipated in the series and parallel arrangements respectively is A. 50:1 B. 3:5 C. 5:3 D. 1:50.

40. Which of the following will be applied when a metal Y is used to electroplate another metal X in electrolysis? A. Y is the cathode and X is the anode. B. Y is the anode and very high current is used. C. X is the anode and very high current is used. D. X is the anode and Y is the cathode

41. A radioactive isotope has a decay constant of 10^{-5} s^{-1} . Calculate its half life. A. $6.93 \times 10^4 \text{ s}$ B. $6.93 \times 10^{-6} \text{ s}$ C. $6.93 \times 10^{-5} \text{ s}$ D. $6.93 \times 10^5 \text{ s}$

42. Which of the following is a property of steel? A. It can be used for making permanent magnets. B. It can easily be magnetized and demagnetized. C. It cannot retain its magnetism longer than iron. D. It can be used for making temporary magnets

43. If the threshold frequency for tungsten is $1.3 \times 10^{15} \text{ Hz}$, what is its work function? A. $8.58 \times 10^{-17} \text{ J}$ B. $8.85 \times 10^{-18} \text{ J}$ C. $8.58 \times 10^{-19} \text{ J}$ D. $8.58 \times 10^{-15} \text{ J}$ [$h = 6.6 \times 10^{-34} \text{ Js}$]

44. In an a.c circuit, the ratio of r.m.s value to peak value of current is A. $\frac{1}{\sqrt{2}}$ B. $\sqrt{2}$ C. 2 D. $\frac{1}{2}$

45. Two inductors of inductances 4 H and 8H are arranged in series and a current of 10A is passed through them. What is the energy stored in them? A. 133 J B. 250 J C. 500 J D. 50 J

46. Under which of the following conditions do gases conduct electricity? A. High pressure and low p.d B. High pressure and high p.d. C. Low pressure and low p.d. D. Low pressure and high p.d.

47. In measuring high frequency a.c., the instrument used is the A. moving iron ammeter B. hot wire ammeter C. d.c. ammeter D. moving coil ammeter.

48. The bond between silicon and germanium is A. dative B. electrovalent C. covalent D. ionic.

49. Which of the following materials has an increase in resistance with temperature? A. Wood. B. Electrolyte. C. Water. D. Metals.

50. The electrical properties of germanium can be altered drastically by the addition of impurities. This process is referred to as A. amplification. B. doping. C. saturation. D. bonding.

2011 UTME PHYSICS SOLUTION

1. C: The question paper type is C

2. A: You may first calculate the velocity with which the hammer will hit the ground and subsequently calculate its attending kinetic energy. Honestly, you don't have to work that much. The potential energy on the top of the roof is equal to the kinetic energy on the ground level.

$$K.E = P.E_{max} = mgh = (1.5 \times 10 \times 20)J = 300J$$

3. - KEY \Rightarrow Since the balls were thrown with the same velocity and at the same time, they are expected to be at the same vertical position at any given moment. Note also that when two objects fall freely from the same level, they will reach the ground level at the same time, provided that the effect of the air resistance is negligible, regardless of what their respective masses are. Let us now calculate what their distance will be after one second.

$$U = 100ms^{-1}, a = -10ms^{-2}, S = ? t = 1s$$

$$S = ut + \frac{1}{2}at^2 = (100 \times 1) + \frac{1}{2}(-10) \times 1^2 = (100 - 5)m$$

$$= 95m$$

4. A: (i) Reaction, $R = mg + ma$ (when the lift is ascending)

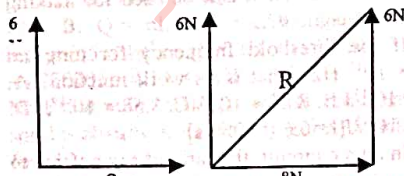
(ii) Reaction, $R = mg - ma$ (when the lift is descending with $g > a$)

(iii) Reaction, $R = ma - mg$ (when the lift is descending with $a > g$)

A person inside a lift that is falling freely will feel weightless as there is no reaction from the floor of the lift. We can easily prove this using either equation (ii) or (iii). Note first that free fall means $a = g$. Using equation (ii)

$$R = mg - ma. \text{ If } a = g, \text{ we have: } R = mg - mg = 0$$

5. D:



$$R^2 = 6^2 + 8^2; R^2 = 36 + 64 = 100$$

$$R = \sqrt{100} = 10N$$

6. A: Centripetal force, $F_c = \frac{mv^2}{r} = \frac{2 \times 10^2}{4} = 50N$

7. A: $t = 3s, a = 10ms^{-2}, u = 0, s = ?$

$$S = ut + \frac{1}{2}at^2 = (0 \times t) + \frac{1}{2} \times 10 \times 3^2 = 45m$$

8. C: X \Rightarrow unstable equilibrium

Y \Rightarrow stable equilibrium

Z \Rightarrow neutral equilibrium

9. A: If a narrow tube is placed in a liquid that does not wet glass (e.g. mercury), the liquid will fall below the liquid level. For a liquid that wets glass (e.g. water), the liquid will rise above the liquid level.

10. C: $P = h\rho g$

As can be seen from the equation above, the pressure (P) depends on the depth below the liquid surface (h), the density of the liquid (ρ) and the acceleration due to gravity (g)

11. B: A good thermometer must have:

(i) Low thermal capacity
(ii) Accuracy over a wide range of temperatures

(iii) Easy readability

(iv) Easy sensitivity

Why is high thermal capacity not a good quality of a thermometer?

High thermal capacity entails that a huge amount of heat will be required to cause a small rise in temperature. This is not good because large percentage of heat will be extracted from the body whose temperature is being measured.

12. D: Workdone by load = $20N \times 10m = 200J$

$$\epsilon = 40\%$$

$$\epsilon = \frac{\text{Workdone by load}}{\text{Workdone by effort}} \times 100\%$$

$$40\% = \frac{200}{\text{Workdone by effort}} \times 100\%$$

$$\text{Workdone by effort} = \frac{200 \times 100\%}{40\%} = 500J$$

13. D: Grease is a good lubricant; it can be used to reduce friction.

14. A: Young modulus = $\frac{\text{Tensile stress}}{\text{Tensile strain}}$

$$1.1 \times 10^{11} Nm^{-2} = \frac{7.7 \times 10^7 Nm^{-2}}{\text{Tensile strain}}$$

$$\text{Tensile strain} = \frac{7.7 \times 10^7 Nm^{-2}}{1.1 \times 10^{11} Nm^{-2}} = 7 \times 10^{-4}$$

15. B: Loss in mass = $30kg - 22kg = 8kg$

Upthrust = Loss in weight

$$= \text{loss in mass} \times g$$

$$= (8 \times 10)N = 80N$$

16. C: KEY \Rightarrow The heat that raised the temperature of the block was electrically generated. All we need to do is to equate the heat energy and the electrical energy.

The heat energy = The electrical energy

$$C\Delta\theta = \text{Power} \times \text{time}$$

$$C \times 10 = (30 \times 5 \times 60)$$

$$C = \left(\frac{30 \times 5 \times 60}{10}\right) JK^{-1} = 900JK^{-1}$$

17. D: A black body is the best absorber as well as the best emitter of radiant energy. A white body, on the other hand is the best reflector.

18. D: If a thin wire is passed round a large block of ice and two heavy weights are attached to the ends of the wire, as time goes on, the wire will slowly sink into the ice but no cut will be seen above it. Eventually, with the block still in one piece, the wire will pass through at the bottom. The above can be explained as follows:

The thin wire produces such a high pressure on the ice below it that the ice melts. The wire now sinks into the water formed, which immediately refreezes above the wire because there is no extra pressure here. So, the wire passes slowly through the ice, leaving the block unchanged; this is known as regelation.

19. - The examiner intended to test your knowledge of Charles' law but there is a mistake in the correlation. Charles' law states that the volume of a given mass of a gas is directly proportional to the absolute temperature, provided that the pressure is constant. The direct variation implies that the volume of the gas will decrease if there is a decrease in temperature, and vice versa provided that the pressure is constant.

20. D: It is because steam possesses greater heat energy per unit mass. Steam possesses latent heat of vapourization while the water does not.

21. C: Sound waves are mechanical waves. Recall that waves which require material medium for their propagation are called mechanical waves while those that do not require such are called electromagnetic waves. Radio waves, infra-red waves, visible light, ultraviolet rays, x-ray and gamma ray are electromagnetic waves.

22. D: The ground is always cold at night because the earth radiates heat to the atmosphere at night.

$$23. - Y = 3\alpha = \frac{\Delta V}{V\Delta\theta}$$

Thus,

$$\Delta V = 3\alpha V\Delta\theta = 3 \times 2 \times 10^{-5} \times 40 \times (90 - 30)$$

$$= (3 \times 2 \times 10^{-5} \times 40 \times 60)cm^3$$

$$= 0.144cm^3$$

24. B: Change of state, diffusion and osmosis can be explained using the kinetic theory while radiation cannot. This is because radiation is not concerned with material medium.

25. D: Accommodation is the ability to focus object at various distances clearly. When the power of accommodation of the eye is lost, it is called presbyopia. Presbyopia is due to old age. It is corrected using bifocal lens.

26. C: Recall that $F = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$. It follows that

$$F \propto \sqrt{T}. \text{ Then, } F = F\sqrt{T}; K = \frac{F}{\sqrt{T}}$$

Therefore,

$$\frac{F_1}{\sqrt{T_1}} = \frac{F_2}{\sqrt{T_2}}; \frac{255}{\sqrt{225}} = \frac{F_2}{\sqrt{324}}$$

$$F_2 = \frac{255 \times \sqrt{324}}{\sqrt{225}} = 306Hz$$

27. - KEY \Rightarrow For the man to see objects clearly at 25cm from the eye, the image must appear to be at 50cm. Note that both the object and image are on the same side of the lens, this indicates that the image is virtual i.e. V is negative.

$$U = 25cm, V = -50cm, f = ?$$

Using the lens equation

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{25} + \frac{1}{-50} = \frac{1}{25} - \frac{1}{50} = \frac{2-1}{50} = \frac{1}{50}$$

$$\frac{1}{f} = \frac{1}{50}, f = 50cm$$

Power of a lens (in diopters, D) =

focal length in metres

So, if you use f as 50cm, 0.02D will be obtained which is wrong

$$f = 50cm = \left(\frac{50}{100}\right)m = 0.5m$$

$$P = \frac{1}{f} = \frac{1}{0.5} = 2D$$

28. B: The electromagnetic wave that has the highest frequency is gamma ray, next to it is x-ray. In term of frequency, radio waves < infra-

red rays < visible light < ultraviolet rays < x-rays < gamma rays.

29. **A:** When a red rose flower is observed in blue light, the observer sees magenta. Please refer to the solution to question 7, 2017 for detailed explanation.

30. **C:** The eclipse of the sun (also known as solar eclipse) occurs when the moon comes between the sun and the earth. The eclipse of the moon (also known as lunar eclipse) occurs when the earth comes between the sun and the moon.

31. **B:** Velocity of sound in air = 330ms^{-1}
 Distance = $4.95\text{km} = (4.95 \times 1000)\text{m} = 4950\text{m}$
 $\text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{4950\text{m}}{330\text{ms}^{-1}} = 15\text{s}$

32. **C:** The real image produced by a converging surface (e.g. a convex lens) is always inverted while the virtual image is always upright or erect (use RIVU – Real in Inverted; Virtual is Upright). Thus, it is clear that the image described here is virtual i.e. v is negative.
 $m = \frac{v}{u}$; $3 = \frac{v}{u}$; $v = 3u$

Since the image is virtual, $v = -3u$

Using the lens equation

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{15} = \frac{1}{u} + \frac{1}{-3u}$$

$$\frac{1}{15} = \frac{3-1}{3u}; \frac{1}{15} = \frac{2}{3u}; u = \left(\frac{2 \times 15}{3}\right)\text{cm} = 10\text{cm}$$

33. **A:** The capacitance of a capacitor is given by the formula $C = \frac{AK\epsilon_0}{d}$

C = capacitance, A = area of overlap of the plates, ϵ_0 = permittivity of free space and K = dielectric constant of the material between the plates. From the formula, it is clear that $C \propto K$. Thus;

$$\frac{C_1}{K_1} = \frac{C_2}{K_2}$$

Also, it must be noted that $K = 1$ if the material between the plates is air $60\mu\text{f} = 6 \times 10^{-5}\text{f}$; $20\mu\text{f} = 2 \times 10^{-5}\text{f}$. It must be known that the conversion is not really necessary as whichever unit used will eventually cancel out.

$$\frac{2 \times 10^{-5}}{1} = \frac{6 \times 10^{-5}}{K_2}$$

$$K_2 = \frac{6 \times 10^{-5}}{2 \times 10^{-5}} = 3$$

34. **D:** When components are connected in parallel, the potential difference across them is the same and it is equal in value to the applied voltage.

$$V = 12\text{V}, R = 12\Omega$$

$$V = IR, I = \frac{V}{R} = \left(\frac{12}{12}\right)\text{A} = 1\text{A}$$

35. **D:** Power = $IV = (2 \times 250)\text{W} = 500\text{W} = 0.5\text{kW}$

Time = 6hrs

$$\text{Energy} = \text{power} \times \text{time} = 0.5\text{kW} \times 6\text{hr} = 3\text{kWh}$$

Since electricity cost ₦4 per kWh, the cost of 3Kwh = ₦(3 × 4) = ₦12

36. **B:** The electric potential, $V = \frac{Kq}{r}$

$$\text{But } K = \frac{1}{4\pi\epsilon_0}$$

Then,

$$V = \frac{Kq}{r} = K \times \frac{q}{r} = \frac{1}{4\pi\epsilon_0} \times \frac{q}{r} = \frac{q}{4\pi\epsilon_0 r}$$

37. **B:** When similar cells are connected in series, the total emf is the sum of the individual emf values. If, however, they are connected in parallel, the total emf is just the emf value of only one of them. Thus, for a parallel connection of three 2V cells, the emf = 2V. the resultant

resistance is obtained by reciprocal law (as typical of any parallel arrangement of resistor).

$$\frac{1}{r} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2}; \frac{1}{r} = \frac{3}{2}; r = \left(\frac{2}{3}\right)\Omega = 0.67\Omega$$

38. **D:** Series connection uses high voltage. For parallel connection, the voltage across each of the appliances equals the supply voltage.

39. – When the resistors are arranged in series, the equivalent resistance, $R = 5\Omega + 10\Omega = 15\Omega$
 $\text{Power} = \frac{V^2}{R} = \frac{24^2}{15} = 38.4\text{W}$

When the resistors are connected in parallel, $\frac{1}{R} = \frac{1}{5} + \frac{1}{10}$, $\frac{1}{R} = \frac{2+1}{10} = \frac{3}{10}$

$$R = \left(\frac{10}{3}\right)\Omega = 3.3333\Omega$$

$$P = \frac{V^2}{R} = \frac{24^2}{3.3333} = 172.8\text{W}$$

Power in series : Power in parallel = $38.4 : 172.8 = 11 : 50$

40. **B:** to electroplate a metal X with another metal Y, X is made the cathode while Y is made the anode.

41. **A:** $T_{\frac{1}{2}} = \frac{0.693}{\lambda}$ (Where $T_{\frac{1}{2}}$ = half-life and λ = decay constant)

$$T_{\frac{1}{2}} = \left(\frac{0.693}{10^{-5}}\right)\text{s} = 6.93 \times 10^4\text{s}$$

42. **A:** Steel is less easily magnetized than iron but once magnetized, it retains its magnetism longer than iron. This is why steel is used for making permanent magnets while iron is used for making temporary magnets.

43. **D:** Work function, $W_0 = hf_0$ (f_0 = threshold frequency)

$$W_0 = hf_0$$

$$= (6.6 \times 10^{-34} \times 1.3 \times 10^{15})\text{J}$$

$$= 8.58 \times 10^{-19}\text{J}$$

44. **A:** $I_{\text{r.m.s}}$ = Root mean square value of current
 I_0 = Peak value of current

Then,

$$\frac{I_{\text{r.m.s}}}{I_0} = \frac{1}{\sqrt{2}}$$

45. – When inductors are connected in series, the equivalent inductance, $L = L_1 + L_2 + L_3 \dots$

For a parallel connection,

$$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$$

$$\text{Here, } L = 4\text{H} + 8\text{H} = 12\text{H} \text{ (H means Henry)}$$

$$E = \frac{1}{2}LI^2 = \frac{1}{2} \times 12 \times 10^2 = 600\text{J}$$

46. **D:** Gases conduct electricity under low pressure and high potential difference.

47. **D:** A moving coil ammeter is used for measuring high frequency alternating current.

48. **C:** Since both atoms are tetravalent, neither of them is capable of electron donation. Thus, the bond between silicon and germanium is covalent.

49. **D:** The resistance of metals increases as temperature increases while that of semi-conductors decreases with a temperature rise.

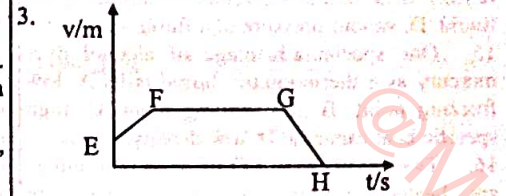
50. **B:** The addition of impurities to a pure semi-conductor to form an impure or extrinsic semi-conductor is known as doping.

2010 UTME PHYSICS QUESTIONS PAPER TYPE: B

1. Which. Physics Question Paper Type is given to you? A. Type A B. Type BC. Type CD. Type D

2. Two cars moving in the same direction have speeds of 100kmh^{-1} and 130kmh^{-1} . What is the velocity of the faster car as measured by

an observer in the slower car? A. 130kmh^{-1} B. 230kmh^{-1} C. 200kmh^{-1} D. 30kmh^{-1}




The diagram above shows a velocity-time graph. The statement that is true about this motion is that, the car A. decelerates between points F and H. B. accelerates between points F and G. C. has a constant speed between points E and F. D. has no acceleration between point F and G.

4. A stone and feather are dropped from the same height above the earth surface. Ignoring air resistance, which of the following is correct? A. The stone and feather will both reach the ground at the same time B. The stone will reach the ground first C. The feather will reach the ground first D. The feather will be blown away by the wind while stone will drop steadily

5. A car moves with an initial velocity of 25ms^{-1} and reaches a velocity of 45ms^{-1} in 10s. What is the acceleration of the car? A. 5ms^{-2} B. 25ms^{-2} C. 20ms^{-2} D. 2ms^{-2}

6. An object is weighed at different locations on the earth. What will be the right observation? A. Both the mass and weight vary B. The weight is constant while the mass varies C. The mass is constant while the weight varies D. Both the mass and weight are constant

7.  The diagram above represents balls in an undulating surface. Which of the following options represents positions of stable equilibrium? A. II, V and VIII B. I, IV and VII C. III, VI and IX D. III, IV and VIII

8. A bob of weight 0.1 N hangs from a mass less string of length 50 cm. A variable horizontal force which increases from zero is applied to pull the bob until the string makes an angle of 60° with the vertical. The work done is A. 0.250 J. B. 0.025 J. C. 0.050 J. D. 0.500 J.

9. The surfaces of conveyor belts are made rough so as to A. prevent the load from slipping B. make them stronger C. enable them to carry more load. D. protect them while carrying loads.

10. A machine of velocity ratio 6 requires an effort of 400 N to raise a load of 800 N through 1 m. Find. The efficiency of the machine. A. 50.0%. B. 22.2%. C. 33.3%. D. 55.6%.

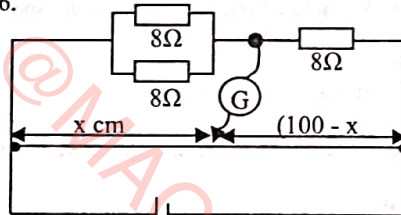
11. If a wire 30 cm long is extended to 30.5 cm by a force 300 N. Find the strain energy of the wire. A. 7.50 J. B. 750.00 J. C. 75.00 J. D. 0.75 J.

12. In a hydraulic press, the pump piston exerts a pressure of 100 Pa on the liquid. What force is exerted in the second piston of cross-sectional area 3m^2 ? A. 200 N B. 100 N C. 150 N D. 300 N

13. The accurate measurement of the relative density of a substance in its powdered form is done with a beam balance and A. an eureka can. B. a burette. C. a pipette. D. a density bottle.

14. A hydrometer is an instrument used in measuring A. density of liquid. B. relative density of a liquid. C. relative humidity of a liquid. D. vapour pressure of a fluid.
15. One special advantage of alcohol over mercury as a thermometric liquid is its A. low freezing point. B. low boiling point. C. high specific heat capacity. D. low density.
16. Two metals P and Q of lengths l_1 and l_2 are heated through the same temperature difference. If the ratio of the linear expansivities of P to Q is 2:3 and the ratio of their lengths is 3:4. What is the ratio of increase in lengths of P to Q? A. 5:7 B. 2:1 C. 1:2 D. 7:5
17. The density of a certain oil on frying becomes 0.4 kgm^{-3} with a volume of 20 m^3 . What will be its initial volume when its initial density is 0.8 kgm^{-3} assuming no loss of oil due to spillage? A. 10 kgm^{-3} B. 5 kgm^{-3} C. 8 kgm^{-3} D. 12 kgm^{-3}
18. Heat is radiated by all hot objects in the form of A. light energy. B. solar energy. C. infrared rays. D. x-rays.
19. If a container is filled with ice to the brim, what happens to the level of water when the ice completely melts? A. The water in the glass overflows B. The level of water drops C. The level of water remains unchanged D. The level of water goes up
20. The small droplet of water that forms on the grass in the early hours of the morning is A. dew. B. mist. C. fog. D. hail.
21. A vapour is said to be saturated when A. a dynamic equilibrium exists such that more molecules return to the liquid than are leaving it. B. the vapour pressure is atmospheric. C. the temperature of the vapour varies. D. a dynamic equilibrium exists between liquid molecules and the vapour molecules.
22. The pressure of one mole of an ideal gas of volume 10^{-2} m^3 at a temperature of 27°C is A. $2.24 \times 10^5 \text{ Nm}^{-2}$. B. $2.24 \times 10^5 \text{ Nm}^{-1}$. C. $2.49 \times 10^5 \text{ Nm}^{-2}$. D. $2.49 \times 10^4 \text{ Nm}^{-2}$. [Molar gas constant = $8.3 \text{ J mol}^{-1} \text{ K}^{-1}$]
23. Which of the following has no effect on radiation? A. density B. temperature C. surface area D. nature of the surface
24. The wavelength of a wave travelling with a velocity of 420 ms^{-1} is 42 m. What is its period? A. 1.0 s B. 0.1 s C. 0.5 s D. 1.2 s
25. The sound of an electric bell dies down slowly when air is slowly pumped out from a bottle because A. sound cannot pass through the bottle. B. sound can pass through a vacuum. C. sound needs a material medium. D. the wavelength of sound becomes greater in the bottle.
26. During a thunderstorm, the sound is heard over a long time. This phenomenon is referred to as A. refraction of sound B. reverberation C. superposition D. diffraction of sound.
27. The velocity of sound in air at 16°C is 340 ms^{-1} . What will it be when the pressure is doubled and its temperature raised to 127°C ? A. $4,000 \text{ ms}$ B. $160,000 \text{ ms}$ C. $8,000 \text{ ms}$ D. 40 ms
28. In comparing the camera and the human eye, the film of the camera functions as the A. iris. B. pupil. C. cornea. D. retina.

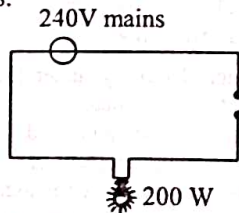
29. An object 4cm high is placed 15cm from a concave mirror of focal length 5cm. The size of the image is A. 3cm. B. 5cm. C. 4cm. D. 2cm.
30. An object is embedded in a block of ice, 10 cm below the plane surface. If the refractive index of the ice is 1.50, the apparent depth of the object below the surface is A. 6.77 cm. B. 7.63 cm. C. 7.50cm D. 2.50cm.
31. Which of the following is used for the correction of short-sightedness? A. Concave lens B. Concave mirror C. Convex mirror D. Convex lens
32. Dispersion occurs when white light passes through a glass prism because of the A. different speeds of the colours in the glass. B. high density of the glass. C. defects in the glass. D. different hidden colours in the glass.
33. When a positively charged rod is brought nearer the cap of a positively charged electroscope, the leaves' divergence will A. converge. B. remain constant. C. diverge. D. be induced.
34. Three capacitors of capacitance, $2\mu\text{F}$, $4\mu\text{F}$ and $8\mu\text{F}$ are connected in parallel and a p.d of 6V is maintained across each capacitor, the total energy store is A. $6.90 \times 10^{-6} \text{ J}$. B. $6.90 \times 10^{-4} \text{ J}$. C. $2.52 \times 10^{-4} \text{ J}$. D. $2.52 \times 10^{-6} \text{ J}$.
35. A cell of emf 12 V. and internal resistance 4Ω is connected to an external resistor of resistance 2Ω . Find the current flow. A. 4A B. 2A C. 3A D. 5A.
- 36.



The diagram above shows a balanced metre bridge, the value of x is A. 66.7cm. B. 25.0 cm. C. 33.3 cm. D. 75.0cm.

37. Three 4Ω resistors connected in parallel have a potential difference of 16 V applied across them. What is the Total current in the circuit? A. 12A B. 8A C. 10A D. 14A

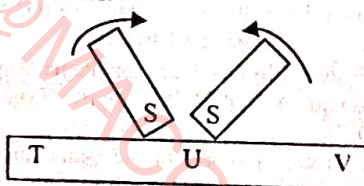
38.



In the diagram above, a 200 W bulb is lighted by a 240 V a.c mains supply. If 1 kWh is sold at ₦40, the cost of keeping the bulb lighted for a day is A. ₦192.00. B. ₦1.92. C. ₦19.20. D. ₦920.00.

39. Power supply is transmitted at a very high voltage and low current in order to A. increase the power supply B. prevent overheating of the coil C. make it travel fast D. make it pass through the transformers.

40.



In the diagram above, if the south-poles of two magnets stroke a steel bar, the polarities at T and V will respectively be A. north and south. B. south and south. C. north and north. D. south and north.

41. A galvanometer with full-scale deflection of 10 mA is to be converted to a voltmeter with full-scale deflection of 5 V. If a series resistance of 498Ω is used for the conversion, the resistance of the galvanometer is, A. 2Ω B. 10Ω C. 5Ω D. 1Ω

42. Two inductors of inductances 5 mH and 15 mH are connected in series and a current of 5 A flows through them. The total energy stored in the inductors is A. 250.0J B. 50.0J C. 62.5J D. 500.0J

43. In alternating current circuit at resonance, the angle of lead or lag is A. $\frac{\pi}{2}$ B. 0° C. $\frac{\pi}{3}$ D. π°

44. In Faraday's law of electrolysis, a graph of mass deposited against the quantity of electricity is plotted. The slope of the graph gives A. the electrochemical equivalent B. the charge released. C. the current flowing. D. the energy released.

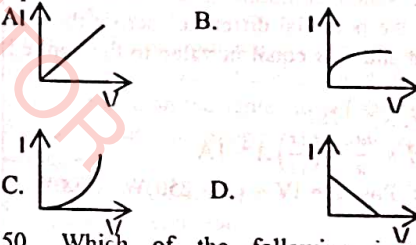
45. In a discharge tube, most of the gas is pumped out so that electricity is conducted at A. steady voltage. B. low pressure. C. high pressure. D. low voltage.

46. The radioisotope $^{235}_{92}\text{U}$ decays by emitting two alpha particles, three beta particles and a gamma ray. What is the mass and atomic numbers of the resulting daughter element? A. 91 and 227 B. 92 and 238 C. 227 and 91 D. 215 and 88.

47. The ground state energy for a hydrogen atom is $5.44 \times 10^{-19} \text{ J}$. If an electron drops from zero energy to ground state, calculate the frequency of the emitted radiation. A. $2.0 \times 10^{16} \text{ Hz}$. B. $2.0 \times 10^{15} \text{ Hz}$. C. $5.0 \times 10^{15} \text{ Hz}$. D. $5.0 \times 10^{16} \text{ Hz}$. [$h = 6.6 \times 10^{-34} \text{ Js}$]

48. Transistors are used for the A. conversion of a.c. to d.c. B. conversion of d.c. to a.c. C. amplification of signals. D. rectification of signals.

49. A typical transistor characteristic is represented as



50. Which of the following is a pure semiconductor? A. Silicon B. Phosphorus C. Transistor D. Carbon

2010 UTME PHYSICS SOLUTION

- B:** The question paper type is B
- D:** To a stationary observer, a car moving at 130 km/h will appear to be at 130 km/h . However, an observer travelling at 100 km/h in the same direction as a car travelling 130 km/h will measure the speed to be 30 km/h .
- D:** The car is accelerating between E and F, it has no acceleration between F and G (since

the velocity is constant) and is decelerating between G and H.

4. A: If the air resistance is to be ignored, both the stone and the feather will reach the ground at the same time as they are under the same acceleration (due to gravity).

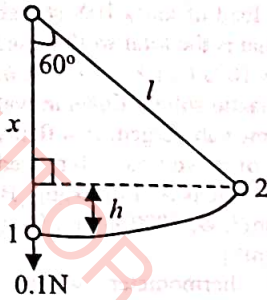
5. D: $a = \frac{v-u}{t} = \frac{(45-25)}{10} \text{ms}^{-2} = 2 \text{ms}^{-2}$

6. C: The mass is constant while the weight varies from one place to another.

7. C: A body is in stable equilibrium. If it will always return to its original position when slightly displaced.

Position III, VI and IX represent stable equilibrium.

8. B:



The workdone equals the potential energy of the bob at position 2.

$$P.E = mgh$$

The only issue here is that 'h' is not available.

First of all note that $x + h = l$ (since it is the same string).

$$\cos 60^\circ = \frac{x}{l}$$

$$x = l \cos 60^\circ$$

$$\text{Then, } h = l - x = l - \cos 60^\circ = l(1 - \cos 60^\circ)$$

Then,

$$P.E = mgh = mg(l(1 - \cos 60^\circ))$$

$$L = 50 \text{cm} = \left(\frac{50}{100}\right) \text{m} = 0.5 \text{m}$$

Then,

$$P.E = mgh = Wl(1 - \cos 60^\circ)$$

$$= 0.1 \times 0.5(1 - 0.5)$$

$$= 0.025 \text{J}$$

9. A: The surfaces of conveyor belts are made rough so as to prevent the load from slipping. It is one of the advantages of friction.

10. C: $M.A = \frac{L}{E} = \frac{800 \text{N}}{400 \text{N}} = 2$

$$V.R = 6$$

$$\epsilon = \frac{M.A}{V.R} \times 100\%; \quad \epsilon = \frac{2}{6} \times 100\% = 33.33\%$$

11. D: Length, $L_1 = 30 \text{cm}$, $L_2 = 30.5 \text{cm}$, $F = 300 \text{N}$, extension $= L_2 - L_1 = 30.5 \text{cm} - 30 \text{cm} = 0.5 \text{cm} = 0.005 \text{m}$

$$\text{Energy} = \frac{1}{2} Fe = \left(\frac{1}{2} \times 300 \times 0.005\right) \text{J} = 0.75 \text{J}$$

12. D: The pressure on the two pistons are equal. Thus, the second piston also experience a pressure of 100Pa

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$\text{Force} = \text{Pressure} \times \text{Area} = (100 \times 3) \text{N} = 300 \text{N}$$

13. D: The accurate measurement of the relative density of a substance in its powdered form is done with a beam balance and a density bottle.

14. B: A hydrometer is used for measuring relative density while a hygrometer is for measuring relative humidity.

15. A: An advantage of mercury over alcohol is that it can be used to measure very high

temperature since it boils at 357° while alcohol boils at a meager temperature of 78°C

Also, alcohol has its own advantage over mercury as a thermometric liquid since it freezes at -112°C . This makes an alcohol-in-glass thermometer suitable for measuring extremely low temperature values, whereas mercury-in-glass thermometer can't be so used.

16. C: Same as question 20, 2012.

17. A: Since there is no loss of oil, the mass is constant. From the relation

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{It follows that density } (\rho) \propto \frac{1}{\text{Volume } (v)}$$

$$\rho = \frac{k}{v}; \quad k = \rho v$$

$$\rho_1 v_1 = \rho_2 v_2; \quad 0.4 \times 20 = 0.8 \times v_2$$

$$v_2 = \frac{(0.4 \times 20)}{0.8} = 10 \text{m}^3$$

18. C: Heat is radiated from all objects in the form of infra-red rays.

19. B: The density of ice is about 0.9gcm^{-3} while that of water is 1.0gcm^{-3} . This means that when the equal mass of each substance is considered, the volume of ice will be greater than that of water (Yes, volume and density vary inversely as each other). Thus, when the ice melts, it forms water whose volume is lower. This means that the volume will drop.

20. A: The small droplet of water that forms on the grass in the early hours of the morning is known as dew.

21. D: A vapour is said to be saturated when a dynamic equilibrium exists between liquid molecules and the vapour molecules i.e. when the amount of liquid turning into vapour equals that of vapour condensing back into the liquid.

22. C: $PV = nRT$

$$P = ? \quad V = 10^{-2} \text{m}^3, \quad n = 1.0 \text{mol}, \quad R = 8.3 \text{Jmol}^{-1} \text{K}^{-1}, \quad T = 27^\circ = 300 \text{K}$$

$$P = \frac{nRT}{V} = \left(\frac{1 \times 8.3 \times 300}{10^{-2}}\right) \text{Nm}^{-2} = 2.49 \times 10^5 \text{Nm}^{-2}$$

23. A: Density has no effect on radiation at all. Factors such as temperature, surface area and nature of the surface affect radiation.

24. B: Frequency $= \frac{\text{Velocity}}{\text{Wavelength}} = \frac{420 \text{ms}^{-1}}{42 \text{m}} = 10 \text{s}^{-1}$ or 10Hz

$$\text{Period, } T = \frac{1}{f} = \left(\frac{1}{10}\right) \text{s} = 0.1 \text{s}$$

25. C: Sound, being a mechanical wave, cannot travel through vacuum. It requires a material medium for its propagation.

26. B: Reverberation is the phenomenon whereby sound is heard over a long time after reflection from hard surface.

27. D; The velocity sound in air is not affected by pressure; but for temperature, we have:

$$V \propto \sqrt{T}, \quad V = K\sqrt{T}, \quad K = \frac{V}{\sqrt{T}} \text{ i.e. } \frac{V_1}{\sqrt{T_1}} = \frac{V_2}{\sqrt{T_2}}$$

$$T_1 = 16^\circ \text{C} = 289 \text{K}, \quad T_2 = 127^\circ \text{C} = 400 \text{K}$$

$$V_2 = \frac{V_1 \sqrt{T_2}}{\sqrt{T_1}} = 340 \times \frac{\sqrt{400}}{\sqrt{289}} = 400 \text{ms}^{-1}$$

28. D: In comparing the camera and the human eye, the film of the camera functions the same way the retina of the human eye does. Note as well that:

(i) The aperture functions like the pupil

(ii) The diaphragm functions like the iris.

29. D: $H_0 = 4 \text{cm}$, $u = 15 \text{cm}$, $f = 5 \text{cm}$, $H_1 = ?$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}; \quad \frac{1}{5} = \frac{1}{15} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{1}{5} - \frac{1}{15} = \frac{3-1}{15} = \frac{2}{15}$$

Then,

$$v = \frac{15}{2} = 7.5 \text{cm}$$

$$\text{Magnification} = \frac{\text{Image distance } (v)}{\text{Object distance } (u)}$$

Also,

$$\text{Magnification} = \frac{\text{Image height } (H_1)}{\text{Object height } (H_0)}$$

Thus,

$$\frac{v}{u} = \frac{H_1}{H_0}; \quad H_1 = \frac{v \times H_0}{u} = \frac{7.5 \times 4}{15}$$

30. A: Refractive index $= \frac{\text{Real depth}}{\text{Apparent depth}}$

$$1.5 = \frac{10 \text{cm}}{\text{Apparent depth}}$$

$$\text{Apparent depth} = \frac{10 \text{cm}}{1.5} = 6.67 \text{cm}$$

31. A: Short-sightedness is corrected with concave or diverging lens while long-sightedness is corrected with convex or converging lens.

32. A: White light is dispersed into the respective components (red, orange, yellow, green, blue, indigo and violet) because the components travel at different speeds.

33. C: Since the electroscope and the rod are both positively charged, the divergence of the leaves (of the electroscope) will increase. If the two were oppositely charged, the divergence would decrease.

34. C: When capacitors are connected in parallel,

$$C_{\text{Total}} = C_1 + C_2 + C_3 \dots$$

$$= 2 \mu\text{f} + 4 \mu\text{f} + 8 \mu\text{f} = 14 \mu\text{f} = 1.4 \times 10^{-5} \text{f}$$

$$V = 6 \text{V}$$

$$\text{Energy} = \frac{1}{2} C V^2 = \frac{1}{2} \times 1.4 \times 10^{-5} \times 6^2$$

$$= 2.52 \times 10^{-4} \text{J}$$

35. B: $E = 12 \text{V}$, $R = 2 \Omega$, $r = 4 \Omega$

$$E - IR + Ir = I(R + r)$$

$$12 = I(2 + 4); \quad 12 = 6I, \quad I = \left(\frac{12}{6}\right) \text{A} = 2 \text{A}$$

36. C: The two 8Ω resistors connected in parallel will have an effective resistance of 4Ω .

$$\frac{R_1}{L_1} = \frac{R_2}{L_2}; \quad \frac{4}{x} = \frac{8}{100-x}; \quad 8x = 400 - 4x$$

$$8x + 4x = 400; \quad 12x = 400, \quad x = \left(\frac{400}{12}\right) \text{cm} = 33.33 \text{cm}$$

$$33.33 \text{cm}$$

37. A: Since they are connected in parallel,

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{4} + \frac{1}{4}; \quad \frac{1}{R} = \frac{1+1+1}{4} = \frac{3}{4}, \quad R = \frac{4}{3} = 1.3333 \Omega$$

$$V = 16 \text{V}$$

$$V = IR, \quad I = \frac{V}{R} = \left(\frac{16}{1.3333}\right) \text{A} = 12 \text{A}$$

38. A: Power = 200w = 0.2Kw, t = 1day = 24hrs

$$\text{Energy} = \text{Power} \times \text{time} = (0.2 \times 24) \text{Kwh} = 4.8 \text{Kwh}$$

Since 1Kwh is N40, 4.8Kwh will cost N(40 \times 4.8) = N192

39. B: Power is transmitted at a very high voltage and a low current in order to prevent the conducting cable from being over heated.

40. A: Both T and V will inherit north pole. If, on the other hand, the two magnets being used on the bar TUV are with north poles, the ends T and V will inherit south poles.

41. A: The multiplier resistance, $R_m = \frac{v}{I_g}$

$$r_g$$

Where V = Voltmeter reading

I_g = current in the galvanometer

r_g = Resistance of the galvanometer.

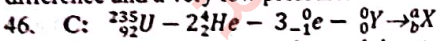
Thus,
 $498 = \frac{s}{10 \times 10^{-3}} - r_g$
 $498 = 500 - r_g$

$r_g = (500 - 498)\Omega = 2\Omega$
 42. C: $L_{\text{effective}} = L_1 + L_2 = 5\text{mH} + 15\text{mH} = 20\text{mH} = 20(10^{-3})\text{H} = 0.02\text{H}$
 $E = \frac{1}{2}LI^2$
 $= \frac{1}{2} \times 0.02 \times 5^2$
 $= 0.25\text{J}$

43. B: In alternating current circuit at resonance, the capacitive reactance X_c equals the inductive reactance X_L and current and voltage are in phase (i.e. the angle of lead or lag is 0°)

44. A: $m \propto Q$ (Faraday's first law of electrolysis) $m = ZQ$. The slope Z (which equal $\frac{m}{Q}$) is known as the electrochemical equivalent of the element involved. The S.I. unit of Z is Kgc^{-1}

45. B: Pumping cost of the gas out ensures that the gas pressure is low. Gases conduct electricity only at a very high potential difference and a very low pressure.



We have taken the mass number and the atomic number of the hypothetical daughter element X as a and b respectively.

NB: You can write the alpha particle, beta particle and gamma ray on the right hand side but that will compel the signs to change from negative to positive.

$235 - 2(4) - 3(0) - 0 = a$

$235 - 8 - 0 - 0 = a$

$a = 227$

$92 - 2(2) - 3(-1) - 0 = b$,

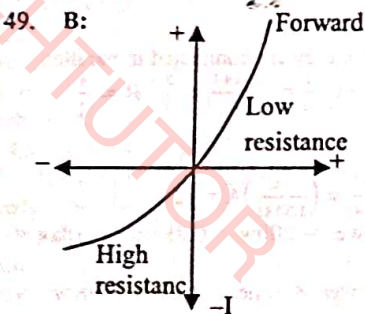
$92 - 4 + 3 - 0$

$b = 91$

47. $-\Delta E = hf$

$f = \frac{\Delta E}{h} = \frac{5.44 \times 10^{-19}}{6.6 \times 10^{-34}} = 8.24 \times 10^{14}\text{Hz}$

48. C: Transistors are used for the amplification of signals. They are also used as a switch in a computer system.



(The I - V diagram of a transistor)

50. A: Silicon and germanium are good examples of pure or intrinsic semi-conductors. When impurities are added to intrinsic semi-conductors (doping), an extrinsic semi-conductor is formed.

2009 UME PHYSICS QUESTIONS

1. The values of x, y and z respectively in the expression $\text{M}^x\text{L}^y\text{T}^z$ for the universal gravitational constant G are A. 2, -3, -2 B. -1, 3, -2 C. -1, 2, -3 D. -2, -1, 3.

2. I. Diameter of a small ball bearing II. Thickness of a piece of paper III. Diameter of a measuring cylinder IV. Length of a piece of

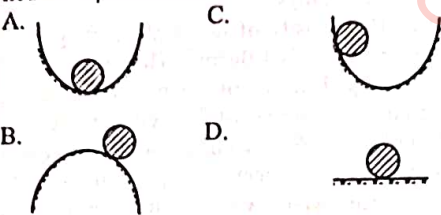
wire. Which of the above can be measured using a micrometer screw gauge? A. I, II and IV only B. I and II only C. II and III only D. III and IV only

3. An aircraft attempts to fly due north at 100kmh^{-1} . If the wind blows against it from east to west at 60kmh^{-1} , its resultant velocity is A. 117kmh^{-1} , $\text{N}31^\circ\text{E}$ B. 127kmh^{-1} , $\text{N}31^\circ\text{E}$ C. 117kmh^{-1} , $\text{N}31^\circ\text{W}$ D. 127kmh^{-1} , $\text{N}31^\circ\text{W}$.

4. What is the acceleration between two points on a velocity-time graph which has coordinates $(10\text{s}, 15\text{ms}^{-1})$ and $(20\text{s}, 35\text{ms}^{-1})$? A. 1.75ms^{-2} B. 3.50ms^{-2} C. 1.00ms^{-2} D. 2.00ms^{-2}

5. A car accelerates uniformly from rest at 4ms^{-2} . How far will it travel in the fifth complete second? A. 100m B. 50m C. 32m D. 18m

6. Which of the diagrams below shows the position at which a small ball-bearing is in neutral equilibrium?



7. A body of mass 12kg travelling at 4.2ms^{-1} collides with a second body of mass 18kg at rest. Calculate their common velocity if the two bodies coalesce after collision. A. 1.5ms^{-1} B. 1.4ms^{-1} C. 2.1ms^{-1} D. 1.7ms^{-1} .

8. A bullet fired vertically upward from a gun held 2.0m above the ground reaches its maximum height in 4.0s . Calculate its initial velocity. A. 10ms^{-1} B. 8ms^{-1} C. 40ms^{-1} D. 20ms^{-1} [$g = 10\text{ms}^{-2}$]

9. I. The motion of the tyres of a moving car II. The motion of a loaded test tube oscillating vertically. III. The beating of the heart IV. A stone tied to a string and whirled round V. The motion of the pistons in a gasoline engine.

Which of the motions above is simple harmonic? A. III, IV and V only B. II, III and V only C. II, III and IV only D. I, II and III only

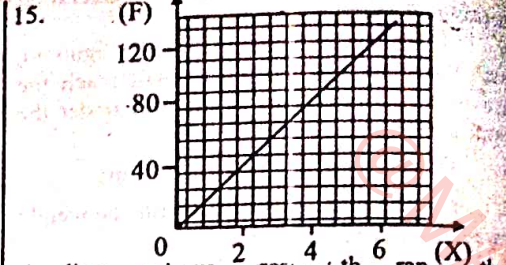
10. If a cage containing a truck of coal weighing 750kg is raised to a height of 90m in 1minute , what is the total power expended? A. 11.50kW B. 12.60kW C. 11.25kW D. 12.10kW [$g \approx 10\text{ms}^{-2}$]

11. An object of mass 80kg is pulled on a horizontal rough ground by a force of 500N . Find the coefficient of static friction A. 0.8 B. 0.4 C. 1.0 D. 0.6 [$g \approx 10\text{ms}^{-2}$]

12. If a heavy barrel is rolled up a plane inclined at 30° to the horizontal, its velocity ratio will be A. 3.0 B. 3.1 C. 3.2 D. 2.0 .

13. The terminal velocity of a ball-bearing falling through a viscous fluid is reached when the A. upthrust is equal to the weight of the ball B. ball accelerates uniformly. C. upthrust is equal to the velocity of the ball. D. velocity is uniform.

14. I. Density of the liquid II. Acceleration due to gravity III. Type of container of the liquid IV. The constituents of the liquid. Which of the above conditions will NOT affect the pressure of fluids? A. I and III only B. II and III only C. III and IV only D. I and II only



The diagram above represents the graph of the force (F) applied in stretching a spiral spring against the corresponding extension (X). The force constant of the spring is A. 20Nm^{-1} B. 40Nm^{-1} C. 30Nm^{-1} D. 10Nm^{-1} .

16. If a load of mass 10N stretches a cord by 1.2cm , what is the total work done? A. $6.0 \times 10^{-2}\text{J}$ B. $7.6 \times 10^{-2}\text{J}$ C. $1.8 \times 10^{-2}\text{J}$ D. $6.6 \times 10^{-2}\text{J}$

17. A plastic sphere floats in water with 50% of its volume submerged. If it floats in glycerine with 40% of its volume submerged, the density of the glycerine is A. 1400kgm^{-3} B. 1250kgm^{-3} C. 500kgm^{-3} D. 1000kgm^{-3} . [density of water = 1000kgm^{-3}]

18. The thermometer whose reading is indicated by a change in colour of its thermometric property is the A. bi-metallic strip thermometer. B. thermocouple. C. platinum resistance thermometer. D. optical pyrometer.

19. At 4°C , the volume of a fixed mass of water is A. constant B. minimum. C. maximum. D. zero.

20. The pressure of two moles of an ideal gas at a temperature of 27°C and volume 10^{-2}m^3 is A. $4.99 \times 10^5\text{Nm}^{-2}$ B. $9.80 \times 10^5\text{Nm}^{-2}$ C. $4.98 \times 10^5\text{Nm}^{-2}$ D. $9.80 \times 10^5\text{Nm}^{-2}$. [$R = 8.313\text{Jmol}^{-1}\text{K}^{-1}$]

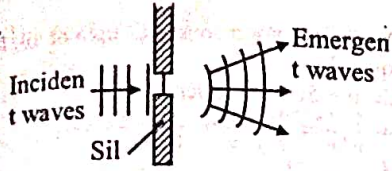
21. An electric heater rated 220V , 1000W is immersed into a bucket full of water. Calculate the mass of water if the temperature changes from 30°C to 100°C and the current flows for 300seconds . A. 4.28kg B. 42.86kg C. 1.02kg D. 7.14kg . [specific heat capacity of water = $4200\text{Jkg}^{-1}\text{K}^{-1}$]

22. If the pressure of the vapour on top of an enclosed liquid is equal to the atmospheric pressure, what will be the temperature of the liquid enclosed? A. Room temperature B. Boiling point C. Freezing point D. Standard temperature

23. A heating coil rated 1000W is used to boil off completely 2kg of boiling water. The time required to boil off the water is A. $1.15 \times 10^4\text{s}$ B. $1.15 \times 10^3\text{s}$ C. $4.6 \times 10^3\text{s}$ D. $4.6 \times 10^5\text{s}$. [specific latent heat of vaporization of water = $2.3 \times 10^6\text{Jkg}^{-1}$]

24. It is observed that water will wet a clean glass because the A. cohesion of water to glass is stronger than the cohesion of water molecules B. adhesion of water molecules is weaker than the cohesion of water to glass C. cohesion of water to glass is weaker than the cohesion of water molecules D. adhesion of water molecules is stronger than the cohesion of water molecules.

25. A man standing 2m from a charcoal fire is warmed mainly by A. convection. B. radiation C. refraction. D. conduction.



The wave phenomenon demonstrated in the diagram above is A. reflection. B. deflection. C. diffraction. D. refraction.

27. A progressive wave is represented by $y = 10 \sin(1000t - \frac{\pi x}{34})$. Two layers of the wave separated by 153cm have a phase difference of A. 270°. B. 450. C. 90°. D. 180°.

28. Metal cables are used as telephone wires because A. they are cheap. B. they are sourced locally. C. the speed of sound in them is very low. D. the speed of sound in them is very high.

29. Musical instruments playing the same note can be distinguished from one another owing to the differences in their A. quality. B. pitch. C. intensity. D. loudness.

30. If a light wave has a wavelength of 500mm in air, what is the frequency of the wave? A. 3.0×10^{14} Hz B. 6.0×10^{14} Hz C. 6.0×10^{12} Hz D. 2.5×10^{14} Hz [$c = 3 \times 10^8$ ms⁻¹]

31. I. Moon II. Sun III. Street light IV. Stars. Which of the above is a natural source of light? A. II, III and IV only B. I, II and III only C. III and IV only D. II and IV only

32. An object is placed 5cm from the pole of a concave mirror. If the focal length of the mirror is 10 cm, what is the image distance? A. 10 cm in front of the mirror B. 5 cm in front of the mirror C. 10 cm behind the mirror D. 5 cm behind the mirror

33. Calculate the position of an object placed in front of a convex mirror having focal length of 12cm such that an image is formed 6cm away from the mirror. A. 4.0 cm. B. 3.0 cm. C. 12.0 cm. D. 9.0 cm.

34. If the refractive index of crown glass is 1.51, its critical angle is A. 48.6°. B. 22.5°. C. 41.5°. D. 45.0°.

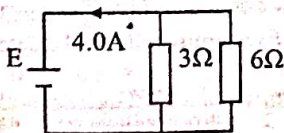
35. When light passes through two media x and y of refractive indices 1.51 and 1.33 respectively, the speed of light in A. x is same as in y. B. x and y is same as in vacuum. C. x is higher than in y. D. y is higher than in x.

36. A near-sighted student has a near point of 0.1m and a focal length of 5.0cm. What is the student's far point? A. 0.200m B. 8.000m C. 0.125m D. 2.100m

37. The ability of the human eye to focus objects on the retina is referred to as the power of A. interference. B. diffraction. C. accommodation D. superposition.

38. Which of the following is a secondary colour? A. Blue B. Orange C. Red D. Green

39. If negative charges are induced on an electroscope and a positively charged rod is brought near the cap of the electroscope, the leaves will A. close up. B. become positively charged. C. become negatively charged. D. open further.

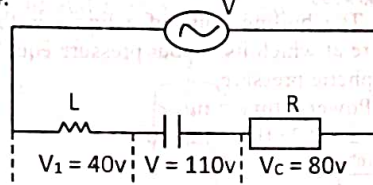
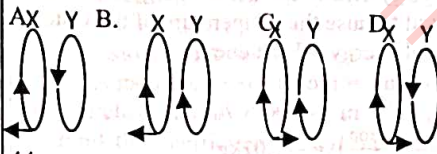


Calculate the e.m.f. of the cell in the above circuit if its internal resistance is negligible. A. 12V. B. 8V. C. 2V. D. 36V.

41. An electric lamp marked 240V, 60W is left to operate for an hour. How much energy is generated by the filament? A. 3.86×10^5 J B. 3.56×10^5 J C. 1.80×10^5 J D. 2.16×10^5 J

42. A band of 500 rectangular loops of wire of area 20 cm by 20 cm, encloses a region of magnetic field which changes from 11.0T to 0.4T within 5 seconds, calculate the induced e.m.f. A. 5.60 V. B. 24.00 V. C. 0.24 V. D. 2.40 V.

43. Two coils x and y are arranged co-axially. If coil x carries a clockwise current and is free to move, which of the figures below depicts the direction of the induced current in coil y?



From the diagram above, if the potential difference across the resistor, capacitor and inductor are 80 V, 110 V and 40 V respectively, the effective potential difference is A. 116.3 V. B. 50.0 V. C. 230.0 V. D. 106.3 V.

45. Cancerous cells can be destroyed by A. ultraviolet rays. B. alpha particles. C. x-rays. D. infrared rays.

46. If the decay constant of a radioactive substance is 0.231s, the half-life is A. 3.00s. B. 0.12s. C. 0.33s. D. 1.50s.

47. A piece of radioactive material contains 1020 atoms. If the half-life of the material is 20 seconds, the number of disintegrations in the first second is A. 3.47×10^{18} . B. 6.93×10^{20} . C. 3.47×10^{20} . D. 6.93×10^{18} .

48. Thermionic emission is the process whereby A. β -rays are produced. B. holes are produced. C. x-rays are produced. D. electrons leave a hot element.

49. Which of the following can conduct electricity owing to the presence of free mobile electrons? A. Germanium B. Silicon C. Grapefruit D. Copper

50. When a pentavalent impurity is added to a pure semiconductor, it becomes A. a p-type semiconductor B. an n-type semiconductor C. an insulator D. an intrinsic semiconductor.

2009 UME PHYSICS SOLUTION

1. B: From Newton's law of universal gravitation,

$$F = \frac{GM_1M_2}{r^2}, \quad G = \frac{Fr^2}{M_1M_2}$$

Let us get the dimension of each parameter:

$$F = ma = MLT^{-2}$$

$$r = \text{length} = L$$

$$m_1 = \text{mass} = M$$

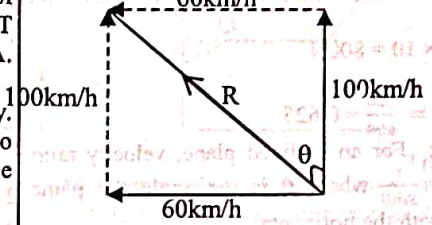
$$m_2 = \text{mass} = M$$

Thus, dimensionally speaking

$$G = \frac{MLT^{-2}L^2}{M \times M} = M^{-1}L^3T^{-2}$$

If the dimension is compared with $M^xL^yT^z$, $x = -1$, $y = 3$ and $z = -2$

2. B: The micrometer screw gauge is used to measure very small distances such as the diameter of a very small ball bearing, thickness of a piece of paper, diameter of a thin wire etc.



The resultant velocity, R is given by:

$$R^2 = 60^2 + 100^2 = 13600$$

$$R = \sqrt{13600} = 116.62 \text{ km} = 117 \text{ km}$$

$$\tan \theta = \frac{60}{100} = 0.6; \theta = \tan^{-1} 0.6 = 31^\circ$$

The direction is thus N31°W

4. D: Point 1: (10s, 15ms⁻¹); Point 2: (20s, 35ms⁻¹). Since acceleration = $\frac{\Delta v}{\Delta t}$, we have:

$$a = \frac{v_2 - v_1}{t_2 - t_1} = \left(\frac{35-15}{20-10}\right) \text{ m/s}^2 = \left(\frac{20}{10}\right) \text{ m/s}^2 = 2 \text{ m/s}^2$$

5. D: KEY \Rightarrow The distance travelled in the fifth second is the difference between the distance covered when $t = 5$ and that covered when $t = 4$.

$U = 0$ (since it starts from rest)

$$a = 4 \text{ m/s}^2$$

when $t = 5$

$$s = ut + \frac{1}{2}at^2 = (0 \times 5) + \frac{1}{2} \times 4 \times 5^2 = 50 \text{ m}$$

when $t = 4$

$$s = ut + \frac{1}{2}at^2 = (0 \times 4) + \frac{1}{2} \times 4 \times 4^2 = 32 \text{ m}$$

Difference covered in the fifth second = 50m - 32m = 18m

6. D: Option A \Rightarrow Stable equilibrium

Option B \Rightarrow Unstable equilibrium

Option C \Rightarrow Unstable equilibrium

Option D \Rightarrow Neutral equilibrium

7. D: $m_1u_1 + m_2u_2 = (m_1 - m_2)v$

Since the second body is at rest, $u_2 = 0$.

$$\text{Then, } m_1u_1 = (m_1 + m_2)v; \quad v = \frac{m_1u_1}{(m_1 + m_2)}$$

$$= \left[\frac{(12 \times 4.2)}{(12+18)}\right] \text{ m/s}$$

$$= \left(\frac{50.4}{30}\right) \text{ m/s} = 1.7 \text{ m/s}$$

8. C: KEY \Rightarrow For the bullet to stop going up at a particular height, the velocity must have been reduced to zero. Thus, at maximum height,

$$v = 0$$

$$a = -g = -10 \text{ m/s}^2$$

$$t = 4.0 \text{ s}$$

$$u = ?$$

$$v = u + at$$

$$0 = u + (-10 \times 4); \quad 0 = u - 40; \quad u = 40 \text{ m/s}$$

9. B: The tyre of a moving car is undergoing both rotational motion and translational motion.

The loaded test tube in oscillation is undergoing simple harmonic motion (S.H.M).

A beating heart is undergoing S.H.M. A stone tied to a string and whirled round is undergoing circular motion. A moving piston in a gasoline engine is undergoing S.H.M.

10. C: Power, $P = \frac{mgh}{t} = \frac{(750) \times 10 \times 90}{(1 \times 60)}$

$$\left(\frac{750 \times 10 \times 90}{60}\right) \text{ W}$$

= 11250W = $\left(\frac{11250}{1000}\right)Kw = 11.25Kw$.

11. **D:** KEY \Rightarrow The assumption here is that

the body moves at a constant velocity i.e. $a = 0$
 $F - Fr = ma$

$500 - Fr = m \times 0 = 0$

$500 - Fr = 0$; $Fr = 500N$

Recall that $Fr = \mu R$

Here, $R = mg$ (since the body is horizontal placed)

$R = 80 \times 10 = 800N$

Then,

$\mu = \frac{Fr}{R} = \frac{500}{800} = 0.625$

12. **D:** For an inclined plane, velocity ratio

(V.R) = $\frac{1}{\sin \theta}$ where θ is the angle the plane makes with the horizontal.

Then,

$V.R = \frac{1}{\sin 30} = \frac{1}{0.5} = 2$

13. **D:** The terminal velocity of a ball bearing

falling through a viscous fluid is reached when the velocity is uniform i.e. when $a = 0$. $V + u - mg = ma$. $V =$ viscous force, $u =$ upthrust. At terminal velocity, $a = 0$. Then, we have: $v + u - mg = m \times 0$; $v + u - mg = 0$. $V + u = mg$.

14. **C:** Hydrostatic pressure, $P = h\rho g$

$h =$ depth of the liquid

$\rho =$ density of the liquid,

$g =$ acceleration due to gravity

This, it can be seen that the fluid pressure depends only on the depth, density and the acceleration due to gravity.

NB: The pressure is also affected by temperature since density varies with temperature.

15. **A:** KEY \Rightarrow The force constant, K is the slope of the graph. This is because $K = \frac{F}{e}$

From the graph,

Slope $K = \frac{120N - 40N}{6m - 2m} = \frac{80N}{4m} = 20Nm^{-1}$

16. **A:** Workdone = $\frac{1}{2} Fe$

$F = 10N$, $e = 1.2cm = \left(\frac{1.2}{100}\right)m = 0.012m$

Workdone = $\frac{1}{2} \times 10 \times 0.012$

= $0.06J = 6 \times 10^{-2}J$

17. **B:** KEY \Rightarrow Whenever the equilibrium of floating objects is considered, the principle of flotation must be invoked. The principle states that an object will float in a fluid when the mass or weight of the fluid displaced equals its own weight.

Back to the question, for the flotation in water, we write:

Mass of sphere = mass of water displaced

= density of water \times volume of water displaced

If the volume of the sphere is taken as v , volume submerged in water = volume of water displaced

= $\frac{50}{100} \times v = 0.5v$

Density of water = $1000kgm^{-3}$

Thus,

Mass of sphere = $1000 \times 0.5v = 500v$

For the flotation in glycerin, we write:

Mass of sphere = mass of glycerin displaced

= density of glycerin \times volume of glycerin displaced

= $d_{glycerin} \times 0.4v$

But mass of sphere = $500v$

Then, we have:

$500v = d_{glycerin} \times 0.4v$

$d_{glycerin} = \frac{500v}{0.4v} = 1250kgm^{-3}$

18. **D:** The thermometer whose reading is indicated by a change in colour of its thermometric property is the optical pyrometer.

19. **D:** Water shows anomalous behavior between $0^\circ C$ and $4^\circ C$. As the temperature rises between $0^\circ C$ and $4^\circ C$, the density of water increases (instead of it to decrease) and the volume consequent decreases (instead of it to increase).

20. **A:** $V = 10^{-2}m^3$, $n = 2$, $R = 8.313$, $T = (27 + 273)K = 300K$

$PV = nRT$ (Ideal gas equation)

$P = \frac{nRT}{V} = \left(\frac{2 \times 8.313 \times 300}{10^{-2}}\right) = 498780Nm^{-2} = 4.99 \times 10^5 Nm^{-2}$

21. **C:** KEY \Rightarrow The electric heater generates heat energy (from electrical energy), which is then used to raise the temperature of the water.

Electrical energy = Heat energy

Power \times time = $mc\Delta\theta$

$1000 \times 300 = m \times 4200 \times 70$

$m = \left(\frac{1000 \times 300}{4200 \times 70}\right)kg = 1.02kg$

22. **B:** The boiling point of a liquid is the temperature at which its vapour pressure equals the atmospheric pressure.

23. **D:** Power \times time = mL_v

$1000 \times t = 2 \times 2.3 \times 10^6 = 4.6 \times 10^6$

$t = \left(\frac{4.6 \times 10^6}{1000}\right)s = 4.6 \times 10^3s$

24. **D:** Water wets glass because the adhesion of water and glass is greater than the cohesion between water molecules. Mercury, on the other hand, does not wet glass because the cohesion between mercury molecules is stronger than the adhesion between mercury and glass.

25. **B:** The man is warmed by radiation and convection (due to the air current in the surrounding. It must be noted that radiation is the chief method of heat transfer here.

26. **C:** The wave phenomenon demonstrated in the diagram is diffraction. Diffraction is the spreading out of wave as it passes through an opening or an aperture.

27. $y = 10 \sin(100t - \frac{2\pi x}{\lambda})$... given

Comparing this with the standard equation $y = A \sin(2\pi ft - \frac{2\pi x}{\lambda})$, we have that the phase difference, $\frac{2\pi x}{\lambda} = \frac{\pi x}{34}$

$x = 153cm = 1.53m$

Phase difference = $\frac{1.53\pi}{34} = 0.045\pi$

But $\pi = 180^\circ$

Thus, Phase difference = $0.045\pi = (0.045 \times 180^\circ) = 8.1^\circ$

28. **D:** Metal cables are used as telephone wires because the speed of sound in them is very high.

29. **A:** Musical instruments playing the same note can be distinguished from one another owing to the differences in their quality. The quality of a sound depends on its overtone.

30. Velocity = $3 \times 10^8ms^{-1}$

Wavelength = $500mm = 500(10^{-3}) = 0.5m$

$F = \frac{v}{\lambda} = \frac{3 \times 10^8}{0.5} = 6 \times 10^8Hz$

31. **D:** The sun and stars are natural sources of light. The street light is an artificial source of light.

A moon is not a source of light at all. It is an opaque object.

32. **C:** $u = 5cm$, $f = 10cm$

$\frac{1}{v} = \frac{1}{u} + \frac{1}{f}$; $\frac{1}{v} = \frac{1}{5} - \frac{1}{10} = \frac{1}{10} - \frac{1}{10} = \frac{1}{10}$

$v = 10cm$ i.e. $10cm$ behind the mirror.

33. **C:** $f = -12cm$, $v = -6cm$

$\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{-6} - \frac{1}{-12} = \frac{1-2}{-12} = \frac{-1}{-12} = \frac{1}{12}$

$u = 12cm$

34. **C:** $n = \frac{1}{\sin c}$ ($n =$ refractive index, $c =$ critical angle)

$1.51 = \frac{1}{\sin C}$; $\sin C = \frac{1}{1.51} = 0.6623$

$C = \sin^{-1}(0.6623) = 41.5^\circ$

35. **D:** The higher the refractive index of a material, the lower the speed of light in it. For instance, light has a speed of $3 \times 10^8m/s$ in air (whose refractive index is 1) and $2 \times 10^8m/s$ in glass (whose refractive index is 1.5)

36. **A:** $f = 5cm$, $\left(\frac{5}{100}\right)m = 0.05m$, $v = 0.1m$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\frac{1}{0.05} = \frac{1}{u} + \frac{1}{0.1}$; $\frac{1}{u} = \frac{1}{0.05} - \frac{1}{0.1} = \frac{2-1}{0.1}$

$\frac{1}{u} = \frac{1}{0.1}$; $u = 0.1m$

37. **C:** Accommodation is the ability of the human eye to focus objects at various distances on the retina.

38. **B:** Red, green and blue are primary colours.

39. **A:** Since the charge on the electroscope is different from that on the rod, the divergence of the leaves will decrease i.e. the leaves close up.

40. **B:** Since the resistors are connected in parallel

$\frac{1}{R} = \frac{1}{6} + \frac{1}{3}$; $\frac{1}{R} = \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}$

Thus, $R = 2\Omega$

$V = IR = (4 \times 2)V = 8V$

41. **D:** Energy = Power \times time

Power = $60W$

time = $1 \text{ hour} = (1 \times 3600)s = 3600s$

Energy = $(60 \times 3600)J = 216000J = 2.16 \times 10^5J$

42. **D:** $E = \frac{N\Delta B}{\Delta t}$

$N =$ Number of loops = 500

$A =$ area = $20cm \times 20cm = 40cm^2 = 400(10^{-4})m^2 = 0.04m^2$

$\Delta B =$ change in magnetic flux density = $0.6T$

$E = \left(\frac{500 \times 0.04 \times 0.6}{5}\right) \Rightarrow 2.40V$

43. **B:** Same current direction gives attraction while different current directions give repulsion. Option B is correct since the two coils x and y carry current in the same direction and they are depicted to attract each other.

44. **D:** $V = \sqrt{V_R^2 + (V_L - V_C)^2}$; $V =$ effective potential difference, $V_R =$ potential difference across the resistor, $V_L =$ potential difference across the inductor and $V_C =$ potential difference across the capacitor. Thus, $V = \sqrt{80^2 + (40 - 110)^2} = \sqrt{80^2 + (-70)^2} = \sqrt{6400 + 4900} = \sqrt{11300} = 106.3V$

45. **C:** Cancerous cells can be destroyed by x-rays

46. **A:** $T_{\frac{1}{2}} = \frac{0.693}{\text{decay constant } (\lambda)} = \frac{0.693}{0.231s^{-1}} = 3s.$

47. A: $N_t = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$, when $t = 1$, $N_0 = 10^{20}$ and $t_{1/2} = 20s$
 $N_t = 10^{20} \left(\frac{1}{2}\right)^{\frac{1}{20}} = 10^{20} \left(\frac{1}{2}\right)^{0.05}$
 9.66×10^{19} atoms

Method 2

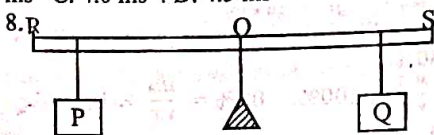
$N_t = N_0 e^{-\lambda t}$; $\lambda = \frac{0.693}{t_{1/2}} = \frac{0.693}{20s} = 0.03465s$

Then,
 $N_t = 10^{20} e^{-0.03465 \times 1} = 10^{20} \times 0.9659$
 $= 9.66 \times 10^{19}$ atoms

48. **D:** Thermionic emission refers to the process whereby electrons are released from the surface of a hot metal.
 49. **D:** Metals (such as copper) use free mobile electrons as their carrier of electricity. Electrolytes use free mobile ions as their own carrier. Semi-conductors use holes and electrons.
 50. **B:** The addition of impurity to a pure semi-conductor is known as doping. When a pentavalent impurity is added to a pure semi-conductor, an n-type semi-conductor is formed. If the impurity is trivalent, a p-type semi-conductor is formed.

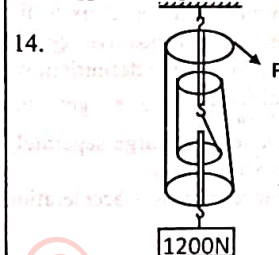
2008 UME PHYSICS QUESTIONS

1. The dimensions of electromotive force are A. $ML^2T^{-3}I^{-1}$ B. $ML^2T^{-3}I^{-2}$ C. $M^2LT^2I^{-1}$ D. $M^2L^2T^{-1}I^{-1}$
 2. I. Force (N) II. Torque (Nm^{-1}) III. Current (A) IV. Power (W). Which of the above are the correct SI. units of the quantities indicated? A. I and II only B. I and III only C. I, II and III only D. I, III and IV only
 3. The resultant of two forces 12 N and 5 N is 13 N. What is the angle between the two forces? A. 0° B. 45° C. 90° D. 180°
 4. Which of the following is NOT a vector quantity? A. Altitude B. Acceleration C. Displacement D. Weight
 5. A force F is required to keep a 5 kg mass moving round a circle of radius 3.5 m at a speed of $7 ms^{-1}$. What is the speed, if the force is tripled? A. $4.0 ms^{-1}$ B. $6.6 ms^{-1}$ C. $12.1 ms^{-1}$ D. $21.0 ms^{-1}$
 6. If a wheel 1.2 m in diameter rotates at one revolution per second, calculate the velocity of the wheel A. $3.6ms^{-1}$ B. $3.8ms^{-1}$ C. $4.0ms^{-1}$ D. $7.5ms^{-1}$
 7. A body of mass 4 kg resting on a smooth horizontal plane is simultaneously acted upon by two perpendicular forces 6 N and 8 N. Calculate the acceleration of the motion A. $2.5 ms^{-1}$ B. $3.0 ms^{-1}$ C. $4.0 ms^{-1}$ D. $4.5 ms^{-1}$



The diagram above shows plank RS pivoted at its centre of gravity O and is in equilibrium with the weights P and Q. If a weight 2P is added to P, the plank will be in equilibrium again by A. moving Q nearer to O B. moving P nearer to O C. adding a weight Q to Q D. moving P further away from O.

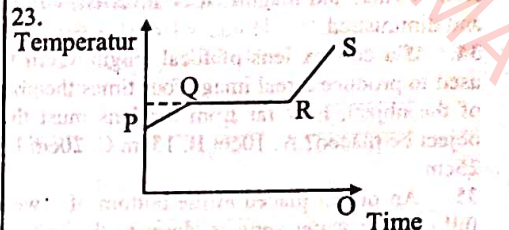
9. I. All the three forces must be concurrent II. The upward force is equal to the downward force III. The algebraic sum of the moment about any point must be zero. Which of the above conditions must hold for a body acted upon by a system of three coplanar forces in equilibrium? A. I and II only B. I and III only C. II and III only D. I, II and III
 10. What is the frequency of vibration if the balance wheel of a wrist-watch makes 90 revolutions in 25 s? A. 0.01 Hz B. 0.04 Hz C. 2.27 Hz D. 3.60 Hz
 11. If a body of mass 5 kg is thrown vertically upwards with velocity u, at what height will the potential energy equal to the kinetic energy? A. $h = \frac{u^2}{g}$ B. $h = \frac{u^2}{4g}$ C. $h = \frac{2u^2}{g}$ D. $h = \frac{u^2}{2g}$
 12. Counting of currency notes with moist fingers is based on the principles of A. diffusion. B. cohesion. C. adhesion. D. viscosity.
 13. A motorcycle of mass 100 kg moves round in a circle of radius 10 m with a velocity of $5ms^{-1}$. Find the coefficient of friction between the road and the tyres. A. 25.00 B. 2.50 C. 0.50 D. 0.025. [$g=10ms^{-1}$]



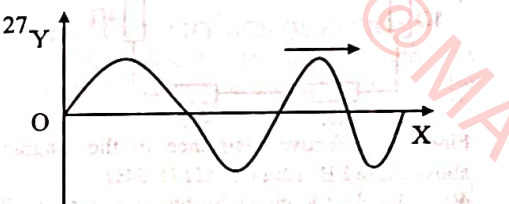
The efficiency of the pulley system shown above is 80%. Find the effort E required to lift a load of 1200 N. A. 275N. B. 325N. C. 375N. D. 573N.

15. A spring of force constant $500 Nm^{-1}$ is compressed such that its length shortens by 5 cm. The energy stored in the spring is A. 0.625 J. B. 6.250 J. C. 62.500 J. D. 625.000J.
 16. In the Hare's apparatus, water rises to a height of 26.5cm in one limb. If a liquid rises to a height of 20.4 cm in the other limb, what is the relative density of the liquid? A. 0.8 B. 1.1 C. 1.2 D. 1.3
 17. When cold water is poured on a can containing hot water, the can collapses because the A. steam condenses and occupies the partial vacuum in the can. B. external air pressure counterbalances the pressure within the can. C. steam expands to occupy the vacuum remaining in the can. D. external pressure becomes greater than the pressure within the can.
 18. An empty density bottle weighs 2 N. If it weighs 5 N when filled with water and 4 N when filled with olive oil, the relative density of olive oil is A. $\frac{1}{3}$ B. $\frac{2}{3}$ C. $\frac{1}{5}$ D. $\frac{2}{5}$
 19. The thermometric property of a thermocouple is the change in A. equivalent resistance. B. electromotive force. C. colour. D. pressure.
 20. During summer, the balance wheel of a clock expands. What effect does this have on the accuracy of the clock? A. The clock gains time B. The accuracy of the clock is not affected C. The clock loses time D. The clock stops working
 21. A sealed flask contains $600 cm^3$ of air at $27^\circ C$ and is heated to $35^\circ C$ at constant pressure.

- The new volume is A. $508 cm^3$. B. $516 cm^3$. C. $608 cm^3$. D. $616 cm^3$.
 22. A block of aluminium is heated electrically by a 25W heater. If the temperature rises by $10^\circ C$ in 5 minutes, the heat capacity of the aluminium is A. $850JK^{-1}$. B. $750JK^{-1}$. C. $650JK^{-1}$. D. $500JK^{-1}$.



- The diagram above is the heating curve for a solid. QR is the A. melting region. B. boiling region C. sublimation region. D. evaporating process.
 24. If the partial pressure of water vapour at $27^\circ C$ is 18mm Hg and the saturated vapour pressure of the atmosphere at the same temperature is 24 mm Hg, the relative humidity at this temperature is A. 25%. B. 33%. C. 75%. D. 82%.
 25. In a good thermos flask, the main cause of heat loss is A. conduction through the cork. B. the plastic base of the thermos flask. C. the silvered walls and shiny metals. D. the outer cover or jacket.
 26. Given the progressive wave equation $y = 5 \sin (2000\pi t - 0.4x)$, calculate the wavelength. A. 12.4m. B. 15.7m. C. 17.5m. D. 18.6m.



- The above figure shows the motion of a progressive wave along a string. The particle motion of the medium is in the direction A. parallel to OX. B. Parallel to OY. C. 60° to OX. D. 60° to OY.
 28. The fundamental property of a propagating wave which depends only on the source and not the medium of propagation is the A. wavelength. B. harmonics. C. frequency. D. velocity.
 29. When the length of a vibrating string is reduced by one-third, its frequency becomes A. three times its former value. B. twice its former value. C. one-third of its former value. D. one-sixth of its former value.
 30. I. Total internal reflection of light II. Conservation of light energy III. Relative motion of the earth, sun and moon IV. Rectilinear propagation of light. Which of the above is a phenomenon of total solar eclipse? A. I and IV only B. II and IV only C. I and III only D. III and IV only
 31. An object of height 4cm is placed in front of a cuboid pinhole camera of size 6 cm. If the image formed is 2cm high, how far is the object from the pinhole? A. 3 Jcm B. 8.0cm C. 12.0cm D. 16.0 cm
 32. An object of height 5cm is placed at 20 cm from a-concave mirror of focal length 10 cm.

The image height is A. 20cm B. 15cm C. 10cm D. 5cm.

33. Convex mirrors are used as driving mirrors because images formed are A. erect, virtual and diminished B. erect, real and diminished C. erect, virtual and magnified D. inverted, virtual and diminished

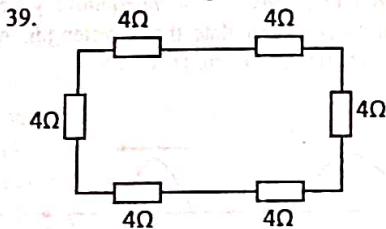
34. If a convex lens of focal length 12cm is used to produce a real image four times the size of the object, how far from the lens must the object be placed? A. 10cm B. 15cm C. 20cm D. 25cm

35. An object placed at the bottom of a well full of clear water appears closer to the surface due to A. diffraction B. reflection C. refraction D. polarization.

36. In the microscope, the eyepiece lens merely acts as A. an inverter B. a refiner C. a diminisher D. a magnifier.

37. An observer with normal eyes views an object with a magnifying glass of focal length 5 cm. The angular magnification is A. -6 B. -5 C. 5 D. 6 [least distance of distinct vision D = 25cm]

38. A short chain is sometimes attached to the back of a petrol tanker to A. generate more friction B. ensure the balancing of the tanker C. caution the driver when overspeeding D. conduct excess charges to the earth.



Find the effective resistance in the diagram above A. 6Ω B. 12Ω C. 18Ω D. 24Ω

40. An electric generator has an e.m.f. of 240 V and an internal resistance of 1 Ω. If the current supplied by the generator is 20 A when the terminal voltage is 220 V, find the ratio of the power supplied to the power dissipated A. 11:1 B. 1:11 C. 12:11 D. 11:12.

41. A generator is on daily use and in the process, ten 60 W and five 40 W tungsten bulbs are on for the same time interval. The energy consumed daily is A. 0.96kWh. B. 1.92kWh. C. 9.60kWh. D. 19.20kWh.

42. The d.c. generator has essentially the same components as the a.c. generator except the presence of A. slip-ring. B. carbon brushes. C. split ring. D. armature.

43. A step-down transformer has a power output of 50W and efficiency of 80%. If the mains supply voltage is 200V, calculate the primary current of the transformer. A. 0.31A B. 3.20A C. 3.40A D. 5.00A.

44. 5mH 10mH 20mH



Given three inductors of inductances 5mH, 10mH and 20mH connected in series, the effective inductance is A. 0.35 mH. B. 3.50 mH. C. 2.90 mH. D. 35.00 mH.

45. If electrons are accelerated from rest through a potential difference of 10kv. what is the wavelength of the associated electron? A. 1.22×10^9 m B. 3.87×10^{-10} m C. 2.27×10^{11} m D.

2.27×10^{14} m [$m_e = 9.1 \times 10^{-31}$ kg, $h = 6.6 \times 10^{-34}$ Js]

46. ${}^1_4\text{N} + {}^4_2\text{He} \rightarrow {}^1_0\text{n} + \text{X}$. In the equation above, the particle X is A. a proton B. a neutron C. an α -particle. D. a β -particle.

47. Caesium has a work function of 3×10^{-19} J. The maximum energy of liberated electrons when it is illuminated by light of frequency 6.7×10^{14} Hz is A. 1.42×10^{-19} J B. 3.00×10^{-19} J C. 4.42×10^{-19} J D. 7.42×10^{-19} J. [$h = 6.6 \times 10^{-34}$ Js]

48. Zener diode is used for A. current amplification B. power amplification C. voltage regulation D. energy conversion.

49. When a pure semiconductor is heated, its resistance A. increases B. decreases C. remains the same D. increases and then decreases.

50. I. For current amplification II. For voltage stabilization III. For power amplification IV. As a switch. Which of the above are the uses of a transistor? A. I, II, III and IV B. I, III and IV only C. I, II and III only D. I, II and IV only

2008 UME PHYSICS SOLUTION

1. A: The electromotive force refers to the workdone in moving a unit positive charge round a circuit. From this simple definition, we write: $e.m.f = \frac{\text{workdone}}{\text{charge}}$. Let's get the dimensions of workdone and charge separately and then mount them accordingly.

Work = Force \times distance = mass \times acceleration \times distance

Dimensionally, we have:

$$\text{Work} = M \times L T^{-2} \times L = M L^2 T^{-2}$$

Recall that electric current (I) is the rate of flow of charge i.e.

$$I = \frac{q}{t}, \text{ then } q = IT.$$

So, dimensionally, charge, $q = IT$

Therefore,

$$e.m.f = \frac{M L^2 T^{-2}}{IT} = M L^2 T^{-3} I^{-1}$$

2. D: Torque has a unit of Nm (not Nm^{-1})

3. C: Let the two forces 12N and 5N be represented by a and b respectively. Angle between them = θ

$$R^2 = a^2 + b^2 - 2ab \cos(180 - \theta)$$

$$13^2 = 12^2 + 5^2 - 2(12 \times 5) \cos(180 - \theta)$$

$$169 = 144 + 25 - 120 \cos(180 - \theta)$$

$$169 = 169 - 120 \cos(180 - \theta)$$

$$120 \cos(180 - \theta) = 0$$

$$\cos(180 - \theta) = \frac{0}{120} = 0$$

$$180 - \theta = \cos^{-1} 0 = 90$$

$$180 - \theta = 90$$

$$\theta = 180 - 90 = 90^\circ$$

4. A: Acceleration, displacement and weight are vector quantities while altitude is a scalar quantity.

5. C: $F = \frac{MV^2}{r}$

Thus, it can be established that $F \propto V^2$

$$F = KV^2, K = \frac{F}{V^2}$$

Then, we have:

$$\frac{F_1}{V_1^2} = \frac{F_2}{V_2^2}$$

If the force is tripled, it means $F_2 = 3F_1$

$$V_2 = \sqrt{\frac{V_1^2 \times F_2}{F_1}} = \sqrt{\frac{V_1^2 \times 3F_1}{F_1}} = \sqrt{3V_1^2} =$$

$$\sqrt{3 \times 7^2} = 12.1 \text{ m/s}$$

6. B: Diameter = 1.2m, $r = \frac{1.2\text{m}}{2} = 0.6\text{m}$

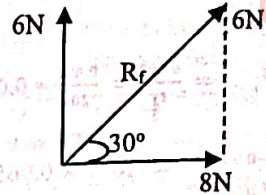
$$F = 1rcVs^{-1} = 1\text{Hz}$$

$$w = 2\pi f = 2 \times 3.143 \times 1 = 6.284 \text{ rads}^{-1}$$

$$v = rw = (0.6 \times 6.284) \text{ m/s} = 3.7704 \text{ m/s} \approx 3.8 \text{ m/s}$$

$$7. A: R_f = ma$$

Let us first get the resultant force, R_f



$$R_f^2 = 6^2 + 8^2 = 36 + 64 = 100$$

$$R_f = \sqrt{100} = 10\text{N}$$

$$m = 4\text{kg}$$

Then,

$$10 = 4 \times a; a = \frac{10}{4} = 2.5 \text{ m/s}^2$$

8. B: The addition of 2P to P will cause the anticlockwise moment to increase. To restore equilibrium, we either find a way to reduce the anticlockwise moment or a way to commensurately increase the clockwise moment constituted by Q. Thus, the plank will be in equilibrium again if P is moved nearer to O (a reduced distance implies a reduced moment). What about option C? If some weight is added to Q, the clockwise moment is increased truly but are we sure the magnitude of the load to be added must also be Q when the values of P and Q are not given? CAPITAL NO!

9. C: For a body acted upon by a system of coplanar forces to be in equilibrium the following conditions must be satisfied: (i) Total upward forces must be equal to the downward force(s). (iii) The algebraic sum of the moment about any point must be zero.

10. D: $F = \frac{n}{t}$ (n = number of oscillations, t = time)

$$F = \frac{90}{25s} = 3.6s^{-1} = 3.6\text{Hz}$$

11. D: Potential energy = kinetic energy

$$mgh = \frac{1}{2}mu^2$$

$$gh = \frac{1}{2}u^2; h = \frac{\frac{1}{2}u^2}{g} = \frac{u^2}{2g}$$

12. C: This is to increase the force of adhesion between the finger and the note so that the notes are parted.

13. D: KEY \Rightarrow The centripetal force harnessed by the motorcycle in moving round the cycle is provided by the friction between the tyre and the road frictional force = centripetal force

$$\mu R = \frac{mv^2}{r} \text{ (R = normal reaction} = mg, r = \text{radius)}$$

$$\mu = \frac{mv^2}{mg \cdot r} = \frac{v^2}{gr} = \frac{5^2}{10 \times 10} = 0.25$$

14. C: Since there are four pulleys, $V.R = 4$

$\epsilon = 80\%$

$$\epsilon = \frac{M.A}{V.R} \times 100\%; \quad 80\% = \frac{M.A}{V.R} \times 100\%$$

Thus,

$$M.A = \frac{80\% \times V.R}{100\%} = 0.8 \times 4 = 3.2$$

$$M.R = \frac{\text{Load}}{\text{Effort}}; \quad 3.2 = \frac{1200}{\text{Effort}}$$

$$\text{effort} = \frac{1200}{3.2} = 375\text{N}$$

15. A: $K = 500\text{Nm}^{-1}$, $c = 5\text{cm} = \left(\frac{5}{100}\right)\text{m} = 0.05\text{m}$

$$E = \frac{1}{2}Kc^2 = \frac{1}{2} \times 500 \times 0.05^2 = 0.625\text{J}$$

16. **D:** KEY => The pressure due to the given liquid must be equal to that due to water.

$$h\rho g = h_w \rho_w g$$
$$20.4 \text{ cm} \times \rho_l = 26.5 \text{ cm} \times 1 \text{ g cm}^{-3}$$
$$\rho_l = 1.299 \text{ g cm}^{-3} = 1.3 \text{ g cm}^{-3}$$

Thus, the relative density of the liquid is 1.3

17. **D:** It is because external pressure becomes greater than the pressure within the can.

18. **B:** Weight of olive oil = 4N - 2N = 2N
Weight of equal volume of water = 5N - 2N = 3N

$$R.D = \frac{\text{Weight of olive oil}}{\text{weight of equal volume of water}} = \frac{2N}{3N} = 0.667$$

19. **B:** The thermometric property of a thermocouple is the change in electromotive force.

20. **C:** The expansion of the clock causes the clock to lose time.

21. **D:** $V \propto T$ (Pressure is constant)

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}, V_1 = 600 \text{ cm}^3, T_1 = (27 + 273) \text{ K} = 300 \text{ K},$$
$$V_2 = ? T_2 = (35 + 273) \text{ K} = 308 \text{ K}$$

$$V_2 = \frac{V_1 T_2}{T_1} = \left(\frac{600 \times 308}{300} \right) \text{ cm}^3 = 616 \text{ cm}^3$$

22. **B:** $P \times t = C \Delta \theta$ (c = heat capacity)

$$25 \times 5 \times 60 = c \times 10$$

$$c = \left(\frac{25 \times 5 \times 60}{10} \right) \text{ J K}^{-1} = 750 \text{ J K}^{-1}$$

23. **A:** PQ is the region where the temperature of the solid is still rising. QR is the melting region (temperature is constant here). At RS all the solid has melted and the temperature has started rising again.

24. **C:**

Relative humidity = $\frac{\text{Partial pressure at the given temp}}{\text{SV (at the same temperature)}}$

$$\frac{18}{24} = 0.75\% = 0.75 \times 100\% = 75\%$$

25. **B:** In a good thermos flask, the vacuum prevent heat loss by conduction and convection, the silvery walls reduce heat loss due to radiation, the insulating stopper reduces loss of heat from the liquid by convection and evaporation, the supporting cork at the base prevents heat loss by conduction.

26. **B:** $y = 5 \sin(2000\pi t - 0.4x) \dots (i)$

$$y = A \sin \left(2\pi f t - \frac{2\pi x}{\lambda} \right) \dots \dots \dots (ii)$$

Comparing the two equations, we have:

$$0.4x = \frac{2\pi x}{\lambda}; \lambda = \frac{2\pi x}{0.4x} = \frac{2\pi}{0.4} = \left(\frac{2 \times 3.142}{0.4} \right) \text{ m} = 15.71 \text{ m}$$

27. **B:** The wave shown in the diagram is a transverse wave. For a transverse wave, the direction of vibration and that of the wave motion are perpendicular. Since the wave travels in the direction OX, the particle motion must be in the direction OY, which is perpendicular to OX.

28. **A:** The fundamental property of a propagating wave which depends only on the source and not the medium of propagation is the wavelength.

29. **A:** $F = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$

Thus, it is evident that $F \propto \frac{1}{l}$

$$F = \frac{K}{l}; K = Fl$$

$$F_1 l_1 = F_2 l_2$$

$$l_2 = \frac{l_1}{3}$$

Then, $F_1 l_1 = F_2 \times \frac{l_1}{3}$

$$F_2 = F_1 l_1 \div \frac{l_1}{3} = F_1 l_1 \times \frac{3}{l_1} = 3F_1$$

30. **D:** Solar eclipse occurs when the moon comes between the sun and the earth. Shadows, eclipse and the working of a pin-hole camera are phenomena supporting the rectilinear propagation of light.

31. **C:** Object height, $H_0 = 4 \text{ cm}$, object distance, $u = ?$

Image height, $H_I = 2 \text{ cm}$, Image distance, $v = 6 \text{ cm}$

$$\frac{H_I}{H_0} = \frac{v}{u}; u = \frac{v \times H_0}{H_I} = \left(\frac{6 \times 4}{2} \right) \text{ cm} = 12 \text{ cm}$$

32. **D:** $H_0 = 5 \text{ cm}$, $u = 20 \text{ cm}$, $f = 10 \text{ cm}$, $v = ?$
 $H_I = ?$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}; \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{10} - \frac{1}{20} = \frac{2-1}{20} = \frac{1}{20}$$

$$\therefore v = 20 \text{ cm}$$

$$\frac{H_I}{H_0} = \frac{v}{u}; \frac{H_I}{5} = \frac{20}{20}; H_I = \left(\frac{5 \times 20}{20} \right) \text{ cm} = 5 \text{ cm}$$

33. **A:** The images produced by convex mirrors are erect, virtual and diminished.

34. **B:** $f = +12 \text{ cm}$ (f is positive for convex lens but negative for concave lens)

Magnification, $m = 4$

$$m = \frac{v}{u}; 4 = \frac{v}{u}; v = 4u$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}; \frac{1}{12} = \frac{1}{u} + \frac{1}{4u}; \frac{1}{12} = \frac{4+1}{4u} = \frac{5}{4u}$$

$$\frac{1}{12} = \frac{5}{4u}; u = \left(\frac{5 \times 12}{4} \right) \text{ cm} = 15 \text{ cm}$$

35. **C:** This is due to refraction

36. **D:** The eyepiece lens magnifies the image produced by the objective lens.

37. **A:** $M = - \left(\frac{D}{f} + 1 \right)$

Here

$$f = 5 \text{ cm}, D = 25 \text{ cm}$$

$$M = - \left(\frac{25}{5} + 1 \right) = -6$$

38. **D:** The function of the short chain sometimes attached to the back of a petrol tanker is to conduct excess charges to the earth.

39. **D:** The resistors are in series. The effective resistance = $4\Omega + 4\Omega + 4\Omega + 4\Omega + 4\Omega + 4\Omega = 24\Omega$

40. **A:** Voltage generated = 240V, voltage supplied = 220V

$$\text{Power generated} = IV_{\text{generated}} = (20 \times 240) \text{ W} = 4800 \text{ W}$$

$$\text{Power supplied} = IV_{\text{supplied}} = (20 \times 240) \text{ W} = 4400 \text{ W}$$

Ratio required = Power supplied : Power dissipated

$$\text{Power dissipated} = \text{Power generated} - \text{power supplied} = 4899 \text{ W} - 4400 \text{ W} = 400 \text{ W}$$

$$P_{\text{supplied}} : P_{\text{dissipated}} = 4400 : 400 = 11 : 1$$

41. **D:** Total power = $(10 \times 60) \text{ W} + (5 \times 40) \text{ W} = 600 \text{ W} + 200 \text{ W} = 800 \text{ W} = 0.8 \text{ Kw}$

Time = 1 day = 24 hrs

$$\text{Energy consumed (in Kwh)} = (0.8 \times 24) \text{ Kwh} = 19.2 \text{ kwh}$$

42. **C:** The d.c generator has a split ring (or commutator) whose sole function is to reverse the direction of the current.

$$43. \text{ A: } \epsilon = \frac{\text{Output power}}{\text{Input power}} \times 100\%$$

$$80\% = \frac{50 \text{ W}}{\text{Input power}}$$

$$\text{Input power} = \frac{50 \text{ W}}{0.8} = 62.5 \text{ W}$$

$$\text{Input power} = I_{\text{primary}} \times V_{\text{primary}}$$
$$62.5 = I_{\text{primary}} \times 200$$

$$I_{\text{primary}} = \left(\frac{62.5}{200} \right) \text{ A} = 0.31 \text{ A}$$

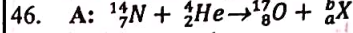
44. **D:** When inductors are connected in series, the effective inductance is simply the sum of the individual inductances.

$$L = 5 \text{ mH} + 10 \text{ mH} = 20 \text{ mH} = 35 \text{ mH}$$

45. **A:** Energy, $E = qV = 1.6 \times 10^{-19} \times 10^4 = 1.6 \times 10^{-15} \text{ J}$

$$\text{Velocity, } v = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-15}}{9.1 \times 10^{-31}}} = 5.93 \times 10^7 \text{ m/s}$$

$$\lambda = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{9.1 \times 10^{-31} \times 5.93 \times 10^7} = 1.22 \times 10^{-11} \text{ m}$$



$$14 + 4 = 17 + a, a = 1$$

$$7 + 2 = 8 + b, b = 1$$

Therefore, the particle X = ${}^1_1\text{H} \Rightarrow$ proton

47. **A:** $E = hf = 6.6 \times 10^{-34} \times 6.7 \times 10^{14} = 4.422 \times 10^{-19} \text{ J}$

Work function, $W_0 = 3 \times 10^{-19} \text{ J}$

The maximum energy of the liberated electrons = $(4.422 \times 10^{-19} - 3 \times 10^{-19}) \text{ J} = 1.422 \times 10^{-19} \text{ J}$

48. **C:** Zener diode is used for voltage regulation.

49. **B:** As the temperature of a semi-conductor increase, its resistance decreases unlike a metal whose resistance experience s a direct variation with temperature.

50. **B:** A transistor is used as a switch, for current amplification and for power amplification.

2007 UME PHYSICS QUESTIONS

1. A glass plate 0.9 cm thick has a refractive index of 1.50. How long does it take for a pulse of light to pass through the plate? A $3.0 \times 10^{-11} \text{ s}$ B. $4.5 \times 10^{-11} \text{ s}$ C. $3.0 \times 10^{-10} \text{ s}$ D. $4.5 \times 10^{-10} \text{ s}$ [$c = 3.0 \times 10^8 \text{ ms}^{-1}$]

2. The fundamental frequency of a plucked wire under tension of 400 N is 250 Hz. When the frequency is change to 500 Hz at constant length, the tension is A. 40N. B.160N. C. 400N. D.1600N.

3. The production of pure spectrum could easily be achieved using a A triangular prism only. B. triangular prism with two concave lenses. C. triangular prism with two convex lenses. D. glass prism with a pin.

4. I. They should be identical II. They should originate from the same source. III. They should be coherent IV. They should be monochromatic. From the statements above, the conditions for two wave to interfere are A. I, III and IV only. B. I, II, III and IV. C. I, II and III only. D. II, III and IV only.

5. The instrument used by designers to obtain different colour patterns is called A. episcope. B. periscope. C. kaleidoscope. D. sextant

6. When an object is placed between the principal focus and the optical centre of a convex lens, it could be used as a A. reflecting lens. B. compound microscope. C. projector. D. simple microscope.

7. In a large telecomm nunications auditorium, perforated absorbent materials are used to line the ceiling so as to A. reduce the reverberation of sound in the hall B. reduce the height of the

ceiling from the floor C. increase the reverberation of sound in the hall D. increase the amount of echo in the hall

8. The phenomenon of light bending round an obstacle is A. reflection. B. polarization. C. refraction D. diffraction.

9. The energy E of a photon and its wavelength are related by $E\lambda = X$. The numerical value of X is A. 1.99×10^{-27} B. 6.60×10^{-26} C. 1.99×10^{-25} D. 6.60×10^{-28} . [$h=6.63 \times 10^{-34}$ Js, $c=3 \times 10^8$ ms $^{-1}$]

10. A radioactive substance has a half-life of 20 days. What fraction of the original radioactive nuclei will remain after 804 days? A. $\frac{1}{16}$ B. $\frac{1}{8}$ C. $\frac{1}{4}$ D. $\frac{1}{32}$

11. Silicon doped with aluminium and germanium doped with arsenic become A. n-type semiconductors. p-type semiconductors C. n- and p- types respectively D. p- and n- types respectively.

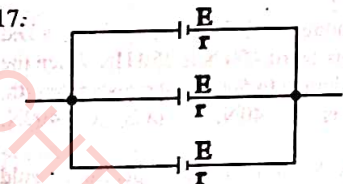
12. A photon of wavelength 6.0×10^{-7} m behaves like a particle of a certain mass. The value of that mass is A. 1.1×10^{-35} kg. B. 2.2×10^{-27} kg. C. 3.5×10^{-36} kg. D. 2.2×10^{-35} kg [$h=6.63 \times 10^{-34}$ Js, $c=3 \times 10^8$ ms $^{-1}$]

13. During the nuclear reactions described by ${}_{92}^{235}\text{W} \rightarrow {}_{93}^{235}\text{X} \rightarrow {}_{91}^{231}\text{Y}$, the particles emitted are respectively A. β and β B. β and α C. α and β D. α and α

14. The bond that forms a semiconductor is A. ionic. B. metallic. C. covalent. D. electrovalent.

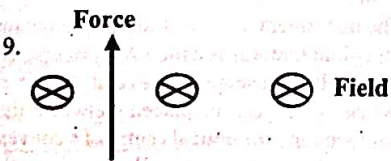
15. The instrument that measures both a.c. and d.c. is A an inverter. B. a current balance. C. a moving coil ammeter. D. a moving iron ammeter

16. Lenz's law is a law of the conservation of A energy. B. momentum. C. electric current. D. electric charge.



17. Three cells each of e.m.f. 1.5V and internal resistance 2.5Ω are connected as shown in the diagram above. Find the net e.m.f. and the internal resistance. A. 4.5V, 7.50Ω B. 4.5V, 0.83Ω C. 1.5V, 7.50Ω D. 1.5V, 0.83Ω

18. A 120 V, 60W lamp is to be operated on 220 V a.c. supply mains. Calculate the value of non-inductive resistance that would be required to ensure that the lamp is run on correct value A. 500Ω B. 300Ω C. 200Ω D. 100Ω .



19. In the diagram above, if the magnetic field points into the paper and the force on a current-carrying conductor points upwards, what is the direction of the current? A. Downwards B. Right C. Left D. Upwards

20. The instantaneous value of the induced e.m.f. as a function of time is $\epsilon = \epsilon_0 \sin \omega t$ where ϵ_0 is the peak value of the e.m.f. The

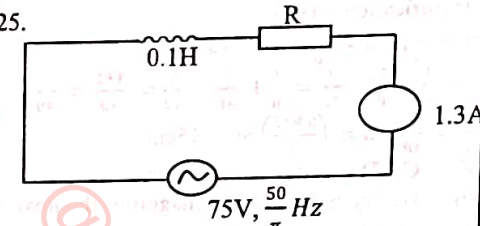
instantaneous value of the e.m.f., one quarter of the period, is A. $\frac{\epsilon_0}{2}$ B. $\frac{\epsilon_0}{2}$ C. $\frac{\epsilon_0}{4}$ D. 0.

21. 118.8cm^2 surface of the copper cathode of a voltmeter is to be coated with 10m thick copper of density $9 \times 10^3 \text{kgm}^{-3}$. How long will the process run with 10 A constant current? A. 10.8 mm B. 20.0 mm C. 5.4 mm D. 15.0 mm [e.c.e. of copper = $3.3 \times 10^{-7} \text{kgC}^{-1}$]

22. A conductor has a diagram of 1.00 mm and length 2.00 m. If the resistance of the material 0.1Ω its resistivity is A. $3.93 \times 10^{-8}\Omega\text{m}$ B. $3.93 \times 10^{-6}\Omega\text{m}$ C. $2.55 \times 10^2\Omega\text{m}$ D. $2.55 \times 10^6\Omega\text{m}$.

23. A charge $50\mu\text{C}$ has an electric field strength of 360NC^{-1} at a certain point. The electric field strength due to another charge $120\mu\text{C}$ kept at the same distance apart and in the same medium is A. 18NC^{-1} B. 144NC^{-1} C. 150NC^{-1} D. 864NC^{-1}

24. Two long parallel wires X and Y carry currents 3A and 5A respectively. If the force experienced per unit length by X is $5 \times 10^{-5} \text{N}$, the force per unit length experienced by wire Y is A. $5 \times 10^{-4} \text{N}$ B. $3 \times 10^{-6} \text{N}$ C. $3 \times 10^{-5} \text{N}$ D. $5 \times 10^{-3} \text{N}$



25. From the diagram above, the inductive reactance and the resistance R are respectively A. 10Ω and 50Ω B. 20Ω and 50Ω C. 25Ω and 50Ω D. 50Ω and 45Ω

26. A 40 kW electric cable is used to transmit electricity through a resistor of resistance 2.0Ω at 800 V. The power loss as internal energy is A. $5.0 \times 10^2 \text{W}$ B. $4.0 \times 10^3 \text{W}$ C. $5.0 \times 10^3 \text{W}$ D. $4.0 \times 10^2 \text{W}$.

27. If two charged plates are maintained at a potential difference of 3 kV, the work done in taking a charge of $600\mu\text{C}$ across the field is A. 9.0J. B. 0.8J. C. 18.0J. D. 1.8J.

28. The ratio of the coefficient of linear expansion of two metals $\frac{\alpha_1}{\alpha_2}$ is 3:4. If, when heated through the same temperature change, the ratio of the increase in lengths of the two metals $\frac{\Delta L_1}{\Delta L_2}$ is 1:2, the ratio of the original lengths is $\frac{L_1}{L_2}$ A. $\frac{2}{3}$ B. $\frac{8}{3}$ C. $\frac{3}{8}$ D. $\frac{3}{2}$

29. I. Mass II. Density III. Temperature IV. Nature of substance. Which of the above affect diffusion? A. I, II and IV only B. II, III and IV only C. I, II, III and IV D. I and II only.

30. A string of length 4 m is extended by 0.02 m when a load of 0.4 kg is suspended at its end. What will be the length of the string when the applied force is 15 N? A. 5.05 m B. 6.08 m C. 4.05 m D. 4.08 m [$g = 10\text{ms}^{-2}$]

31. I. Use a liquid with a high melting point II. Use a liquid of high volume expansivity III. Use a capillary tube of large diameter. Which of the above best describes how the sensitivity of a liquid-in-glass thermometer can be enhanced? A

II only B. II and III only C. I only D. I and III only

32. The blade of a hoe feels colder to touch in the morning than the wooden handle because the A. handle contains stored energy in form of heat B. blade is placed at a lower temperature than the handle C. handle is a better conductor of heat than the blade D. blade is a better conductor of heat than the handle.

33. Which of the following gas laws is equivalent to the work done? A Pressure law B. Van der Waal's law C. Boyle's law D. Charles' law

34. A piece of iron weighs 250 N in air and 200 N in a liquid of density 1000kgm^{-3} . The volume of the iron is A. $2.0 \times 10^{-3} \text{m}^3$ B. $2.5 \times 10^{-3} \text{m}^3$ C. $4.5 \times 10^{-3} \text{m}^3$ D. $5.0 \times 10^{-3} \text{m}^3$. [$g = 10\text{ms}^{-2}$]

35. I. Increase the melting point of the liquid II. Increase the boiling point of the liquid III. Decrease the melting point of the liquid IV. Decrease the boiling point of the liquid. Which of the statements above about the effects of increase in pressure in a liquid are correct? A. II and III only B. I and II only C. III and IV only D. I and III only

36. A blacksmith heated a metal whose cubic expansivity is $6.3 \times 10^{-6} \text{K}^{-1}$. The real expansivity is A. $6.3 \times 10^{-6} \text{K}^{-1}$. B. $4.2 \times 10^{-6} \text{K}^{-1}$ C. $2.1 \times 10^{-6} \text{K}^{-1}$ D. $2.0 \times 10^{-6} \text{K}^{-1}$

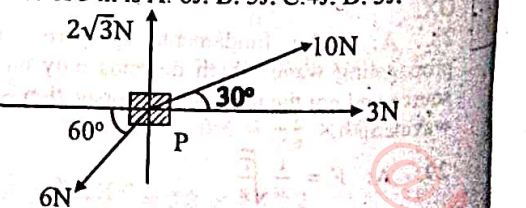
37. The differences observed in solids, liquids and gases maybe accounted for by A their relative masses. B. their melting points. C. the different molecules in each of them D. the spacing and forces acting between the molecules.

38. A reservoir 500 m deep is filled with a fluid of density 850kgm^{-3} . If the atmospheric pressure is $1.05 \times 10^5 \text{Nm}^{-2}$, the pressure at the bottom of the reservoir is A. $4.36 \times 10^6 \text{Nm}^{-2}$ B. $4.25 \times 10^6 \text{Nm}^{-2}$ C. $4.72 \times 10^6 \text{Nm}^{-2}$ D. $4.28 \times 10^6 \text{Nm}^{-2}$. [$g = 10\text{ms}^{-2}$]

39. A clinical thermometer is different from other mercury in glass thermometers owing to A its long stem. B. the constriction on its stem C. its wide range of temperatures D. the grade of mercury used in it.

40. 2 kg of water is heated with a heating coil which draws 3.5A from a 200 V mains for 2 minutes. What is the increase in temperature of the water? A. 25°C B. 15°C C. 10°C D. 30°C [Specific heat capacity of water = $4200 \text{Jkg}^{-1} \text{K}^{-1}$]

41. A boy drags a bag of rice along a smooth horizontal floor with a force of 2 N applied at an angle of 60° to the floor. The work done after a distance of 3 m is A. 6J. B. 5J. C. 4J. D. 3J.



42. The figure above shows four forces 3N, 10N, $3\sqrt{3} \text{N}$ and 6 N acting on a particle P. The resultant of the four forces is A. $10\sqrt{3} \text{N}$. B. 10N. C. $5\sqrt{3} \text{N}$ D. 5N.

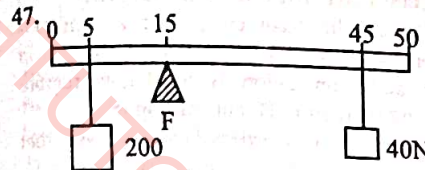
43. Two spheres of masses 5.0 kg and 10.0 kg are 0.3 m apart. Calculate the force of attraction

between them. A. $3.71 \times 10^{-8} \text{ N}$. B. $3.57 \times 10^{-2} \text{ N}$
 C. $4.00 \times 10^{-2} \text{ N}$ D. $3.50 \times 10^{-10} \text{ N}$. [$G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$]

44. A car of mass 1500 kg goes round a circular curve of radius 50 m at a speed of 40 ms^{-1} . The magnitude of the centripetal force on the car is A. $1.2 \times 10^2 \text{ N}$ B. $12 \times 10^3 \text{ N}$ C. $4.8 \times 10^3 \text{ N}$ D. $48 \times 10^4 \text{ N}$

45. The unit of moment of a couple can be expressed as A. Nm. B. Nm^{-1} C. Nm^2 D. Nm^{-2}

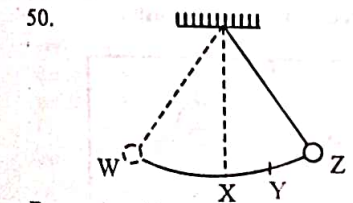
46. A machine has a velocity ratio of 4. If it requires 800 N to overcome a load of 1600 N, what is the efficiency of the machine? A. 2% B. 40% C. 50% D. 60%



In the diagram above, a rod 50 cm long of uniform cross-section is suspended horizontally on a fulcrum, F, by the action of two forces. What is the weight of the rod? A. 120 N B. 200 N C. 40 N D. 80 N

48. A gramophone record takes 5 s to reach its constant angular velocity of $4\pi \text{ rads}^{-1}$ from rest. Find its constant angular acceleration. A. $20.0 \pi \text{ rads}^{-2}$ B. $1.3 \pi \text{ rads}^{-2}$ C. $0.8 \pi \text{ rads}^{-2}$ D. $0.4 \pi \text{ rads}^{-2}$

49. A particle of weight 120 N is placed on a plane inclined at an angle 30° to the horizontal. If the plane has an efficiency of 60%, what is the force required to push the weight uniformly up the plane? A. 210 N B. 175 N C. 100 N D. 50 N.



From the diagram above, the bob of the pendulum has the fastest speed at A. W B. Z C. Y D. X

2007 UME PHYSICS SOLUTION

1. B: We first need to evaluate the velocity of light in the glass plate.

$$n_g = \frac{\text{Velocity of light in vacuum } (V_p)}{\text{Velocity of light in glass } (V_g)}$$

$$V_g = \frac{V_p}{n_g} = \frac{3 \times 10^8}{1.5} = 2 \times 10^8 \text{ m/s}$$

Distance = thickness = $0.9 \text{ cm} = 0.9(10^{-2}) \text{ m} = 9 \times 10^{-3} \text{ m}$

$$\text{Speed} = \frac{\text{distance}}{\text{time}}; \text{time} = \frac{\text{distance}}{\text{speed}} = \frac{9 \times 10^{-3} \text{ m}}{2 \times 10^8 \text{ m/s}} = 4.5 \times 10^{-11} \text{ s}$$

2. D: $F = \frac{1}{2l} \sqrt{T}$

Thus, $F \propto \sqrt{T}$

$$\frac{F_1}{\sqrt{T_1}} = \frac{F_2}{\sqrt{T_2}}; \frac{250}{\sqrt{400}} = \frac{500}{\sqrt{T_2}}$$

$$\sqrt{T_2} = \frac{500 \times 20}{250} = 40$$

$$T_2 = 40^2 = 1600 \text{ N}$$

3. C: The production of pure spectrum could easily be achieved by using a triangular prism with two convex lenses.

4. C: I, II and III are the conditions for two waves to interfere.

5. C: A kaleidoscope comprises two mirrors inclined at 60° to each other. It is used to obtain different colour patterns.

6. D: A simple microscope uses only one convex lens while a compound microscope uses two convex lenses.

7. A: Perforated absorbent materials are used to reduce the reverberation of sound in the hall.

8. D: The bending of light round an obstacle is aptly described as diffraction.

9. C: $E = \frac{hc}{\lambda}$

Thus, $E\lambda = hc = 6.63 \times 10^{-34} \times 3 \times 10^8 = 1.99 \times 10^{-25}$

10. A: $N_t = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_1}}$, $t = 80 \text{ days}$, $t_1 = 20 \text{ days}$

Fraction required = $\frac{N_t}{N_0} = \left(\frac{1}{2}\right)^{\frac{80}{20}} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$

11. D: When a pure semi-conductor like silicon or germanium is doped with a trivalent atom (such as aluminium or boron), a p-type semi-conductor is formed. When a pure semi-conductor is doped with a pentavalent atom (such as phosphorous or arsenic), an n-type semi-conductor is formed.

12. C: KEY \Rightarrow We are to relate Einstein's mass-energy equation to $\frac{hc}{\lambda}$

$$mc^2 = \frac{hc}{\lambda}$$

Then, $mc = \frac{h}{\lambda}; m = \frac{h}{c\lambda} = \frac{6.63 \times 10^{-34}}{3 \times 10^8 \times 6 \times 10^{-7}} = 3.683 \times 10^{-36} \text{ kg}$

13. B: ${}^{235}_{92}\text{U} \rightarrow {}^{235}_{93}\text{Np} + {}^0_{-1}\text{e}$

${}^{235}_{92}\text{U} \rightarrow {}^{231}_{91}\text{Y} + {}^4_2\text{He}$

14. C: Semi-conductors have four valence electrons in their outermost shell. Each valence electron is shared with a surrounding atom in a tetrahedral arrangement. Since sharing of electron is involved, the bond is a covalent type.

15. D: A moving iron ammeter can measure both AC and DC. It harnesses the heating effect of electric current.

16. A: Lenz's law states that the induced emf is in such a direction as to oppose the motion or change producing it. Lenz's law gives the direction of the induced emf or current. Lenz establish his law from the conservation of energy principle.

17. D: The arrangement depicts a parallel connection of cells. Thus, the emf is the value of one cell's emf i.e. resultant emf is 1.5V. Let's get the resultant internal resistance, r.

$$\frac{1}{r} = \frac{1}{2.5} + \frac{1}{2.5} + \frac{1}{2.5}; \frac{1}{r} = \frac{3}{2.5}; r = \frac{2.5}{3} = 0.83 \Omega$$

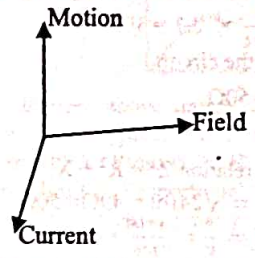
18. C: $P = IV$
 $60 = I \times 120, I = \frac{60}{120} = 0.5 \text{ A}$

$$R_{in} = \frac{V_{in}}{I} = \left(\frac{120}{0.5}\right) \Omega = 240 \Omega$$

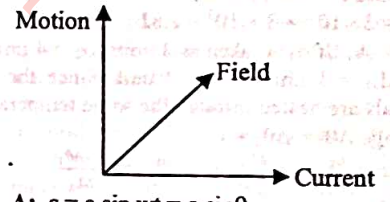
$$R_{out} = \frac{V_{out}}{I} = \left(\frac{220}{0.5}\right) \Omega = 440 \Omega$$

Non-inductive resistance = $440 \Omega - 240 \Omega = 200 \Omega$

19. B: Fleming's left hand rule states that if the thumb, forefinger and middle finger are held mutually at right angles to one another with the fore finger pointing in the direction of the field and the second finger pointing in the direction of the current, then the thumb will point in the direction of motion. For instance, we can have:



If the field not point into the paper and force on the conductor points upward (i.e. the direction of motion is upward, the current will point to the right.



20. A: $\epsilon = \epsilon_0 \sin \omega t = \epsilon_0 \sin \theta$
 One full cycle has θ as 360° , one-quarter of the cycle has $\theta = \frac{360^\circ}{4} = 90^\circ$

Thus, $\epsilon = \epsilon_0 \sin 90^\circ = \epsilon_0 \times 1 = \epsilon_0$
 Hence, $\epsilon = \epsilon_0$

21. Area = $118.8 \text{ cm}^2 = 118.8 \times 10^{-4} \text{ m}^2 = 0.01188 \text{ m}^2$

Thickness = 10^{-6} m
 Volume of copper required = Area \times Thickness

$$= (0.01188 \times 10^{-6}) \text{ m}^3 = 1.188 \times 10^{-8} \text{ m}^3$$

Mass of copper required = density of copper \times volume of copper required

$$= 9 \times 10^3 \text{ kg m}^{-3} \times 1.188 \times 10^{-8} \text{ m}^3 = 1.0692 \times 10^{-4} \text{ kg}$$

From Faraday's first law of electrolysis, $m = Zit$ ($m = \text{mass}$, $z = \text{electrochemical equivalent}$, $I = \text{current}$, $t = \text{time}$)

$$t = \frac{m}{Zi} = \frac{1.0692 \times 10^{-4} \text{ kg}}{3.3 \times 10^{-7} \text{ kgc}^{-1} \times 10 \text{ A}} = 32.4 \text{ s}$$

$$= \left(\frac{32.4}{60}\right) \text{ min} = 0.54 \text{ min}$$

22. A: $R = \frac{\rho l}{A}$ ($R = \text{Resistance}$, $\rho = \text{Resistivity}$, $l = \text{length}$ and $A = \text{area}$)

$$A = \frac{\pi d^2}{4} = \frac{3.142 \times 1 \times 10^{-6} \text{ m}^2}{4} = 7.855 \times 10^{-7} \text{ m}^2$$

$$l = 2 \text{ m}, R = 0.1 \Omega$$

Then, $0.1 = \frac{\rho \times 2}{7.855 \times 10^{-7}}$
 $\rho = \frac{(0.1 \times 7.855 \times 10^{-7})}{2} = 3.93 \times 10^{-8} \Omega \text{ m}$

23. D: $E = \frac{Kq}{r^2}$ ($E = \text{electric field intensity}$, $K = \frac{1}{4\pi\epsilon_0}$ where $\epsilon_0 = \text{permittivity of free space}$ and $q = \text{charge}$ and $r = \text{distance}$)

It can be deduced from the equation above that E varies directly as q i.e. $E \propto q$ (other factors being kept constant)
 Thus,

$$\frac{E_1}{Q_1} = \frac{E_2}{Q_2}$$

$$\frac{360NC^{-1}}{50\mu C} = \frac{E_2}{120\mu C}; E_2 = \frac{360NC^{-1} \times 120\mu C}{50\mu C}$$

$$= 864NC^{-1}$$

24. **D:** The force will be equal for both wires. Note that the force will be attractive if the currents in the wires are in the same direction and repulsive if the directions are opposite.

25. **A:** The inductive reactance $X_L = 2\pi FL$
 $2 \times 3.142 \times \frac{50}{3.142} \times 0.1 = 10\Omega$

The impedance of the circuit
 $Z = \frac{V}{I} = \left(\frac{75}{1.5}\right)\Omega = 50\Omega$

$$R = \sqrt{Z^2 - X_L^2}$$

(From the popular relation $Z^2 = R^2 + X_L^2$)

$$R = \sqrt{50^2 - 10^2} = \sqrt{2400} = 49\Omega \approx 50\Omega$$

26. **C:** $P = IV, I = \frac{P}{V} = \frac{40.00}{800} = 50A$

Power loss = $I^2R = 50^2 \times 2 = 5000W = 5 \times 10^3W$

27. **D:** $W = qV$ ($W =$ workdone, $q =$ charge and $V =$ potential difference)
 $q = 600\mu C = 600 \times 10^{-6}C = 6 \times 10^{-4}C$

$$V = 3KV = 3 \times 10^3V$$

$$W = 3 \times 10^3 \times 6 \times 10^{-4} = 1.8J$$

28. **A:** If α_1 is taken as 3 units, $\alpha_2 = 4$ units
 If $\Delta L_1 = 1$ unit, $\Delta L_2 = 2$ unit. Since the two metals are heated through the same temperature change $\Delta\theta_1 = \Delta\theta_2 = x$

$$\alpha_1 = \frac{\Delta L_1}{\alpha_1 \Delta \theta_1} \div \frac{\Delta L_2}{\alpha_2 \Delta \theta_2} = \frac{\Delta L_1}{\alpha_1 \Delta \theta_1} \times \frac{\alpha_2 \Delta \theta_2}{\Delta L_2}$$

$$= \frac{1}{3 \times x} \times \frac{4 \times x}{2} = \frac{4}{6} = \frac{2}{3}$$

29. **B:** Density, temperature and nature of substance are all factors that affect diffusion rate. Note that mass is already included since density = $\frac{\text{mass}}{\text{volume}}$

30. **D:** Load (F) = $0.4kg = (0.4 \times 10)N = 4N$
 Extension (e) = $0.02m$

$$F = Ke, K = \frac{F}{e} = \frac{4N}{0.02m} = 200Nm^{-1}$$

When the applied force is $15N$

$$15 = K \times e_2; e_2 = \frac{15}{K} = \left(\frac{15}{200}\right)m = 7.5 \times 10^{-2}m = 0.075m$$

$$\text{New length} = \text{Original length} + e_2 = 4m + 0.075m = 4.075m = 4.08m$$

31. **A:** The sensitivity of a liquid-in-glass thermometer can be enhanced by using a liquid of high volume expansivity.

32. **D:** It is because the blade, being a better conductor of heat than the handle, loses more heat and consequently suffers greater temperature drop.

33. **C:** $V \propto \frac{1}{P}$ (K is constant) - Boyle's law

Then, $V = \frac{K}{P}, K = PV$
 P is measure in Nm^{-2} , V is measured in m^3 . Then, the unit of $PV = Nm^{-2} \times Nm$
 Since work can be expressed in Nm , it can be said that Boyle's law is equivalent to Boyle's law.

34. **D:** Upthrust = $250N - 200N = 50N$
 Note that upthrust = weight of fluid displaced.

$$\frac{50}{g} = \text{mass of fluid displaced (m)} \times \frac{g}{g}$$

$$m = \frac{50}{10} = 5kg$$

Mass = density \times volume of liquid displaced
 $5kg = 1000kgm^{-3} \times \text{volume of liquid displaced}$

$$\text{Volume of liquid displaced} = \frac{5kg}{1000kgm^{-3}} = 0.005m^3 = 5 \times 10^{-3}m^3$$

Be mindful that the volume of liquid displaced equals the volume of object (totally) immersed.

35. **A:** Increase in pressure causes an increase in boiling point but a decrease in melting point.

36. **B:** (i) $\gamma = 3\alpha$ ($\gamma =$ cubic expansivity, $\alpha =$ linear expansion).

(ii) $\beta = 2\alpha$ ($\beta =$ Area or superficial expansivity)

From (i), $\alpha = \frac{\gamma}{3}$; from (ii), $\alpha = \frac{\beta}{2}$

Thus, we can write:
 $\frac{\gamma}{3} = \frac{\beta}{2}, \beta = \frac{2\gamma}{3} = \frac{3 \times 6.3 \times 10^{-6}K^{-1}}{3}$

37. **D:** The differences among the three states of matter are as result of the difference in how closely packed their molecules are, as well as the intermolecular forces.

38. **A:** $P = h\rho g +$ atmospheric pressure
 $= [(500 \times 850 \times 10) + 1.05 \times 10^5]Nm^{-2} = 4.355 \times 10^6Nm^{-2}$

39. **B:** The 'Kink' or constriction on the stem of a clinical thermometer makes it different from other mercury-in-glass thermometers.

40. **C:** KEY \Rightarrow We are to relate the electrical energy and the heat energy
 Electrical energy = Heat energy

$$IVt = mc\Delta\theta$$

$$\Delta\theta = \left(\frac{3.5 \times 200 \times 2 \times 60}{2 \times 4200}\right)^\circ C = 10^\circ C$$

41. **D:** Horizontal component of the force = $2\cos 60^\circ$

42. **B:** $3N$ has a horizontal component of $3N$ and a vertical of ON , ION has a horizontal component of $10\cos 30^\circ$ and a vertical component of $10\sin 30^\circ, 3\sqrt{3}N$ has a vertical component of $3\sqrt{3}N$ and a horizontal of ON and finally $6N$ has a horizontal component of $-6\cos 60^\circ$ and a vertical component of $-6\sin 60^\circ$. Note that both vertical and horizontal component of $6N$ are negative because they lie on negative axes.

Total horizontal force (ΣF_x) = $3 + 10\cos 30^\circ + 0 + (-6\cos 60^\circ) = 8.66N$

Total vertical force (ΣF_y) = $0 + 10\sin 30^\circ + 3\sqrt{3} + (-6\sin 60^\circ) = 5$

$$\text{Resultant force} = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$$

$$\sqrt{8.66^2 + 5^2} = 10N$$

43. **A:** $F = \frac{Gm_1m_2}{r^2} = \frac{6.67 \times 10^{-11} \times 5 \times 10}{0.3^2} = 3.71 \times 10^{-8}N$

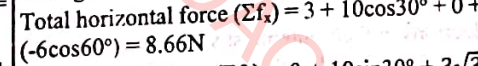
44. **D:** $F = \frac{MV^2}{r} = \frac{(1500 \times 40^2)}{50} = 4.8 \times 10^6N$

45. **A:** Moment of a couple is expressed in Nm

46. **C:** $M.A = \frac{L}{E} = \frac{1600}{800} = 2; V.R = 4$

$$\epsilon = \frac{M.A}{V.R} \times 100\% = \frac{2}{4} \times 100\% = 50\%$$

47. **D:**



$$\text{Clockwise moment} = \text{anticlockwise moment}$$

$$w \times (25 - 15) + 40(45 - 15) = 200(15 - 5)$$

$$w \times 10 + 1200 = 2000$$

$$w = \frac{2000 - 1200}{10} = 80N$$

48. **C:** $w_0 = 0$ (since it is starting from rest)

$\omega_1 = 4\pi \text{rads}^{-1}, t = 5s, \alpha =$ angular acceleration

$$\alpha = \frac{\omega_1 - \omega_0}{t} = \frac{4\pi - 0}{5} = 0.8\pi \text{rads}^{-2}$$

49. **C:** $V.R = \frac{1}{\sin\theta} = \frac{1}{\sin 30} = \frac{1}{0.5} = 2$

$$\epsilon = \frac{M.A}{V.R} \times 100\%, \epsilon = 60\%$$

Then,

$$60\% \frac{M.A}{2} \times 100\%, M.A = \frac{2 \times 60\%}{100\%} = 1.2$$

$$M.A = \frac{L}{E}; 1.2 = \frac{120}{E}; E = \frac{120}{1.2} = 100N$$

50. **D:** The acceleration of a body exhibiting simple harmonic motion is maximum at the extreme ends (W and Z here). The velocity is maximum at the equilibrium position (X here).

2006 UME PHYSICS QUESTIONS

1. When the base current of a common-emitter transistor is kept at zero, it operates in the. A. active-on region. B. breakdown region. C. saturation region. D. cut-off region.

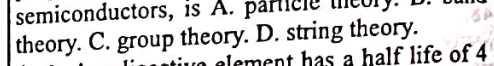
2. One of the properties of gamma rays is that they are A. negatively charged B. massive C. neutral D. positively charged.

3. The theory of electronic conduction in solids, which satisfactorily explains the properties of conductors, insulators and semiconductors, is A. particle theory. B. band theory. C. group theory. D. string theory.

4. A radioactive element has a half life of 4 days. The fraction that has decayed in 16 days is A. $\frac{3}{4}$ B. $\frac{1}{16}$ C. $\frac{15}{16}$ D. $\frac{1}{4}$

5. A certain manufacturer wishes to make an n-type semiconductor. Which materials would he select for doping? A. Arsenic and antimony B. Aluminium and indium C. Boron and antimony D. Helium and boron

6. Which of the following diagrams represents correctly an n-p-n transistor?



7. I. The number of neutrons released exceeds the number that caused the fission. II. There is loss of mass. III. Energy is produced. IV. Smaller nuclei merge to form large nuclei. Which of the statements above are correct about nuclear fission? A. I, II and IV only B. I, II and III only C. I, III and IV only D. II, III and IV only

8. The energy associated with the emitted photon when a mercury atom changes from one state to another is $3.3eV$. Calculate the frequency of the photon. A. $8.0 \times 10^{14}Hz$. B. $3.1 \times 10^{15}Hz$. C. $1.3 \times 10^{15}Hz$. D. $3.2 \times 10^{15}Hz$. [$e = 1.6 \times 10^{-19}C$; $h = 6.6 \times 10^{-34}Js$]

9. A p-n junction diode is used as A. a rectifier in a d.c. circuit. B. an amplifier in an a.c. circuit. C. a rectifier in an a.c. circuit D. an amplifier in a d.c. circuit.

10. The battery connection that permits current to flow across a p-n junction is called A. amplification. B. rectification C. forward biased. D. reverse biased.

11. The process through which free electrons leave the surface of hot metals is known as A.

thermionic emission. B. photo emission. C. photon emission. D. electron emission.

12. A mirror of weight 75 N is hung by a cord from a hook on the wall. If the cord makes an angle of 30° with the horizontal, the tension in the cord is A. 150 N. B. 100 N. C. 1500N. D. 250N.

13. The motion of smoke particles from a chimney is typical of A. oscillatory motion. B. rotational motion. C. circular motion. D. random motion.

14. The component of vector X along the direction of vector Y is zero when A. X is at an angle of 45° to Y. B. X and Y are in opposite directions to each other. C. X and Y are parallel to each other. D. X is perpendicular to Y.

15. I. Work done by load is always less than the work done by effort II. All machines are made of levers, pulleys, screws and gear wheels. III. A fishing rod is a machine IV. Effort is always larger than load. Which of the statements above about machines are true? A. III and IV B. I and II C. I and III D. II and III

16. An engine of a car of power 80 kW moves on a rough road with a velocity of 32 ms^{-1} . The force required to bring it to rest is A. $2.50 \times 10^6 \text{ N}$. B. $2.50 \times 10^3 \text{ N}$. C. $2.56 \times 10^6 \text{ N}$. D. $2.80 \times 10^3 \text{ N}$.

17. If the radius of the earth is $6.4 \times 10^6 \text{ m}$, the escape velocity of a satellite from the earth is A. $8.00 \times 10^3 \text{ ms}^{-1}$ B. $9.00 \times 10^3 \text{ ms}^{-1}$ C. $1.13 \times 10^4 \text{ ms}^{-1}$ D. $1.27 \times 10^4 \text{ ms}^{-1}$ [$g = 10 \text{ ms}^{-2}$]

18. In an experiment to determine terminal velocity, as the pressure increases, the viscosity of a liquid A. increases then decreases. B. decreases. C. remains constant. D. increases.

19. A shooter wants to fire a bullet in such a way that its horizontal range is equal to three times its maximum height. At what angle should he fire the bullet to achieve this? A. 53° B. 68° C. 30° D. 45°

20. The correct unit of energy density is A. $\text{kg m}^{-3} \text{ s}^{-2}$ B. $\text{kg m}^{-1} \text{ s}^{-2}$ C. $\text{kg m}^3 \text{ s}^{-2}$ D. $\text{kg m}^2 \text{ s}^{-2}$.

21. The production and type of charge of a body can only be accounted for by the A. equilibrium in protons and neutrons. B. deficiency or surplus of electrons. C. deficiency or surplus of protons. D. deficiency or surplus of neutrons.

22. The electrolyte in the Nickel-iron (NiFe) accumulator is A. ammonium chloride solution. B. dilute tetraoxosulphate (VI) acid. C. copper tetraoxosulphate (VI) solution D. potassium hydroxide solution

23. The main purpose of the transformer in an ac. radio set is to A. increase power to the radio. B. convert energy from a.c. to d.c. C. step down the voltage D. step up the voltage.

24. When an a.c. voltage is applied to a capacitor, no power is consumed because the current A. and voltage are 180° out of phase. B. and voltage are in phase. C. lags behind the voltage by 90° . D. leads the voltage by 90°

25. An electric heater with a p.d. of 240 V connected across its terminals has a total resistance of 960 Ω . Find the power rating of the heater. A. 4.00 W. B. 0.25 W. C. 60.00W D. 38.40W

26. An ammeter of resistance 5Ω has a full-scale deflection when a current of 50 mA flows

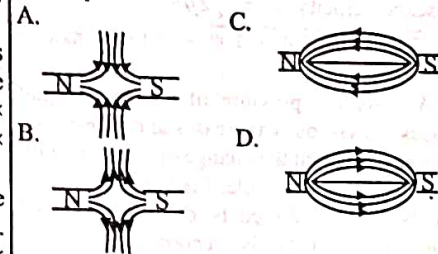
in it. The value of the resistor required to adapt it to measure a current of 5 A is A. 19.80Ω B. 5.00Ω C. 0.05Ω D. 0.25Ω .

27. When a certain a.c. supply is connected to a lamp it lights with the same brightness as it does with a 12 V d.c. battery. The r.m.s. value of the a.c. supply is A. 8.5 V. B. 17.0 V C. 3.5V. D. 12.0V.

28. During electrolysis, 2.0 g of a metal is deposited using a current of 0.05A in 3 hours. The mass of the same metal which can be deposited using a current of 1.5A in 1 hour is A. 3.0g. B. 2.0g. C. 0.5g. D. 1.0g.

29. If the capacitance of a capacitor is $= \frac{\epsilon A}{d}$, which of the following parameters is varied when a variable capacitor is used for tuning radio sets? A. Area and distance B. Constant (ϵ) only C. Constant (ϵ) and area. D. Distance only.

30. Which of the following diagrams represents the magnetic field of two isolated unlike poles?

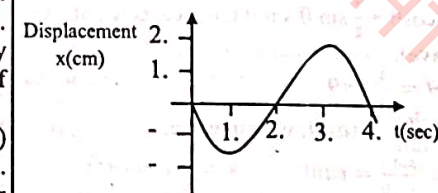


31. A cell of internal resistance r is connected to an external resistor R . The condition for maximum power transfer is A. $R < r$ B. $R = 2r$ C. $R = r$ D. $R > r$.

32. The capacitance of a parallel-plate capacitor when in air is $3 \mu\text{F}$ and in the presence of a dielectric material $6 \mu\text{F}$. The dielectric constant is A. 3. B. 18. C. 2. D. 9.

33. A person can focus objects when they lie beyond 75cm from his eyes. The focal length of the lens required to reduce his least distance of distinct vision to 25 cm is A. 25.00 cm. B; 37.50 cm. C. 75.00 cm. D. 18.75 cm.

34.



The frequency of the wave in the diagram above is A. 1.05 Hz. B. 0.17 Hz. C. 1.57 Hz. D. 0.25 Hz.

35. An object placed 10 cm from a concave mirror of focal length 5cm would have its image A. at infinity. B. 10cm from the focus. C. at the centre of curvature. D. at the radius of curvature.

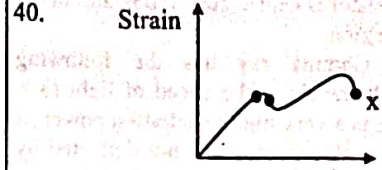
36. A progressive wave equation is represented by $y = a \sin(150\pi t - \frac{\pi x}{4})$. If the phase difference of a progressive wave is 450, the value of x in the equation is A. 3cm. B. 4cm. C. 2 cm. D. 1 cm.

37. Non-luminous objects can be seen because they A. are polished. B. are near. C. reflect light. D. emit light.

38. A submarine is observed to rise from a real depth of 80 m to 60 m in water. Calculate the

change in apparent depth. A. 60m. B. 15m. C. 80m. D. 45m. [Refractive index of water = $\frac{4}{3}$]

39. The wavelength of the first overtone of a note in a closed pipe of length 33cm is A. 44cm. B. 33cm. C. 22cm. D. 17cm.



The diagram above represents the stress-strain graph for a typical metal rod. What does X represent? A: Yield point B. Breaking point C. Elastic limit D. Proportional limit

41. If the relative density of gold is 19.2, the volume of 2.4kg of gold is A. $1.92 \times 10^{-4} \text{ m}^3$ B. $4.61 \times 10^{-3} \text{ m}^3$ C. $8.00 \times 10^{-3} \text{ m}^3$ D. $1.25 \times 10^{-4} \text{ m}^3$. [Density of water = 10^3 kg m^{-3}]

42. The thermos flask is designed to A. prevent heat gain by conduction, convection and radiation. B. prevent heat loss by conduction, convection and radiation. C. prevent heat loss or gain by conduction, convection and radiation. D. store hot tea or water.

43. An immersion heater rated 2.0 A, 240 V is used to boil water from temperature 52°C to 100°C . If the mass of the water is 2.5 kg, determine the time taken to boil the water. A. $1.05 \times 10^4 \text{ s}$ B. $1.05 \times 10^5 \text{ s}$. C. $1.05 \times 10^3 \text{ s}$ D. $1.05 \times 10^2 \text{ s}$ [Specific heat capacity of water = $4.2 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$]

44. What is likely to happen if the glass of a thermometer expands more upon heating than the liquid inside? A. The glass will shrink B. The liquid will go down in the stem C. The liquid will rise up in the stem D. The glass will break

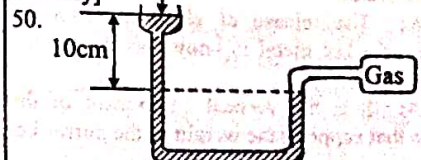
45. A drop of petrol makes a finger colder than a drop of water would because A. petrol takes its latent heat of fusion from the finger. B. petrol takes its latent heat of vaporization from the finger. C. water has higher surface tension than petrol. D. water is more viscous than petrol.

46. A uniform solid cube material 10 cm on each side of mass 700 g is submerged in water. Which of the following best describes the behaviour of the cube in water? A. The cube will rest at an equilibrium position in water B. The cube will melt after a period of time C. The cube will sink in water D. The cube will float

47. In a gas experiment, if the volume of the gas is plotted against the reciprocal of the pressure, the unit of the slope of the resulting curve is A. power. B. work. C. temperature. D. force.

48. The thermometric property of a constant volume thermometer is A. change in pressure. B. change in length. C. differential expansion. D. change in volume.

49. At low humidity in an environment, the human skin is usually A. dry and smooth. B. damp and smooth. C. damp and rough. D. dry and rough. [Atmospheric pressure = 76cm mercury]



In the diagram above, the pressure of the gas is
 A. 96cm of mercury. B. 86cm of mercury C.
 66cm of mercury D. 76cm of mercury.

2006 UME PHYSICS SOLUTION

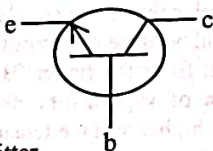
- C: When the base current of a common emitter transistor is kept at zero, it operates in the saturation region.
- C: Gamma ray has the following properties. It travels at the speed of light (3×10^8 m/s). It has a very high penetration power. It is neutral and this is why it is not deflected by electric or magnetic field.
- B: The theory of electronic conduction in solids which satisfactorily explains the properties of conductors, insulators and semi-conductors is the band theory.
- C:

Fraction remaining	Time (days)
N	0
$\frac{N}{2}$	4
$\frac{N}{4}$	8
$\frac{N}{8}$	12
$\frac{N}{16}$	16

Fraction remaining after 16 days = $\frac{N}{16}$

Fraction that has decayed = $\frac{15N}{16} = \frac{15}{16}$ i.e. $\frac{15}{16}$ of the original size.

- A: To produce an n-type semi-conductor, the manufacture should dope a pure semi-conductor with a pentavalent atom for a p-type semi-conductor, the atom to be used for doping must be trivalent.
- B: For an n-p-n transistor, the collector must be positive.



e = emitter

b = base

c = collector

symbol for n-p-n transistor (please not the direction of the arrow).

NB: For a p-n-p transistor, the collector must be negative.

7. B: I, II and III are true for nuclear fission. In fact the inclusion of 'IV' (which says to form a heavy nucleus - which is wrong)

8. A: since $1\text{eV} = 1.6 \times 10^{-19}\text{J}$, $3.3\text{eV} = (3.3 \times 1.6 \times 10^{-19})\text{J} = 5.28 \times 10^{-19}\text{J}$

$$E = hf, f = \frac{E}{h}$$

Then,

$$f = \frac{(5.28 \times 10^{-19})}{(6.6 \times 10^{-34})} = 8 \times 10^{14}\text{Hz}$$

9. C: A p-n junction diode is used as a rectifier in an a.c. circuit. It must be known that rectification involves the conversion of ac to d.c.

10. C: A battery connection that permits current to flow across a p-n junction is said to be forward biased.

11. A: The release of electrons from the surface of a hot metal is known as thermionic emission.

12. A: It is the vertical component of the tension that supports the weight of the mirror i.e.

$$T \sin 30^\circ = W; T \sin 30^\circ = 75\text{N}$$

$$T = \frac{75\text{N}}{\sin 30^\circ} = 150\text{N}$$

13. D: Smoke particles released from a chimney move in haphazard manner i.e. no a specific direction. Thus, it cannots random motion.

14. D: This occurs when X and Y are perpendicular to each other i.e. when the angle between them is 90° .

15. C: I is correct and this is why efficiency will always be less than 100%. II is not correct as there are many other types of machine. III is correct. Yes! A fishing rod is a machine - it is a lever! IV is wrong as load is normally greater than the effort.

16. B: Power can be expressed as a product of force and velocity.

$$P = 80\text{Kw} = 80,000\text{W}, V = 32\text{ms}^{-1}, F = ?$$

$$P = FV, F = \frac{P}{V} = \left(\frac{80,000}{32}\right)\text{N} = 2500\text{N} = 2.5 \times 10^3\text{N}$$

17. C: $R = 6.4 \times 10^6\text{m}$, $g = 10\text{ms}^{-2}$.

The escape velocity, $V = \sqrt{2gR}$

$$V = \sqrt{2 \times 10 \times 6.4 \times 10^6} = 11313.7\text{m/s} = 1.131 \times 10^4\text{m/s}$$

18. A: As the pressure of a typical liquid increases, its viscosity increases and vice-versa.

It must be noted that the change of viscosity with pressure is not appreciable, I mean the pressure has to be greatly altered before a pronounced change in viscosity is recorded. Viscosity responds better to temperature. Viscosity of a liquid varies with temperature in an inverse manner i.e. increase in temperature causes a decrease in viscosity and vice-versa.

19. A: Range = $3 \times$ maximum height (required)

$$\frac{U^2 \sin^2 \theta}{g} = 3 \times \frac{U^2 \sin^2 \theta}{2g} \text{ (} U^2 \text{ cancels out, then we have):}$$

$$\frac{\sin^2 \theta}{g} = \frac{3 \sin^2 \theta}{2g} \text{ (} g \text{ cancels out, then we have):}$$

$$\sin^2 \theta = \frac{3 \sin^2 \theta}{2}$$

$$\sin 2\theta = 2 \sin \theta \cos \theta \text{ and } \sin^2 \theta = (\sin \theta)^2$$

Then, we have

$$2 \sin \theta \cos \theta = \frac{3}{2} \sin^2 \theta \text{ (} \sin \theta \text{ cancels out, then we have):}$$

$$2 \cos \theta = \frac{3}{2} \sin \theta$$

Since $\frac{\sin \theta}{\cos \theta} = \tan \theta$, we can write:

$$\frac{2 \times 2}{3} = \frac{\sin \theta}{\cos \theta} = \tan \theta$$

$$\tan \theta = \frac{4}{3} = 1.3333$$

$$\theta = \tan^{-1} 1.3333 = 53^\circ$$

Thus, a shooter must fire at an angle of 53° to the horizontal to record a range which is three times the maximum height attained.

20. B: Energy density is the total amount of energy stored in a given system per unit volume. It is measured in Jm^{-3} or $\text{Kg m}^{-1}\text{s}^{-2}$.

21. B: It depends on the availability of electrons. If a body is deficit of electrons, it is positively charged and if it has excess electrons, it is negatively charged.

22. D: The Nickel-Iron (NIFE) accumulator uses nickel as the positive electrode, iron as the negative electrode and potassium hydroxide solution as electrolyte. When fully charged, its

e.m.f is about 1.5 volts and falls to about 1.3 volts after some time.

23. C: The main purpose of the transformer in an a.c radio set is to step down the voltage.

24. D: In a capacitive circuit, the current leads the voltage by 90° or $\frac{\pi}{2}$. In other words, the

voltage lags the current by 90° or $\frac{\pi}{2}$. In an inductive circuit, the voltage leads the current by

90° or $\frac{\pi}{2}$. In other words, the current lags the voltage by 90° or $\frac{\pi}{2}$.

$$25. C: P = \frac{V^2}{R} = \frac{240^2}{960} = 60\text{W}$$

26. A shunt is required here. The resistance of the shunt, $R_s = \frac{(I_g \times R_g)}{(I - I_g)} = \frac{(50(10^{-3}) \times 5)}{5 - 50(10^{-3})}$

$$= \frac{0.005 \times 5}{5 - 0.05} = 0.05\Omega$$

27. D: The root mean square (r.m.s) of an ac voltage is the voltage that will give the same effect as a given d.c voltage thus, $V_{r.m.s} = 12\text{V}$

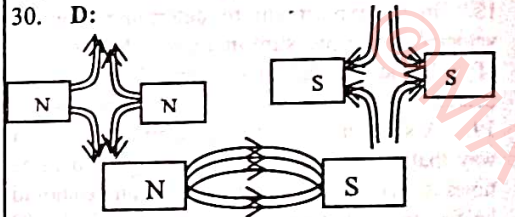
28. B: $Q_1 = I_1 t_1 = (0.5 \times 3 \times 3600)\text{C} = 5400\text{C}$
 $Q_2 = I_2 t_2 = (1.5 \times 1 \times 3600)\text{C} = 5400\text{C}$

Faraday's first law states that the mass of an element produced during electrolysis is directly proportional to the quantity of electricity passing through the electrolyte. Thus, Q_2 will be the same mass of the same metal as Q_1 (since they are equal)

29. A: In the formula $C = \frac{A\epsilon_0}{d}$

ϵ_0 is a constant known as the permittivity of free space. A and d can be altered but ϵ_0 can't (since it is a constant)

30. D:



Please note keenly the direction of the arrows

31. D: For maximum power transfer, the internal resistance must be small i.e. the external resistance must be greater than the internal resistance.

32. C: $C = \frac{AK\epsilon_0}{d}$ (for air, $K = 1$)

From the equation, it is established that the capacitance varies directly as the dielectric constant i.e. $C \propto K$. Then,

$$\frac{C_1}{K_1} = \frac{C_2}{K_2}, \frac{3\mu\text{f}}{1} = \frac{6\mu\text{f}}{K_2}; K_2 = \frac{6\mu\text{f} \times 1}{2\mu\text{f}} = 3$$

33. B: KEY \Rightarrow The lens to be used must produce an image which is to be situated at where the eye can see it i.e. 75cm. Note that V is always negative for images on the same side of the lens as the objects

$$V = -75\text{cm}, U = 25\text{cm}, f = ?$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{25} + \frac{1}{-75} = \frac{1}{25} - \frac{1}{75} = \frac{3-1}{75} = \frac{2}{75}$$

$$2f = 75, f = \frac{75}{2} = 37.5\text{cm}$$

34. D: Since it takes the wave 4.0s to complete a cycle, the period $T = 4.0\text{s}$

$$F = \frac{1}{T} = \frac{1}{4} = 0.25\text{Hz}$$

35. C: If $f = 5\text{cm}$, $u = 10\text{cm} = 2f$ (the centre of curvature). For objects placed at the centre of curvature of a concave mirror, the images will also be at the centre of curvature.

36. D: $y = a \sin(150\pi t - \frac{\pi x}{4})$

Phase difference = $\frac{\pi x}{4} = 45^\circ (\pi = 180^\circ)$

Then, we have:

$\frac{180^\circ \times x}{4} = 45^\circ; x = \frac{45^\circ \times 4}{180^\circ} = 1$

37. C: Non-luminous objects are seen due to the light they reflect.

38. D: $\frac{\text{Real depth (R.D)}}{\text{Apparent depth (A.D)}} =$

Refractive index (n)

A.D = $\frac{R.D}{n}$. At the depth of 80m, we have:

A.D = $\frac{80}{1.3333} = 60\text{m}$

At the depth of 60m, we have:

A.D = $\frac{60}{1.333} = 45\text{m}$

39. A: For the first overtone or second harmonic,

$l = \frac{3\lambda}{4}, l = 33\text{cm} = \frac{3\lambda}{4}; \lambda = (\frac{4 \times 33\text{cm}}{3}) = 44\text{cm}$

40. B: X represents the breaking point

41. D: Density = Relative density × density of water

$= 19.2 \times 10^3 \text{Kg m}^{-3} = 19200 \text{Kg m}^{-3}$

Volume = $\frac{\text{Mass}}{\text{density}} = \frac{2.4\text{kg}}{19200 \text{kg m}^{-3}} = 1.25 \times 10^{-4} \text{m}^3$

42. C: The thermos flask keep hot liquid hot and cold liquid cold. Thus, it can be deduced that it prevents both heat loss and heat gain. It prevents heat loss or gain by conduction, convection and radiation

43. C: Electrical energy is converted to heat energy for raising the temperature of the water here.

IVt = mcΔθ

$2 \times 240 \times t = 2.5 \times 4200 \times (100 - 52) = 504,000$

$t = (\frac{504,000}{2 \times 240})\text{s} = 1050\text{s} = 1.05 \times 10^3\text{s}$

44. B: This will cause the liquid to go down in the stem.

45. B: The finger feels cold as petrol takes its latent heat of vaporization from the finger.

46. D: Mass = 700g, Volume = $L^3 = (10\text{cm})^3 = 1000\text{cm}^3$

Density of the cube = $\frac{\text{Mass}}{\text{Volume}} = \frac{700\text{g}}{1000\text{cm}^3}$

Since the density of the cube is less than that of water (1gcm^{-3}), the cube will float on water.

47. B: $V \propto \frac{1}{P}, V = \frac{K}{P}, K = PV$

Pressure, P is measured in Nm^{-2} and volume V is measured in m^3 . Thus, the unit of $PV = \text{Nm}^{-2} \times \text{m}^3 = \text{Nm}$. Note that work can also be expressed in Nm.

48. A: Thermometric property of a constant volume thermometer is change in pressure.

49. D: When the amount of water vapour in the air is little (low humidity), the rate of evaporation is high and our skin feels dry and rough. On the other hand, when there is high humidity, the rate of evaporation is high and our skin feels damp and smooth.

50. B: Pressure of the gas = Pressure due to 10cm of mercury + The atmospheric pressure = $10\text{cmHg} + 76\text{cmHg} = 86\text{cmHg}$.

2005 UME PHYSICS QUESTIONS

1. A transformer is rated 240 V. If the primary coil is 4000 turns and the secondary voltage 12V, determine the number of turns in the secondary coil A. 250. B. 100. C. 150. D. 200.

2. Which of the following materials is a conductor? A. Plastic B. Sodium C. Wax D. Glass

3. The charge carriers in gases are A. ions only. B. electrons and holes. C. electrons only. D. electrons and ions.

4. When impurities are added to semi-conductors, the conductivity of the semi-conductor A. remains constant. B. increases then decreases. C. increases. D. decreases.

5. The ray which causes gas molecules to glow is known as A. molecular ray. B. gamma ray. C. anode ray. D. cathode ray.

6. A proton moving with a speed of $1.0 \times 10^6 \text{ms}^{-1}$ through a magnetic field of 1.0T experiences a magnetic force of magnitude $8.0 \times 10^{-14} \text{N}$. The angle between the proton's velocity and the field is A. 45° . B. 30° . C. 60° . D. 90° . [Proton charge = $1.6 \times 10^{-19} \text{C}$]

7. ${}^{235}_{92}\text{U} + {}^1_0\text{n} \rightarrow {}^{144}_{54}\text{Ba} + {}^{90}_{36}\text{Kr} + 2\text{X}$. In the reaction above, X is A. neutron. B. electron. C. neutrino. D. proton.

8. A silicon material is doped with an element of a certain group and an n-type semiconductor is formed. The most likely group of the element is A. II. B. I C. V. D. III

9. The time d will take a certain radioactive material with a half-life of 50 days to reduce to $\frac{1}{32}$ of its original number is A. 300 days. B. 150 days. C. 200 days. D. 250 days.

10. In an a.c. circuit that contains only a capacitor, the voltage lags behind the current by A. 90° B. 180° C. 60° D. 30°

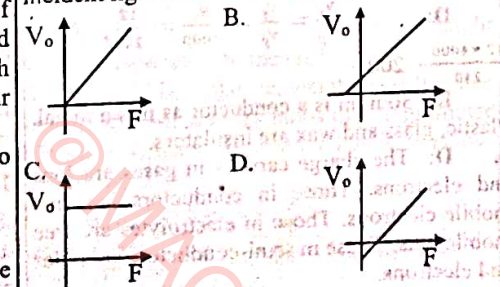


In the circuit diagram of a transistor above, the terminals P, Q and R represent. A. COLLECTOR, EMITTER and BASE B. EMITTER, BASE and COLLECTOR C. BASE, EMITTER and COLLECTOR D. BASE, COLLECTOR and EMITTER.

12. The amount of energy released when 0.5 kg of uranium is burnt completely is A. $4.5 \times 10^{16} \text{J}$. B. $1.5 \times 10^{16} \text{J}$. C. $1.5 \times 10^9 \text{J}$. D. $4.5 \times 10^8 \text{J}$. [c = $3 \times 10^8 \text{ms}^{-1}$]

13. The current in a reverse-biased junction is due to A. electrons. B. majority carriers. C. holes. D. minority carriers.

14. In photoelectric effect, which of the following graphs correctly represents the graph of stopping potential V_0 against frequency f of incident light?

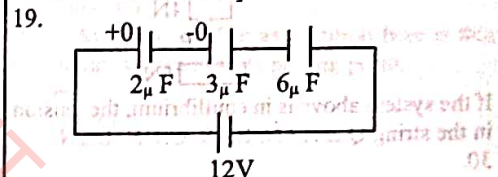


15. If two inductors of inductances 3H and 6H are arranged in series, the total inductance is A. 18.0 H. B. 9.0 H. C. 2.0 H. D. 0.5 H.

16. Satellite communication network makes use of A. infra-red rays. B. sound wave. C. visible light. D. radio wave.

17. The electric field intensity in a place where a charge of 10^{-10}C experiences a force of 0.4N is A. $8.0 \times 10^{-12} \text{NC}^{-1}$. B. $8.0 \times 10^9 \text{NC}^{-1}$. C. $4.0 \times 10^9 \text{NC}^{-1}$. D. $4.0 \times 10^{-11} \text{NC}^{-1}$.

18. The resistance of a piece of wire of length 20m and cross-sectional area $3 \times 10^{-6} \text{m}^2$ is A. 1.0Ω . B. 10.0Ω . C. 0.5Ω D. 5.0Ω . [Resistivity of the wire = $4 \times 10^{-7} \Omega \text{m}$]



The figure above shows three capacitors, $2\mu\text{F}$, $3\mu\text{F}$ and $6\mu\text{F}$ connected in series. If the p.d. across the system is 12V, the p.d. across the $6\mu\text{F}$ capacitor is A. 4V. B. 6V. C. 12V. D. 2V.

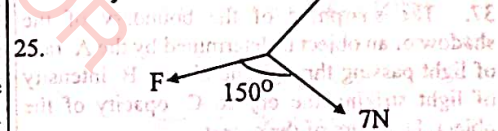
20. The north pole of a magnet can never be separated from the south pole because of a property known as A. magnetic dipole. B. magnetic octopole. C. magnetic monopole. D. magnetic quadrupole.

21. An electric device is rated 2000 W, 250 V. The correct fuse rating of the device is A. 8A. B. 9A. C. 7A. D. 6A.

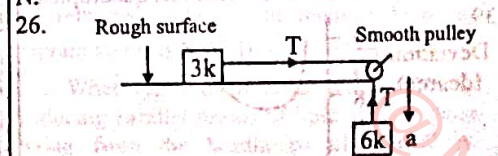
22. A car battery rated 45 AH is charged with a charger whose rating is 2.5 A. How long will it take to charge the battery fully? A. 20 hrs B. 13. 10 hrs C. 25 hrs D. 18 hrs

23. If the distance between two point charges is increased by a factor of four, the magnitude of the electrostatic force between them will be A. $\frac{1}{2}$ of its former value B. $\frac{1}{16}$ of its former value C. $\frac{1}{4}$ of its former value D. 4 times its former value.

24. Two charged particles are projected into a region where there is a magnetic field perpendicular to their velocities. If the charges are deflected in opposite directions, which of the following statements is true of the charges? A. The charges are of the same sign B. Positive charges are more in number C. The charges must be of opposite sign D. The charges are electrically neutral.

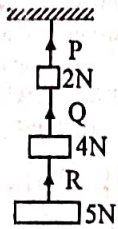


The value of F in the figure above when in equilibrium is A. 10 N. B. 12 N. C. 27 N. D. 20 N.



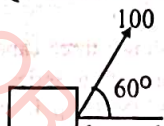
In the figure above, the coefficient of static friction is 0.5. If the tension in the string is T, the acceleration of the system in motion is A. 1.5ms^{-2} B. 3ms^{-2} C. 5ms^{-2} D. 9ms^{-2} . [$g = 10 \text{ms}^{-2}$]

27. In an ideal wheel and axle system, R stands for the radius of the wheel and r is the radius of the axle. The mechanical advantage is
A. $\frac{R}{r}$ B. $\left(\frac{r}{R}\right)^2$ C. $\frac{r}{R} D. \left(\frac{R}{r}\right)^2$.
28. A motorcyclist travelling at 30 ms^{-1} starts to supply his brakes when he is 50 m from the traffic light that has just turned red. If he just reached the traffic light, his deceleration is A. 5 ms^{-2} . B. 9 ms^{-2} . C. 10 ms^{-2} . D. 18 ms^{-2} .
- 29.



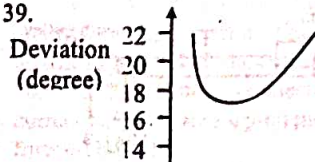
If the system above is in equilibrium, the tension in the string Q is A. 6N. B. 4N. C. 1N. D. 9N.

30.



In the figure above, the work done by the force of 100N inclined at an angle of 60° to the object dragged horizontally to a distance of 8m is A. 600J. B. 800J. C. 400J. D. 100J. [Neglect frictional effect]

31. An object is projected from a height of 80 m above the ground with a velocity of 40 ms^{-1} at an angle of 30° to the horizontal. The time of flight is A. 4s. B. 16s. C. 10s. D. 8s. $[g = 10 \text{ ms}^{-2}]$
32. A force of 200 N acts between two objects at a certain distance apart. The value of the force when the distance is halved is A. 100 N. B. 200 N. C. 800 N. D. 400 N.
33. The pair of physical quantities consisting of vectors only are A. acceleration and speed. B. displacement and torque. C. velocity and distance. D. momentum and power.
34. A real image three times the size of an object is formed 24 cm from a converging mirror. What is the focal length of the mirror? A. 8cm B. 16cm C. 6cm D. 12cm
35. Marching soldiers crossing a suspension bridge are usually advised to break their steps to avoid damaging the bridge owing to A. swinging B. vibration C. oscillation D. resonance.
36. A thin converging lens has a power of 4.0 diopters. Determine its focal length. A. 0.25 m. B. 0.03 m. C. 5.00 m. D. 2.50 m.
37. The sharpness of the boundary of the shadow of an object is determined by the A. rays of light passing through the object. B. intensity of light striking the object. C. opacity of the object. D. nature of the object.
38. The velocity of sound in air will be doubled if its absolute temperature is A. doubled. B. halved. C. constant. D. quadrupled.
- 39.



The figure above shows a thin prism of angles of deviation through $15, 20, 25, 30, 35, \theta$ (degree) is incident at 0 degrees on the prism. The incident

angle that produces the minimum deviation is A. 25° . B. 18° . C. 35° . D. 20° .

40. Two liquids L_1 and L_2 are contained in a U-tube. The height and the density of L_1 are 8 cm and 10^3 kgm^{-3} respectively. If the density of L_2 is 800 kgm^{-3} , its height measured from the same level A. 8cm. B. 16cm. C. 12cm. D. 10cm.
41. When the temperature difference between the wet and dry bulbs of a hygrometer is high, this indicates that A. it is about to rain. B. there is plenty of sunshine. C. the relative humidity is low. D. the relative humidity is high.
42. An elastic material has a length of 36cm when a load of 40 N is hung on it and a length of 45 cm when a load of 60 N is hung on it. The original length of the string is A. 18cm. B. 12cm. C. 20cm. D. 15cm.
43. I. Reproducibility II. Sensitivity III. High thermal capacity IV. High accuracy. The qualities of a good thermometer include A. I, III and IV only B. I, II and IV only C. II, III and IV only. D. I, II and III only.
44. The process whereby the molecules of different substances move randomly is called A. surface tension. B. diffusion. C. capillarity. D. osmosis.
45. 10^6 J of heat is required to boil off completely 2 kg of a certain liquid. Neglecting heat lost to the surroundings, the latent heat of vaporization of the liquid is A. $5.0 \times 10^5 \text{ J kg}^{-1}$. B. $2.0 \times 10^5 \text{ J kg}^{-1}$. C. $5.0 \times 10^6 \text{ J kg}^{-1}$. D. $2.0 \times 10^6 \text{ J kg}^{-1}$.
46. A 3 m^3 volume of liquid W of density 200 kgm^{-3} is mixed with another liquid L of volume 7 m^3 and density 150 kgm^{-3} . The density of the mixture is A. 265 kgm^{-3} B. 165 kgm^{-3} C. 100 kgm^{-3} . D. 350 kgm^{-3} .
47. I. Melting II. Boiling III. Refraction IV. Conduction. Which combination of the above is evident of the molecular nature of matter? A. I, II and IV only B. I, III and IV only C. I, II and III only D. II, III and IV only
48. When very hot water is poured into two identical thin and thick glass tumblers in equal volumes, the thick one cracks because A. of the even expansion of glass. B. glass is a good conductor of heat. C. of the uneven expansion of glass. D. glass is a crystal.
49. A body of mass 36 kg falls through a viscous liquid which offers a drag force of 260 N on the body. The upthrust on the body at terminal velocity is A. 310N B. 50N C. 620 N D. 100N. $[g = 10 \text{ ms}^{-2}]$
50. The process whereby a liquid turns spontaneously into vapour is called A. evaporation. B. regulation C. boiling D. sublimation.

2005 UME PHYSICS SOLUTION

1. D: $\frac{N_s}{N_p} = \frac{V_s}{V_p} = \frac{N_s}{4000} = \frac{12}{240}$; $N_s = \frac{12 \times 4000}{240} = 200$
2. B: Sodium is a conductor as it is a metal. Plastic, glass and wax are insulators.
3. D: The charge carriers in gases are ions and electrons. Those in conductors are free mobile electrons. Those in electrolytes are free mobile ions. Those in semi-conductors are holes and electrons.
4. C: When impurities are added to semi-conductors, the conductivity increases.

5. D: This is a description of cathode ray.
6. B: $V = 1 \times 10^6 \text{ m/s}$, $B = 1.0 \text{ T}$, $F = 8 \times 10^{-4} \text{ N}$
 $F = qvB \sin \theta$; $q = +1.6 \times 10^{-19} \text{ C}$
 $8 \times 10^{-4} = 1.6 \times 10^{-19} \times 1 \times 10^6 \times 1 \times \sin \theta$
 $8 \times 10^{-4} = 1.6 \times 10^{-13} \sin \theta$
 $\sin \theta = \frac{8 \times 10^{-4}}{1.6 \times 10^{-13}} = 0.5$
Then, $\theta = \sin^{-1} 0.5 = 30^\circ$

7. A: ${}_{92}^{235}\text{U} + {}_0^1n \rightarrow {}_{56}^{144}\text{Ba} + {}_{36}^{90}\text{Kr} + 2{}_0^1n$
 $235 + 1 = 144 + 90 + 2a$, $2a = 2$, $a = 1$
 $92 + 0 = 56 + 36 + 2b$, $2b = 0$, $b = 0$
 ${}_0^1n = {}_0^1n \Rightarrow$ Neutron

8. C: When a pure semi-conductor is doped with a trivalent atom (element in group III), a p-type semi conductor is formed. When the atom semi-conductor is doped with is pentavalent (element in group V), an n-type semi-conductor is formed.

9. D: $N \Rightarrow 0$ (Where N represent the original amount)

$\frac{N}{2} \Rightarrow 50$ days
 $\frac{N}{4} \Rightarrow 100$ days

$\frac{N}{8} \Rightarrow 150$ days
 $\frac{N}{16} \Rightarrow 200$ days
 $\frac{N}{32} \Rightarrow 250$ days

10. A: In a capacitive circuit, the voltage will lag the current by 90° or $\frac{\pi}{2}$.

11. B:

P \Rightarrow Emitter

Q \Rightarrow Base

R \Rightarrow Collector

12. A: Key \Rightarrow Einstein's equation that relates mass and energy is needed here. $E = mc^2 = 0.5 \times (3 \times 10^8)^2 \Rightarrow 4.5 \times 10^{16} \text{ J}$

13. D: Current in a reversed-biased junction is due to minority carriers.

14. B: Energy of the photon, $E = hf$
Energy to break the barrier of the surface, which is also known as the work function $= W_0$

(i) $E = W_0 + \frac{1}{2}mv^2$ (where $v =$ Velocity)

(ii) $E = W_0 + V_0$ (where $V_0 =$ stopping potential)

From equation ii, we have

$hf = W_0 + V$. Thus,

$V_0 = hf - W_0 \dots$ (iii)

It is obvious that V_0 varies directly as f but what about the intercept. Consider the equation of a straight line: $y = mx + c$.

Equation (iii) can be re-written so as to resemble the equation of a straight line as below:

$V_0 = hf + (-W_0)$. Thus, the intercept C is negative

$(-W_0)$. This is illustrated by the graph contained in option B.

15. B: When inductors are connected in series, the effective inductance $L = L_1 + L_2 \dots$

Thus, $L = 3\text{H} + 6\text{H} = 9\text{H}$

16. D: Satellite communication network makes use of radio waves.

17. C: $I = Eq$; $E = \frac{F}{q} = \frac{0.4 \text{ N}}{10^{-10} \text{ C}} = 4 \times 10^9 \text{ NC}^{-1}$

18. A: $R = \frac{\rho l}{A} = \frac{4 \times 10^{-7} \times 20}{8 \times 10^{-6}} = 1\Omega$

19. D: Since the three capacitors are connected in series, the same charge pass through them $Q = CV$ ($Q =$ charge, $C =$ capacitance, $V =$ potential difference)

$$\frac{1}{C} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = \frac{3+2+1}{6} = \frac{6}{6} = 1$$

$$C = 1\mu f = 1 \times 10^{-6} f$$

$$Q = (1 \times 10^{-6} \times 12)C \Rightarrow 1.2 \times 10^{-5} C$$

$$\text{For the } 6\mu f \text{ capacitor, } V = \frac{Q}{C} = \frac{1.2 \times 10^{-5}}{6 \times 10^{-6}} = 2V$$

20. A: The property is known as the magnetic dipole.

21. A: Power = current \times voltage

NB: the fuse rating \equiv current (I)

$$2000W = I \times 250V, I = \left(\frac{2000}{250}\right)A = 8A$$

$$22. D: \text{Time taken} = \frac{45Ah}{2.5A} = 18 \text{ hours}$$

23. D: $F \propto \frac{kq_1q_2}{r^2}$. Then, it follows that $F \propto \frac{1}{r^2}$

$$F = \frac{C}{r^2} \text{ (C is the constant of proportionality)}$$

$$\text{Thus, } C = Fr^2 = F_1r_1^2 = F_2r_2^2$$

Since the distance is increased by a factor of 4, $r_2 = 4r_1$. Then, we write:

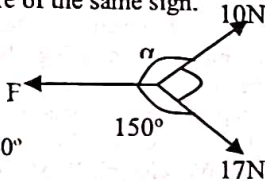
$$F_1 \times r_1^2 = F_2 \times (4r_1)^2 = F_2 \times 16r_1^2$$

$$F_2 = \frac{F_1 \times r_1^2}{16} = \frac{F_1}{16} = \frac{1}{16}F_1$$

Thus, the force will be $\frac{1}{16}$ of the original force.

24. C: The charges must be of opposite sign. They would unequivalently travel in the same direction if they were of the same sign.

25. D:



$$\alpha + 90^\circ + 150^\circ = 360^\circ$$

$$\alpha = 120^\circ$$

Using Lami's theorem

$$\frac{10}{\sin 150^\circ} = \frac{F}{\sin 90^\circ}; F = \frac{10 \sin 90^\circ}{\sin 150^\circ} = 20N$$

You may choose α instead

Then, you should write:

$$\frac{F}{\sin 90^\circ} = \frac{17}{\sin 120^\circ}; F = \frac{17 \sin 90^\circ}{\sin 120^\circ} = 19.63N \approx 20N$$

26. C: (i) $T - \mu m_1 g = m_1 a$ ($m_1 = 3\text{kg}$)

(ii) $m_2 g - t = m_2 a$ ($m_2 = 6\text{kg}$)

Add equations (i) and (ii)

$$m_2 g - \mu m_1 g = m_1 a + m_2 a$$

$$g(m_2 - \mu m_1) = a(m_1 + m_2)$$

$$a = g \frac{(m_2 - \mu m_1)}{m_1 + m_2} = 10 \frac{(6 - (0.5 \times 3))}{3+6} = 5\text{m/s}^2$$

27. A: Velocity ratio of a wheel and axle =

$$\frac{\text{Distance moved by the effort}}{\text{Distance moved by the load}} = \frac{2\pi R}{2\pi r} = \frac{R}{r} \text{ (R = radius of the wheel, r = radius of the axle)}$$

In an ideal machine, efficiency is 100% i.e. $M.A = V.R$

$$\text{Thus, } M.A = \frac{R}{r}$$

28. B: KEY \Rightarrow It is assumed that he will stop on getting to the traffic light. $U = 30\text{ms}^{-1}$, $S = 50\text{m}$, $V = 0$, $a = ?$

$$V^2 = U^2 + 2aS, a = \frac{v^2 - u^2}{2S} = \frac{0^2 - 30^2}{2 \times 50} = -9\text{m/s}^2$$

His acceleration will be -9m/s^2 i.e. his deceleration = 9m/s^2 .

29. D: The string P supports $2N + 4N + 5N = 11N$

The string Q supports $4N + 5N = 9N$

The string R supports $2N$

30. C: Horizontal force = $100\cos 60^\circ = 50N$

Horizontal distance = 8m

$$\text{Workdone} = \text{Force} \times \text{distance} = (50 \times 8)\text{J} = 400\text{J}$$

31. A: KEY \Rightarrow One has to be extremely careful here. Please, the question does not require us to calculate the time that the object will take to reach the ground level but the time of flight! Many a physicist will argue that the two are the same but nay, they are two different things!

By definition, the time of flight of a projectile is the time it takes to return to its original level of projection. So, unless the projectile was launched from the ground level, the time to flight should not be considered as the time to reach the ground.

$$\text{Time of flight, } T = \frac{2u\sin\theta}{g} = \frac{2 \times 40 \times \sin 30^\circ}{10} = 4s$$

$$32. C: F \propto \frac{1}{r^2}; F = \frac{K}{r^2}$$

$$K = Fr^2 = F_1r_1^2 = F_2r_2^2$$

When the distance is halved, $r_2 = \frac{1}{2}r_1$

Then, we have:

$$F_1r_1^2 = F_2(\frac{1}{2}r_1)^2 = F_2 \times \frac{1}{4}r_1^2$$

Then,

$$F_2 = \frac{4 \times F_1r_1^2}{r_1^2} = 4F_1$$

If $F_1 = 200N$

$$F_2 = (4 \times 200)N = 800N$$

33. B: Acceleration, displacement, torque, velocity and momentum are vector quantities while speed, distance and power are scalar quantities.

$$34. C: M = 3, M = \frac{v}{u}; 3 = \frac{24}{u}; U = \frac{24}{3} = 8$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{8} + \frac{1}{24} = \frac{3+1}{24} = \frac{4}{24}; f = \frac{24}{4} = 6\text{cm}$$

35. D: It is to avoid damaging the bridge due to resonance.

$$36. A: \text{Power} = \frac{1}{\text{focal length}}$$

$$\text{Focal length} = \frac{1}{\text{power}} = \frac{1}{4} = 0.25\text{m}$$

37. B: It is determined by the intensity of light striking the object.

$$38. D: V \propto \sqrt{T}; V = K\sqrt{T}$$

$$K = \frac{V}{\sqrt{T}} = \frac{v_1}{\sqrt{T_1}} = \frac{v_2}{\sqrt{T_2}}$$

When velocity is doubled, $V_2 = 2V_1$

$$\frac{v_1}{\sqrt{T_1}} = \frac{2v_1}{\sqrt{T_2}}; \sqrt{T_2} = \frac{2v_1 \times \sqrt{T_1}}{v_1}$$

$$\sqrt{T_2} = 2\sqrt{T_1}; T_2 = (2\sqrt{T_1})^2 = 4T_1$$

Thus, the temperature will have to be quadrupled for the velocity to double

39. A: The angle of minimum deviation is about 18° and the corresponding incident angle (as seen from the graph) is 25° .

$$40. D: P_1 = P_2 \text{ i.e. } h_1\rho_1g = h_2\rho_2g$$

$$8\text{cm} \times 10^3\text{kgm}^{-3} \times 10 = h_2 \times 800\text{kgm}^{-3} \times 10$$

$$h_2 = \left(\frac{8\text{cm} \times 10^3\text{kgm}^{-3} \times 10}{800\text{kgm}^{-3} \times 10}\right) = 10\text{cm}$$

Could you tell why we didn't convert the height given in centimeters to meters?

41. C: When the temperature difference between the wet and dry bulbs of a hygrometer is large, it indicates the relative humidity is low and vice versa.

$$42. A: F \propto \frac{e}{e_1}. \text{ So, } \frac{F_1}{e_1} = \frac{F_2}{e_2}$$

$$\frac{40}{36-l_0} = \frac{60}{45-l_0}; 60(36-l_0) = 40(45-l_0)$$

Thus,

$$3(36-l_0) = 2(45-l_0)$$

$$108 - 3l_0 = 90 - 2l_0$$

$$-3l_0 + 2l_0 = 90 - 108 = -18$$

$$-l_0 = -18, l_0 = 18\text{cm}$$

43. B: The qualities of a good thermometer include:

Reproducibility

Sensitivity

High accuracy

Note that high thermal capacity is not desired for a good thermometer as this implies that a humongous amount of heat will be extracted by thermometer just to cause its temperature to rise a bit.

44. B: Diffusion involves random movement of molecules

45. A: KEY \Rightarrow The assumption here is that the liquid is already at its boiling point.

Q - ml,

$$10^6 = 2 \times l,$$

$$L_v = \frac{10^6}{2} = 5 \times 10^5 \text{Jkg}^{-1}$$

46. B: KEY \Rightarrow Density is an intrinsic property i.e. you cannot say resultant density = density₁ + density₂

$$\text{Resultant density} = \frac{m_1 + m_2}{v_1 + v_2} = \frac{m_w + m_l}{v_w + v_l}$$

$$m_w = d_w v_w = (200 \times 3)\text{kg} = 600\text{kg}$$

$$m_l = d_l v_l = (150 \times 7)\text{kg} = 1050\text{kg}$$

$$v_w = 3\text{m}^3, v_l = 7\text{m}^3$$

$$\text{Resultant density} = \frac{600\text{kg} + 1050\text{kg}}{3\text{m}^3 + 7\text{m}^3} =$$

$$\frac{1650\text{kg}}{10\text{m}^3} = 165\text{kgm}^{-3}$$

47. A: Refraction is not an evidence of the molecular nature of matter as it is a wave property.

48. C: The inner wall of the thick glass tumbler will expand more than the outer wall and the tumbler will crack.

49. D: $V + U - mg = ma$ (for a body of mass m moving through a viscous liquid).

At terminal velocity, $a = 0$. Then, we have:

$$V + U - mg = m \times 0 = 0$$

$$V + U - mg = 0; V + U = mg$$

$$V = \text{Viscous force} = 260N, U = \text{Uphrust}, M = 36\text{kg}$$

Again,

$$V + U = mg$$

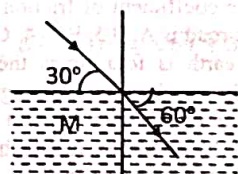
$$260 + U = 36 \times 10 = 360$$

$$U = 360 - 260 = 100N$$

50. A: The Process whereby a liquid turns spontaneously into vapour is called evaporation.

2004 UME PHYSICS QUESTIONS

1.



The refractive index of the medium M in the diagram above is A. $\frac{2}{\sqrt{3}}$ B. $\frac{1}{\sqrt{3}}$ C. $2\sqrt{3}$ D. $\sqrt{3}$

2. What types of mirrors are capable of producing parallel beams of light such as those arising from the headlamps of a car? A. cylindrical mirrors B. parabolic mirrors C. spherical mirrors D. plane mirrors

3. A person can focus an object only when it lies within 200 cm from him. Which spectacles should be used to increase his maximum distance of distinct vision to infinity? A. concave

lens B. plane glasses C. binoculars D. convex lens

4. In which of the following material media would sound travel fastest? A. water B. oil C. metal D. gas

5. Calculate the angle of minimum deviation for a ray which is refracted through an equiangular prism of refractive index 1.4. A. 29° B. 60° C. 99° D. 90°

6. What happens to the rays in a parallel beam of light? A. they diverge as they travel B. they meet at infinity C. they intersect D. they converge as they travel

7. If u is the object distance and v the image distance, which of the following expressions gives the linear magnification produced by a convex lens of focal length f ? A. $\frac{u}{v} + f$ B. $\frac{u}{f} - f$ C. $\frac{v}{f} - 1$ D. $\frac{v}{f} + 1$

8. A ray of light makes an angle of 35° with a plane mirror. What is the angle of reflection? A. 55° B. 35° C. 70° D. 65°

9. The pitch of a sound note depends on A. timbre. B. harmonics C. quality D. frequency.

10. If the angle between two vectors P and Q is 0°, the vectors are said to A. be perpendicular. B. be parallel. C. intersect at angle 60°. D. intersect at angle 45°

11. A machine whose efficiency is 60% has a velocity ratio of 5. If a force of 500N is applied to lift a load P, what is the magnitude of P? A. 750N B. 4166N C. 500N D. 1500N

12. A body of mass 4kg is acted on by a constant force of 12N for 3 seconds. The kinetic energy gained by the body at the end of the time is A. 162J B. 144J C. 72J D. 81J.

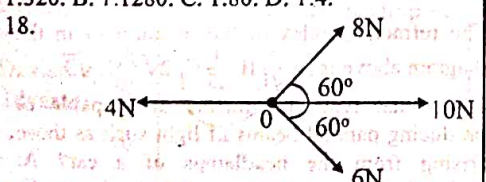
13. As the pressure of a fluid increases, its viscosity A. decreases. B. remains constant. C. increases, then decreases. D. increases.

14. I. Jet-propelled aircraft II. Rocket propulsion III. The recoil of a gun IV. A person walking. Which of the above is based on Newton's third law of motion? A. I, II, III and IV B. I and III only C. I and II only D. I, II and III only.

15. In a hydraulic press, a force of 40N is applied on the effort piston of area 0.4m². If the force exerted on the load piston is 400N, the area of the large piston is A. 8m² B. 4m² C. 2m² D. 1m².

16. A 100kg box is pushed along a road with a force of 500N. If the box moves with a uniform velocity, the coefficient of friction between the box and the road is A. 0.5 B. 0.4 C. 1.0 D. 0.8

17. The earth is four times the size of the moon and the acceleration due to gravity on the earth is 80 times that on the moon. The ratio of the mass of the moon to that of the earth is A. 1:320 B. 1:1280 C. 1:80 D. 1:4.



The diagram above shows forces 4N, 6N, 10N and 8N which act at a point O in the directions indicated. The net horizontal force is A. $7\sqrt{3}$ N B. 17N C. $\sqrt{3}$ N D. 13N

19. A radioisotope has a decay constant of 10^{-7} s⁻¹. The average life of the radioisotope is. A. 6.93×10^8 s. B. 1.00×10^{-7} s. C. 1.00×10^7 s D. 6.93×10^7 s.

20. A moving-coil galvanometer has a full-scale deflection of 3A equivalent to 30° deflection. The sensitivity of the instrument is A. 10.0. B. 33.0. C. 90.0. D. 0.1.

21. The binding energy of helium He is A. 2.017U. B. 0.033 U. C. 4.033 U. D. 0.330 U. [atomic mass of proton = 1.00783U, atomic mass of neutron = 1.00867U]

22. In a tuned radio receiver R, L, C series circuit for resonance, the inductive and capacitive reactance X_L and X_C respectively are related as A. $X_L = \frac{1}{X_C}$ B. $X_L = \frac{1}{2}X_C$ C. $X_L = X_C$ D. $X_L = 2X_C$

23. The particle and wave nature of matter are demonstrated in the equation. A. $\lambda = \frac{h}{p}$ B. $\lambda = \frac{c}{f}$ C. $\lambda = 2d \sin \theta$ D. $\lambda = \frac{hc}{E}$

24. For semiconductors to have negative temperature coefficient of resistance implies that A. they have electrons and holes at high temperatures. B. their resistance is constantly changing with temperature. C. their resistance increases with temperature. D. their resistance decreases with temperature.

25. Fluorescent tubes produce light by the A. refraction of light by gas molecules B. excitation of gas molecules. C. conduction of solar energy D. thermal agitation of electrons in the tube.

26. In a reverse biased junction diode, current flows in by A. electrons alone. B. majority carriers. C. minority carriers. D. positive holes alone.

27. The energy stored in an inductor of inductance 5mH when a current of 6A flows through it is A. 1.8×10^{-2} J. B. 9.0×10^{-3} J. C. 1.4×10^{-2} J D. 9.0×10^{-2} J.

28. X-rays can be used in the study of crystal structures because they A. have an extremely short wavelength. B. have a very long-reaching wavelength. C. are very fast. D. are invisible.

29. An a.c. circuit of emf 12V has a resistor of resistance 8Ω connected in series to an inductor of inductive reactance 16Ω and a capacitor of capacitive reactance 10Ω. The current flow in the circuit is A. 1.4A. B. 14.0A C. 1.2A. D. 12.0A.

30. A generator-manufacturing company was contracted to produce an a.c. dynamo but inadvertently produced a d.c. dynamo. To correct this error, the A. commutator should be replaced with slip rings. B. commutator should be replaced with split rings. C. armature coil should be made of aluminium. D. armature coil should be made of silver.

31. Transverse waves can be distinguished from longitudinal waves using the characteristics of A. diffraction. B. polarization. C. reflection. D. refraction.

32. A man exerts a pressure of 2.8×10^3 Nm⁻² on the ground and has 4×10^{-2} m² of his feet in contact with the ground. The weight of the man is A. 112N. B. 140N. C. 102N. D. 70N.

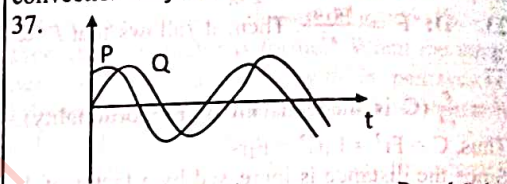
33. When left in a freezer, a bottle full of water cracks on freezing into ice because of the A. decrease in the volume of water. B. contraction

of the bottle. C. expansion of the bottle. D. increase in the volume of water.

34. The change in volume when 450kg of ice is completely melted is A. 0.05m³. B. 0.45m³. C. 4.50m³. D. 0.50m³ [density of ice = 900 kgm⁻³, density of water = 1000 kgm⁻³]

35. If a force of 50N stretches a wire from 20m to 20.01 m, what is the amount of force required to stretch the same material from 20m to 20.05m? A. 100N B. 50N C. 250N D. 200N

36. Tea pots are often silver-coated to prevent heat loss by A. convection and conduction. B. radiation only. C. conduction only. D. convection only.



The phase difference between waves P and Q in the diagram above is A. $\frac{\pi}{2}$ B. 2π C. $\frac{\pi}{4}$ D. π

38. Metal rods of length 20m each are laid end to end to form a bridge at 25°C. What gap will be provided between consecutive rails for the bridge to withstand 75°C? A. 0.22m B. 0.25m C. 0.02m D. 0.20m [Linear expansivity of the material = 2.0×10^{-5} K⁻¹]

39. A 50W electric heater is used to heat a metal block of mass 5kg. If in 10 minutes a temperature rise of 12°C is achieved, the specific heat capacity of the metal is A. 500 J kg⁻¹K⁻¹. B. 130 J kg⁻¹K⁻¹. C. 390 J kg⁻¹K⁻¹. D. 4.00 J kg⁻¹K⁻¹.

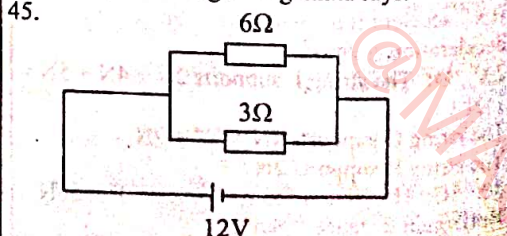
40. I. Wavelength II. Medium of propagation III. Wave velocity IV. Frequency V. Energy. Which of the above are used for characterizing waves? A. I, II and V B. III, IV and V C. I and V D. I, III and IV

41. The instrument used for securing a large number of similar charges by induction is called A. capacitor. B. electrophorus. C. electroscope. D. proof-plane.

42. A steady current of 2A flows in a coil of emf 1 2V for 0.4s. A back emf of 3V was induced during this period. The stored energy in the loop that can be utilized is A. 7.2J. B. 12.0J. C. 2.4J. D. 9.6J.

43. If 16mA of current flows through a conductor in one second, the number of electrons transported per second is A. 1.00×10^{20} . B. 1.00×10^{17} . C. 2.56×10^{17} . D. 2.56×10^{18} . [1 electronic charge = 1.6×10^{-19} C]

44. The difference between x-rays and gamma rays is that A. x-rays arise from energy changes in the electronic structure of atoms while gamma rays come from the nucleus. B. x-rays are electromagnetic radiations while gamma rays are negatively charged radiations. C. x-rays have higher frequencies than gamma rays. D. x-rays are more penetrating than gamma rays.



45.

In the diagram above, the ratio of the electric power dissipated in the 6Ω and 3Ω resistors respectively is A. 2:3. B. 1:2. C. 1:3. D. 2:1.

46. To protect a material from the influence of an external magnetic field, the material should be kept in a A. square steel ring. B. loop of copper wire. C. triangular zinc ring. D. soft iron ring.

47. Which of the following is an electrolyte? A grape juice B. sugar solution C. alcohol D. paraffin

48. Electrical appliances in homes are normally earthed so that A. both the a.c. and d.c. sources can be used. B. a person touching the appliances is safe from electric shock. C. the appliances are maintained at a higher p.d. than the earth. D. the appliances are maintained at a lower p.d. than the earth.

49. A cell whose internal resistance is 0.5Ω delivers a current of $4A$ to an external resistor. The lost voltage of the cell is A. $1.250V$. B. $8.000V$. C. $0.125V$. D. $2.000V$.

50. Given three capacitors $0.3\mu F$, $0.5\mu F$ and $0.2\mu F$, the joint capacitance when arranged to give minimum capacitance is A. $0.3\mu F$. B. $1.0\mu F$. C. $0.1\mu F$. D. $0.5\mu F$.

2004 UME PHYSICS SOLUTION

1. D: $\text{Refractive index} = \frac{\sin i}{\sin r} =$

$$\frac{\sin 60^\circ}{\sin 30^\circ} = \frac{\sqrt{3}}{2} \div \frac{1}{2} = \frac{\sqrt{3}}{2} \times \frac{2}{1} = \sqrt{3}$$

2. B: Parabolic mirrors are used for producing parallel beams of light.

3. A: A person who cannot see beyond $200cm$ suffers from short sightedness (this is because the far point of a normal eye should be at infinity). Short sightedness is corrected using concave or diverging lens.

4. C: Sound travels fastest in metals. For instance sound travels at $330m/s$ in air, $1500m/s$ in water and a whopping $5000m/s$ in steel.

5. A: $n = \frac{\sin(\frac{A+Dm}{2})}{\sin(\frac{A}{2})}$

(A = angle of prism, Dm = angle of minimum deviation).

For an equilateral triangular prism the angle of prism = 60°

$$1.4 = \frac{\sin(\frac{60+Dm}{2})}{\sin(\frac{60}{2})}$$

Then,

$$\sin(\frac{60+Dm}{2}) = 1.4 \sin(\frac{60}{2}) = 1.4 \sin 30^\circ = 0.7$$

$$\sin(\frac{60+Dm}{2}) = \sin^{-1} 0.7 = 44.42^\circ$$

$$60 + Dm = 2 \times 44.42 = 88.84$$

$$Dm = 88.84 - 60 = 28.84^\circ = 29^\circ$$

6. B: Parallel rays do not intersect. In other words, they meet at infinity.

7. C: $n = \frac{v}{u}$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$u = \frac{v}{m}; \quad \frac{1}{u} = \frac{m}{v}$$

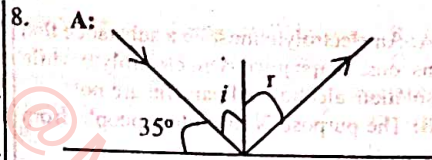
Then, we write:

$$\frac{1}{f} = \frac{m}{v} + \frac{1}{v} = \frac{m+1}{v}$$

Then,

$$(m+1)f = v; \quad m+1 = \frac{v}{f}$$

$$m = \frac{v}{f} - 1$$



$$i + 35^\circ = 90^\circ, \quad i = 90^\circ - 35^\circ = 55^\circ$$

From the law of reflection, the angle of incidence i equals the angle of reflection.

9. D: The pitch of a sound depends on frequency. The quality depends on overtone or harmonics. The loudness depends on amplitude.

10. B: Two vectors are parallel if the angle between them is 0° .

11. D: $\epsilon = \frac{M.A}{V.R} \times 100\%$ (ϵ = Efficiency, M.A. = Mechanical advantage, V.R = Velocity ratio)

$$60\% = \frac{M.A}{5} \times 100\%; \quad M.A = \frac{60\% \times 5}{100\%} = 3$$

$$M.A = \frac{\text{Load}}{\text{Effort}}; \quad \text{Load} = M.A \times \text{Effort}$$

$$= (3 \times 500)N = 1500N$$

12. A: $a = \frac{f}{m} = \frac{12}{4} = 3m/s^2$

$$v = u + at; \quad v - u = at; \quad \Delta v = at$$

$$= (3 \times 3)m/s = 9m/s$$

$$\Delta K.E = \frac{1}{2}m\Delta v^2 = \frac{1}{2} \times 4 \times 9^2 = 162J$$

13. D: As the pressure of a fluid increases, the viscosity increases.

14. D: I, II and III are all based on Newton's third law of motion. Newton's third law of motion states that for every action, there is an equal but opposite reaction.

15. B: $\frac{F_s}{A_s} = \frac{F_l}{A_l}$ (F_s = Force on the small piston, A_s = Area of the small piston, F_l = Force on the large piston, A_l = Area of the large piston).

16. A: $F - Fr = ma$ (F = Force applied, Fr = Frictional force). If the velocity is uniform, $a = 0$. Then, $F = Fr = \mu mg$

$$\mu = \frac{F}{mg} = \left(\frac{500}{100 \times 10} \right) = 0.5$$

17. B: (i) $g_e = \frac{Gm_e}{R_e^2}$; (ii) $g_m = \frac{Gm_m}{R_m^2}$

(g = acceleration due to gravity, G = Gravitational constant, M = mass, R = radius, 'e' and 'm' are used as subscripts for earth and moon respectively).

"The earth is four times the size of the moon..." The above enables us to write $R_e = 4R_m$

"... the acceleration due to gravity on the earth is 80 times that on moon".

The above entails that $g_e = 80g_m$.

Thus, equation (i) can be re-written as:

$$80g_m = \frac{Gm_e}{(4R_e)^2} = \frac{Gm_e}{16R_e^2}$$

Then,

$$G = \frac{80g_m \times 16R_m^2}{M_e} \quad \text{OR} \quad M_e = \frac{80g_m \times 16R_m^2}{G}$$

From equation (ii), we coin:

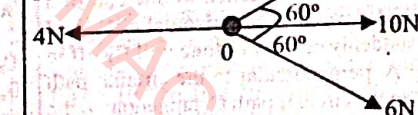
$$M_m = \frac{g_m R_m^2}{G}$$

$$M_m \div M_e = \frac{g_m R_m^2}{G} \div \frac{80g_m \times 16R_m^2}{G}$$

$$= \frac{g_m R_m^2}{G} \times \frac{G}{80g_m \times 16R_m^2}$$

$$= \frac{1}{1280} = 1 : 1280$$

18. D:



The horizontal components of $8N$ and $6N$ are $8\cos 60^\circ$ respectively which give a respective value of $4N$ and $3N$. Note that both $4N$ and $3N$ are now pointing to the right. Thus, overall horizontal forces can now be represented as:



Thus, the net horizontal force equals $(4N + 10N + 3N) - 4N = 13N$

19. A: $T_{\frac{1}{2}} = \frac{0.693}{\lambda}$

($T_{\frac{1}{2}}$ = half life, λ = decay constant)

$$= \frac{0.693}{10^{-7} \text{s}^{-1}} = 6.93 \times 10^6 \text{s}$$

20. A: The sensitivity = $\frac{30}{3} = 10$

NB: The current sensitivity of a galvanometer is the deflection produced when unit current passes through it i.e. sensitivity = $\frac{\text{Deflection}}{\text{Current}}$

21. B: ${}^4_2\text{He}$ has two protons and two neutrons
1 proton = $1.00783u$; 1 neutron = $1.00867u$.

Thus,

$$\text{Total mass of nucleon} = 2(1.00783) + 2(1.00867)u = 4.033u$$

$$R.A.M = 4 = 4u$$

$$\text{Binding energy} = 4.033u - 4u = 0.033u$$

(u = atomic mass unit)

22. C: At resonance, the capacitive reactance equals the inductive reactance.

23. A: $\lambda = \frac{h}{p}$ (λ = wavelength, h = Planck's constant, p = momentum)

The equation is De-Broglie's equation. It can also be written as: $\lambda = \frac{h}{mv}$ (m = mass).

24. D: It implies that the resistance of semi-conductors decreases as temperature increases.

25. B: Fluorescent tubes produce light by the excitation of gas molecules

26. C: Current flows in by minority carriers.

27. D: $E = \frac{1}{2} \times 5 \times 10^{-3} \times 6^2 \Rightarrow 9 \times 10^{-2} J$

28. A: The use of X-rays in studying crystal structures is credited to their possession of very short wavelength.

29. C: $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$$X_L = 2\pi f L = 16\Omega$$

$$X_C = \frac{1}{2\pi f C} = 10\Omega$$

$$R = 8\Omega$$

$$Z = \sqrt{8^2 + (16 - 10)^2} = \sqrt{64 + 36} =$$

$$\sqrt{100} = 10\Omega$$

$$I = \frac{V}{Z} = \left(\frac{12}{10} \right) A = 1.2A$$

30. A: An a.c. generator uses slip ring while a d.c generator uses split ring. Thus, to convert a d.c generator to an a.c generator, the split ring (commutator) must be replaced by slip ring.

31. B: Only transverse waves can be polarized, longitudinal waves cannot be polarized.

32. A: Weight = $W = F(\text{Force})$

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}; \quad \text{Force (W)} = \text{Pressure} \times \text{Area}$$

$$= 2.8 \times 10^4 \times 4 \times 10^{-3} \text{N} = 112N$$

33. D: The density of ice (about $0.9g/cm^3$) is less than that of water. Thus, when water changes into ice the volume must increase (since

the density has decreases and again density and volume vary inversely).

$$34. A: V_{ice} = \frac{M_{ice}}{\rho_{ice}} \quad (V_{ice} = \text{volume of ice, } M_{ice} = \text{mass of ice and } \rho_{ice} = \text{density of ice})$$

$$= \frac{450kg}{900kgm^{-3}} = 0.5m^3$$

$$V_{H_2O} = \frac{M_{H_2O}}{\rho_{H_2O}} = \frac{400kg}{1000kgm^{-3}} = 0.45m^3$$

(The mass of ice and the water formed upon melting must be equal unless there is spillage).
Change in volume = $0.5m^3 - 0.45m^3 = 0.05m^3$

35. C: When stretched from 20m to 20.01m, extension = $20.01m - 20m = 0.01m$.

When stretched from 20.05m - $20m = 0.05m$

$$F \propto e; \frac{F_1}{e_1} = \frac{F_2}{e_2}$$

$$F_2 = \frac{F_1 \times e_2}{e_1} = \frac{50 \times 0.05}{0.01} = 250N$$

36. B: The silver-coated surface prevents heat loss by radiation.

37. A: The phase difference = 90° or $\frac{\pi}{2}$.

38. C: KEY \Rightarrow It is an indirect way of demanding ΔL

$$\alpha = \frac{\Delta L}{L\Delta\theta}; \Delta L = \alpha L\Delta\theta = 2 \times 10^{-5} \times 20 \times (75 - 25)$$

$$= 2 \times 10^{-2}m = 0.02m$$

39. A: Power \times time = $mc\Delta\theta$

$$(50 \times 10 \times 60) = 5 \times c \times 12$$

$$c = \left(\frac{50 \times 10 \times 60}{5 \times 12}\right) Jkg^{-1}K^{-1} = 500 Jkg^{-1}K^{-1}$$

40. D: Wavelength, velocity and frequency are all used for characterizing waves.

$$NB: \text{Frequency} = \frac{\text{Velocity}}{\text{Wavelength}}$$

41. B: The instrument used for securing a large number of similar charges by induction is the electrophorus.

$$42. A: \text{Useful e.m.f.} = (12v - 3v) = 9v$$

$$\text{Energy} = Ivt = (2 \times 9 \times 0.4)J = 7.2J$$

43. B: $Q = It = 16(10^{-3})A \times 1s = 1.6 \times 10^{-2}C$

But an electron has a charge of magnitude = $1.6 \times 10^{-19}C$. Number of electrons that will give a total of $1.6 \times 10^{-2}C = \frac{1.6 \times 10^{-2}C}{1.6 \times 10^{-19}C} = 1 \times 10^{17}$

Electrons.

44. A: X-rays arise from energy changes in the electronic structure of atoms while gamma rays originate from the nucleus.

Both x-rays and gamma rays are electromagnetic radiations.

X-ray has a lower frequency but a longer wavelength than gamma rays.

Gamma rays are more penetrating than X-rays.

$$45. B: P = I^2R$$

$$I_1 = \frac{1}{2} = 2A, I_2 = \frac{12}{3} = 4A,$$

$$P_1 = I_1^2 R_1 = 2^2 \times 6 = 24W$$

$$P_2 = I_2^2 R_2 = 4^2 \times 3 = 48W$$

$$\text{Thus } P_1 : P_2 = 24 : 48 = 1 : 2$$

We don't really need to calculate here. All other factors being kept constant, the current will be small when resistance is large. If the power dissipated by the 3Ω resistor is $2x$, that dissipated by the 6Ω resistor will be x i.e. the ratio $1 : 2$. This is because the product IV will be larger for the 3Ω resistor, remember that they have the same potential difference.

46. D: The material should be kept in a soft iron ring.

47. A: An electrolyte must be a substance that contains ions. Grape juice is an electrolyte while sugar solution, alcohol and paraffin are not.

48. B: The purpose is to protect people from electric shock.

49. D: Lost voltage = $Ir = (4 \times 0.5)V = 2V$.

50. C: For capacitors to give minimum capacitance, it has to be arranged in series

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$= \frac{1}{0.3} + \frac{1}{0.5} + \frac{1}{0.2} = 3.3333 + 2 + 5 = 10.333$$


$$\frac{1}{C} = \frac{1}{10.333} = 0.09\mu F = 0.1\mu F$$

2003 UME PHYSICS QUESTIONS

1. A bead travelling on a straight wire is brought to rest at 0.2m by friction. If the mass of the bead is 0.01kg and the coefficient of friction between the bead and the wire is 0.1, determine the work done by the friction. A. $2 \times 10^{-4}J$ B. $2 \times 10^{-3}J$ C. 2×10^3J D. 2×10^2J [$g = 10ms^{-2}$]

2. On top of a spiral spring of force constant $500Nm^{-1}$ is placed a mass of $5 \times 10^{-3}kg$. If the spring is compressed downwards by a length of 0.02m and then released, calculate the height to which the mass is projected. A. 8m B. 4m C. 2m D. 1m [$g = 10ms^{-2}$]

3. A test tube of radius 1.0cm is loaded to 8.8g. If it is placed upright in water, find the depth to which it would sink. A. 2.8cm B. 5.2cm C. 25.5cm D. 28.0cm [$g = 10ms^{-2}$, density of water = $1000kg m^{-3}$]

4. 

The length of a piece of glass block was measured by means of a vernier calliper as shown above. The length of the glass block is A. 1.63 cm B. 1.64cm C. 1.65 cm D. 1.66 cm

5. A hose of cross-sectional area $0.5m^2$ is used to discharge water from a water tanker at a velocity of $60ms^{-1}$ in 20s into a container. If the container is filled completely, the volume of the container is A. $240m^3$ B. $600m^3$ C. $2400m^3$ D. $6000m^3$

6. If an object just begins to slide on a surface inclined at 30° to the horizontal, the coefficient of friction is A. $\sqrt{3}$ B. $\frac{\sqrt{3}}{2}$ C. $\frac{1}{\sqrt{2}}$ D. $\frac{1}{\sqrt{3}}$


7. A force of 100N is used to kick a football of mass 0.8kg. Find the velocity with which the ball moves if it takes 0.8s to be kicked. A. $32ms^{-1}$ B. $50ms^{-1}$ C. $64ms^{-1}$ D. $100ms^{-1}$

8. Water does not drop through an open umbrella of silk material unless the inside of the umbrella is touched. This is due to A. capillarity B. osmotic pressure C. viscosity D. surface tension.

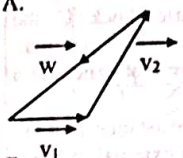
9. The stylus of a phonograph record exerts a force of $7.7 \times 10^{-2}N$ on a groove of radius $10^{-5}m$. Compute the pressure exerted by the stylus on the groove. A. $2.45 \times 10Nm^{-2}$ B. $3.45 \times 10Nm^{-2}$ C. $4.90 \times 10Nm^{-2}$ D. $2.42 \times 10 Nm^{-2}$

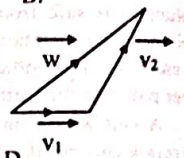
10. A piece of stone attached to one end of a string is whirled round in a horizontal circle and the string suddenly cuts. The stone will fly off in a direction A. perpendicular to the circular path B. parallel to the circular path C. tangential to the circular path D. towards the centre of the circle.

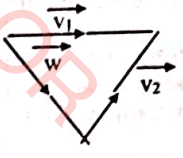
11. A 90cm uniform lever has a load of 30N suspended at 15cm from one of its ends. If the fulcrum is at the centre of gravity, the force that must be applied at its other end to keep it in horizontal equilibrium is A. 15N B. 20N C. 30N D. 60N

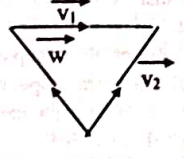
12. 

The figure above shows two velocities v_1 and v_2 . Which of the following diagrams correctly represents the vector difference $\vec{w} = \vec{v}_1 - \vec{v}_2$?


A. 

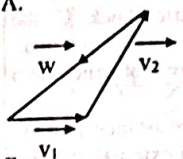
B. 

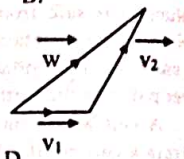
C. 

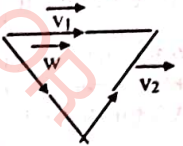
D. 

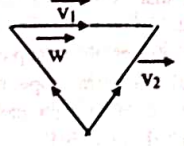
11. A 90cm uniform lever has a load of 30N suspended at 15cm from one of its ends. If the fulcrum is at the centre of gravity, the force that must be applied at its other end to keep it in horizontal equilibrium is A. 15N B. 20N C. 30N D. 60N

12. 
The figure above shows two velocities v_1 and v_2 . Which of the following diagrams correctly represents the vector difference $\vec{w} = \vec{v}_1 - \vec{v}_2$?

A. 

B. 

C. 

D. 

13. A satellite is in a parking orbit if its period is A. less than the period of the earth B. more than the period of the earth C. equal to the period of the earth D. the square of the period of the earth

14.

t/°C	0	5	10	15	20	40	60
S.V.P (mmHg)	4.58	6.51	8.94	12.67	17.50	55.10	149.00

The table above shows the saturation vapour pressure against temperature in a certain town. If the vapour pressure in this town at $20^\circ C$ is 10mmHg, what is the relative humidity? A. 170.0% B. 57.0% C. 17.5% D. 10.0%

15. A tuning fork of frequency 340Hz is vibrated just above a cylindrical tube of height 1.2m. If water is slowly poured into the tube, at what maximum height will resonance occur? A. 0.95 m B. 0.60m C. 0.50m D. 0.45m [speed of sound in air = $340ms^{-1}$]

16. By what factor will the size of an object placed 10cm from a convex lens be increased if the image is seen on a screen placed 25cm from the lens? A. 15.0 B. 25 C. 1.5 D. 0.4

17. Thermal equilibrium between two objects exists when A. the temperatures of both objects are equal B. the quantity of heat in both objects is the same C. the heat capacities of both objects are the same D. one object loses heat continuously to the other.

18. An open pipe closed at one end produces its first fundamental note. If the velocity of sound in air is v and l the length of the pipe, the frequency of the note is A. $\frac{2v}{l}$ B. $\frac{v}{2l}$ C. $\frac{v}{4l}$ D. $\frac{v}{l}$

19. Given that Young's modulus for aluminium is $7.0 \times 10^{10}Nm^{-2}$ and density is $2.7 \times 10^3kgm^{-3}$, find the speed of the sound produced if a solid bar is struck at one end with a hammer. A. $5.1 \times 10^3ms^{-1}$ B. $4.2 \times 10^3ms^{-1}$ C. $3.6 \times 10^3ms^{-1}$ D. $2.8 \times 10^3ms^{-1}$

20. On a fairly cool rainy day when the temperature is $20^\circ C$, the length of a steel railroad track is 20m. What will be its length on a hot dry

day when the temperature is 40°C ? A. 20.013m
B. 20.009m C. 20.004m D. 20.002m [coefficient of linear expansion of steel = $11 \times 10^{-6} \text{K}^{-1}$]

21. If an object is placed between two parallel plane mirrors with their reflecting surfaces facing each other, how many images of the object will be formed? A. Infinite B. Eight C. Four D. Two

22. The phenomenon whereby the water droplets in the atmosphere combine with dust particles in the air to reduce visibility is A. cloud B. mist C. hail D. fog.

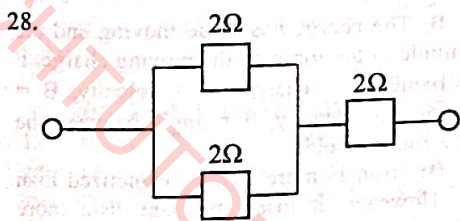
23. At what position will an object be placed in front of a concave mirror in order to obtain an image at infinity? A. At the pole of the mirror B. At the principal-focus C. At the centre of curvature D. Between The principal focus and the centre of curvature.

24. If the distance from a point source of sound is obtained, by what factor does the intensity decrease? A. 4.00 B. 2.00 C. 0.50 D. 0.25

25. A 2000W electric heater is used to heat a metal object of mass 5kg initially at 10°C . If a temperature rise of 30°C is obtained after 10mi the heat capacity of the material is A. $6.0 \times 10^4 \text{J}^{\circ}\text{C}^{-1}$ B. $4.0 \times 10^4 \text{J}^{\circ}\text{C}^{-1}$ C. $1.2 \times 10^4 \text{J}^{\circ}\text{C}^{-1}$ D. $8.0 \times 10^3 \text{J}^{\circ}\text{C}^{-1}$

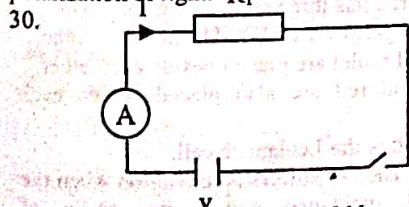
26. If $1.2 \times 10^6 \text{J}$ of heat energy is given off in 1 sec. from a vessel maintained at a temperature gradient of 30K m^{-1} , the surface area of the vessel is A. $1.0 \times 10^2 \text{m}^2$ B. $9.0 \times 10^2 \text{m}^2$ C. $1.0 \times 10^3 \text{m}^2$ D. $9.0 \times 10^4 \text{m}^2$ [thermal conductivity of the vessel = $400 \text{W m}^{-1} \text{K}^{-1}$]

27. A positively charged rod X is brought near an uncharged metal sphere Y and is then touched by a finger with X still in place. When the finger is removed, the result is that Y has A. no charge and a zero potential B. a positive charge and a zero potential C. a negative charge and a zero potential D. a negative charge and a negative potential.



28. In the diagram above, if each of the resistors can dissipate a maximum of 18W without becoming excessively heated, what is the maximum power that circuit can dissipate? A. 27W B. 18W C. 9W D. 5W

29. The operation of an optical fibre is based on the principle of A. dispersion of light B. interference of light C. refraction of light D. polarization of light. R₁



30. In the diagram above, what would happen to the current, I, if another resistor, R₂, is connected in parallel to R₁? A. It will increase because the

equivalent resistance will increase B. It will decrease if R₂ is greater than R₁. C. It will increase because the effective resistance will decrease. D. It will decrease if R₂ is less than R₁.

31. A ray of light is incident on an equilateral triangular glass prism of refractive index μ . Calculate the angle through which the ray is minimally deviated in the prism. A. 30.0° B. 37.2° C. 42.0° D. 48.6°

32. A wire of 5Ω resistance is drawn out so that its new length is two times the original length. If the resistivity of the wire remains the same and the cross-sectional area is halved, the new resistance is A. 40Ω B. 20Ω C. 10Ω D. 5Ω

33. An electron of charge $1.6 \times 10^{-19} \text{C}$ is accelerated between two metal plates. If the kinetic energy of the electron is $4.8 \times 10^{-17} \text{J}$, the potential difference between the plates is A. 30V B. 40V C. 300V D. 400V

34. A magnetic field is said to exist at a point if a force is A. exerted on a stationary charge at the point B. exerted on a moving charge at the point C. deflected at the D. strengthened at the point.

35. I. It retains its magnetism much longer than steel. II. It is more easily magnetized than steel. III. It is more easily demagnetized than steel. IV. It produces a stronger magnet than steel. Which combination of the above makes iron preferable to steel in the making of electromagnets? A. I and II only B. II and III only C. I, III and IV only D. II, III and IV only.

36. Which of the following pairs of light rays shows the widest separation in the spectrum of white light? A. Blue and red B. Green and yellow. C. Indigo and violet D. Orange and red

37. The most suitable cell-used for short interval switches in electric bells is A. lead-acid accumulator B. Daniel cell C. Leclanche cell D. nickel iron accumulator

38. A ray-incident on a glass prism undergoes minimum deviation when the A. incident angle is equal to the angle of refraction B. refraction angle equals 90° C. incident angle equals 90° D. incident angle is equal to the angle of emergence.

39. In the calibration of an Ammeter using Faraday's laws of electrolysis, the ammeter reading is kept constant at 1.20A. If 0.99g of copper is deposited in 40 minutes, the correction to be applied to the ammeter is A. 0.03A B. 0.04A C. 0.05AD. 0.06A [e.c.e. of copper = $3.3 \times 10^{-4} \text{g C}^{-1}$]

40. The count rate of a radioactive material is 800count/min. If the half-life of the material is 4 days, what would the count rate be 16 days later? A. 200 count/min. B. 100 count/min. C. 50 count/min. D. 25 count/min

41. A circuit has an area of 0.4m^2 and consists of 50 loops of wire. If the loops are twisted and allowed to rotate at a constant angular velocity of 10 red s/l in a uniform magnetic field of 0.4T, the amplitude of the induced voltage is A. 8V B, 16V C. 20V D. 80V

42. If the uncertainty in the measurement of the position of a particle is $5 \times 10^{-10} \text{m}$, the uncertainty in the momentum of the particle is A. $1.32 \times 10^{-44} \text{Ns}$ B. $3.30 \times 10^{-44} \text{Ns}$ C. $132 \times 10^{-44} \text{Ns}$ D. $3.30 \times 10^{-24} \text{Ns}$ [$h = 6.6 \times 10^{-34} \text{Js}$]

43. The force on a charge moving with velocity v in a magnetic field B is half of the maximum force when the angle between v and B is A. 90° B. 45° C. 30° D. 0°

44. The maximum kinetic energy of the photoelectrons emitted from a metal surface is 0.34eV. If the work function of the metal surface is 1.83eV, find the stopping potential. A. 2.17V B. 1.49V C. 1.09V D. 0.34V

45. When an alternating current given by $I = 10 \sin(120\pi t)$ passes through a 12Ω resistor, the power dissipated in the resistor is A. 1200W. B. 600W C. 120W D. 30W

46. In a fission process, the decrease in mass is 0.01%. How much energy could be obtained from the fission of 1.Og of the material? A. $9.0 \times 10^{11} \text{J}$ B. $9.0 \times 10^{10} \text{J}$ C. $6.3 \times 10^{11} \text{J}$ D. $9.0 \times 10^{11} \text{J}$ [$c = 3.0 \times 10^8 \text{ms}^{-1}$]

47. In a semiconductor junction diode, as the depletion or barrier layer is forward-biased, the layer A. widens B. narrows C. remains constant D. widens then narrows

48. An electron makes a transition from a certain energy level E_K to the ground state E_0 . If the frequency of emission is $8.0 \times 10^{14} \text{Hz}$, the energy emitted is A. $8.25 \times 10^{-19} \text{J}$ B. $5.28 \times 10^{-19} \text{J}$ C. $5.28 \times 10^{19} \text{J}$ D. $8.25 \times 10^{19} \text{J}$ [$h = 6.6 \times 10^{-34} \text{Js}$]

49. The major difference between a pure semiconductor and a pure metal is that A. metals are harder than semiconductors B. While the resistance of metals decreases with temperature, the reverse is the case for semiconductors C. the resistance of metals increases with temperature while for semiconductors, it is the reverse D. metals have forbidden gaps while semiconductors have not.

50. When a nucleus, is formed by bringing protons and neutrons together, the actual mass of the formed nucleus is less than the sum of the masses of the constituent protons and neutrons. The energy equivalent of this mass difference Es the A. lost energy B: work function C. building energy D. stability energy

2003 UME PHYSICS SOLUTION

1. B: KEY \Rightarrow The concept to be employed is still that of work as a product of force and distance. The force here is the frictional force and it has to be calculated first

Frictional force, $F_r = \mu mg = (0.1 \times 0.01 \times 10) \text{N} = 10^{-2} \text{N} = 0.01 \text{N}$

Distance = 0.2m

Workdone = $0.01 \text{N} \times 0.2 \text{m} = 2 \times 10^{-3} \text{J}$

2. C: KEY \Rightarrow The gravitational potential energy attained after the spring has been released equals the elastic potential energy stored in the spring.

$mgh = \frac{1}{2} kx^2$

$5 \times 10^{-3} \times 10 \times h = \frac{1}{2} \times 500 \times 0.02^2$

$0.05h = 0.1$

$h = \left(\frac{0.1}{0.05}\right) \text{m} = 2 \text{m}$

3. A: KEY \Rightarrow When an object floats, it is that it has displaced its own weight of the liquid in which it is floating. Thus, mass of water displaced = 8.8g

$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{8.8 \text{g}}{1 \text{g cm}^{-3}} \Rightarrow 8.8 \text{cm}^3$

Since the radius is given, the rest is simple

$\text{Volume} = \pi r^2 h$

$$8.8 \text{ cm}^3 = 3.142 \times 1 \text{ cm}^2 \times h \Rightarrow$$

$$h = \frac{8.8 \text{ cm}^3}{3.142 \text{ cm}^2} = 2.8 \text{ cm}$$

4. B: Main reading = 1.6cm

Since it is the fourth line on the vernier that comes most directly in line with the main scale and the accuracy of a vernier caliper is 0.01cm, we have:

$$\text{Vernier reading} = 4 \times 0.01 \text{ cm} = 0.04 \text{ cm}$$

$$\text{Total reading} = \text{main reading} + \text{vernier reading}$$

$$= 1.6 \text{ cm} + 0.04 \text{ cm}$$

$$= 1.64 \text{ cm}$$

5. B: Volume = $A \times V \times t$

$$= (0.5 \times 60 \times 20) \text{ m}^3$$

$$= 600 \text{ m}^3$$

6. D: For an object that just begins moving or already moving at constant velocity, $\mu = \tan \theta$

$$= \tan 30^\circ = \frac{1}{\sqrt{3}}$$

7. D: $U = 0, V = ? F = 100 \text{ N}, m = 0.8 \text{ kg}, t = 0.8 \text{ s}$

$$F = \frac{m(v-u)}{t}$$

$$100 = \frac{0.8(v-0)}{0.8} = \frac{0.8v}{0.8} = v$$

$$v = 100 \text{ m/s}$$

8. D: It is as a result of surface tension

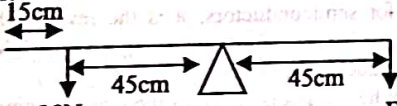
9. A: Area = $\pi r^2 = 3.142 \times (10.5)^2 = 3.142 \times 10^{-10} \text{ m}^2$

$$\text{Force} = 7.7 \times 10^{-2} \text{ N}$$

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{7.7 \times 10^{-2} \text{ N}}{3.142 \times 10^{-10} \text{ m}^2} = 2.45 \times 10^8 \text{ Nm}^{-2}$$

10. C: The stone will fly off in a direction tangential to the circular path.

11. B:



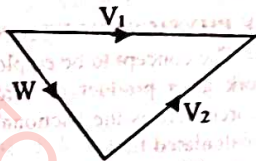
Clockwise moment = Anticlockwise moment

$$F \times 45 = 30(45 - 15)$$

$$F \times 45 = 30 \times 30$$

$$F = \left(\frac{30 \times 30}{45}\right) \text{ N} = 20 \text{ N}$$

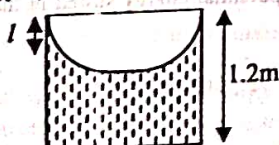
12. C: $\vec{v} = \vec{v}_1 + \vec{v}_2$ can be represented by:



13. C: A satellite is said to be in a parking orbit if its period equal to that of the earth

14. B: $\text{Relative humidity} = \frac{\text{Vapour pressure}}{\text{SVP at the same temperature}} \times 100\% = \frac{10 \text{ mmHg}}{17.5 \text{ mmHg}} \times 100\% = 57\%$

15. A: a



$$l = \frac{1}{4}$$

$$F = \frac{v}{\lambda}, \lambda = \frac{v}{f} = \left(\frac{340}{340}\right) \text{ m} = 1 \text{ m}$$

$$l = \frac{1 \text{ m}}{4} = 0.25 \text{ m}$$

$$\text{Height at which resonance occurs} = 1.2 \text{ m} - 0.25 \text{ m} = 0.95 \text{ m}$$

16. B: $m = \frac{v}{u} = \frac{25 \text{ cm}}{10 \text{ cm}} = 2.5$

17. A: There is thermal equilibrium when the temperature of objects are equal.

18. C: For the fundamental note, $l = \frac{\lambda}{4}$

$\lambda = 4l$; Velocity = v

$$\text{Frequency} = \frac{\text{Velocity}}{\text{Wavelength}} = \frac{v}{4l}$$

19. A: $\text{Velocity} = \sqrt{\frac{\text{Young's modulus}}{\text{Density}}} =$

$$\sqrt{\frac{7 \times 10^{10}}{2.7 \times 10^3}} = 5.1 \times 10^3 \text{ ms}^{-1}$$

20. C: $L_1 = 20 \text{ cm}, \alpha = 11 \times 10^{-6} \text{ K}^{-1}, \Delta \theta = 45^\circ \text{ C} - 20^\circ \text{ C} = 20^\circ \text{ C}$

$$L_2 = L_1(1 + \alpha \Delta \theta)$$

$$= (20(1 + 11 \times 10^{-6} \times 20)) = 20.0044 \text{ m}$$

21. A: Two parallel plane mirror, $\theta = 0^\circ$

$$N = \frac{360}{\theta} - 1$$

$$= \frac{360}{0} - 1 = \infty$$

Thus, an infinite number of images will be formed.

22. D: The phenomenon whereby the water droplets in the atmosphere combine with dust particles in the air to reduce visibility is known as fog.

23. B: On a concave mirror, an object placed at the principal focus has its image at infinity. As a corollary, an object at infinity will have its image at the focus.

24. A: $I \propto \frac{1}{r^2}$; $K = Ir^2 = I_1 r_1^2 = I_2 r_2^2$ (I = intensity of sound, r = distance from the source)

If the distance is doubled, $r_2 = 2r_1$

Then,

$$I_1 r_1^2 = I_2 \times (2r_1)^2 = I_2 \times 4r_1^2$$

$$I_2 = \frac{I_1 r_1^2}{4r_1^2} = \frac{I_1}{4} = \frac{1}{4} \times I_1$$

25. C: Power \times time = $mc\Delta \theta$

$$2000 \times 10 \times 60 = 5 \times c \times 20 = 100C$$

$$C = \left(\frac{2000 \times 10 \times 60}{100}\right) \text{ Jkg}^{-1} \text{ K}^{-1} = 12000 \text{ Jkg}^{-1} \text{ K}^{-1} = 1.2 \times 10^4 \text{ Jkg}^{-1} \text{ K}^{-1}$$

26. A: $\frac{\Delta Q}{\Delta t} = KA \left(\frac{\theta_2 - \theta_1}{l}\right)$

ΔQ = Heat flow

Δt = time taken

$\frac{\Delta Q}{\Delta t}$ is collectively regarded as flow rate

K = thermal conductivity;

A = Cross sectional area

$\frac{\theta_2 - \theta_1}{l}$ = Temperature gradient

$$\frac{1.2 \times 10^6}{1} = 400 \times A \times 30$$

$$A = \frac{1.2 \times 10^6}{400 \times 30} \Rightarrow 100 \text{ m}^2 = 1.0 \times 10^2 \text{ m}^2$$

27. D: This illustrates charging by induction. The charged body acquires a charge opposite to that of the charging body.

28. A: The two 2Ω resistors are in parallel.

$$\text{Thus, } \frac{1}{R} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} = 1$$

$$R = 1 \Omega$$

This R is now in series with a 2Ω resistor. Therefore,

$$R_{\text{effective}} = 2\Omega + 1\Omega = 3\Omega$$

If each of the 2Ω resistors can dissipate 18W, we can easily calculate what the effective resistance will dissipate

$$P = I^2 R \text{ i.e. } P \propto R$$

Then,

$$\frac{P_1}{R_1} = \frac{P_2}{R_2}, \frac{18}{2} = \frac{P_2}{3}, P_2 = \left(\frac{18 \times 3}{2}\right) \text{ W} = 27 \text{ W}$$

29. C: Optical fibres are flexible guides which can 'pipe' light to the other end. They are used severally in engineering. They also have medical use for example, to examine the throat.

The operation of an optical fibre is based on refraction, total internal reflection to be precise. 30. C: Connecting another resistor in parallel to R_1 decreases the overall resistance. Thus, the current will increase. NB: This is regardless of whatever the resistance value of the added resistor is. Be reminded that when resistors are connected in parallel the overall resistance R is given by $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$..., and it is always smaller than the smallest resistance (of the combined resistors).

31. B: $n = 1.5$

$$n = \frac{\sin\left(\frac{A+Dm}{2}\right)}{\sin\left(\frac{A}{2}\right)}; 1.5 = \frac{\sin\left(\frac{60^\circ + Dm}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)}$$

$$1.5 = \frac{\sin\left(\frac{60^\circ + Dm}{2}\right)}{\sin 30^\circ}$$

$$\sin\left(\frac{60^\circ + Dm}{2}\right) = 1.5 \sin 30^\circ = 0.75$$

$$\frac{60^\circ + Dm}{2} = \sin^{-1} 0.75 = 48.59$$

$$60^\circ + Dm = 2 \times 48.59 = 97.18$$

$$Dm = 97.18 - 60 = 37.18^\circ = 37.2^\circ$$

32. B: $R_1 = \frac{\rho L_1}{A_1}$; $R_2 = \frac{\rho L_2}{A_2}$

Since resistivity, ρ is the same

$$\frac{R_1 A_1}{L_1} = \frac{R_2 A_2}{L_2}$$

From the question, $L_2 = 2L_1$ and $A_2 = \frac{A_1}{2}$

$$\frac{R_1 \times A_1}{L_1} = \frac{R_2 \times \frac{A_1}{2}}{\frac{2L_1}{2}} = \frac{R_2 \times 0.5A_1}{L_1}$$

$$\text{Then, } R_2 = \frac{R_1 \times A_1 \times 2L_1}{0.5A_1 \times L_1} = 4R_1$$

But $R_1 = 5 \Omega$

$$\text{So, } R_2 = (4 \times 5) \Omega = 20 \Omega$$

33. C: KEY \Rightarrow The kinetic energy is tantamount to the workdone (W).

$W = qV$ (q = charge, V = potential different)

$$4.8 \times 10^{-17} = 1.6 \times 10^{-19} \times V$$

$$V = \frac{4.8 \times 10^{-17}}{1.6 \times 10^{-19}} = 300 \text{ V}$$

34. B: The charge has to be moving and the magnitude of the force on the moving charge. $F = qVB \sin \theta$ (q = charge, V = velocity, B = magnetic flux density, θ = angle between the charge and the field).

35. D: Iron is more easily magnetized than steel. However, it loses its magnetism more quickly than steel. Under the same magnetizing force, iron is magnetized to a greater degree than steel.

36. A: Red \rightarrow Orange \rightarrow Yellow \rightarrow Green \rightarrow Blue \rightarrow Indigo \rightarrow Violet

The widest separation occurs between red and violet. If other colours are now matched, we may determine the degree of separation by just counting the colours in between.

Blue and red has three colour between them. Green and yellow are placed beside each other. Indigo and violet are placed beside each other. Orange and red are also placed beside each other.

37. C: It is the Leclanche cell.

38. D: The ray suffers no deviation when the angle of incidence equals the angle of emergence.

39. C: $m = \frac{v}{u}$

$$I = \frac{m}{\Delta t} = \frac{0.99g}{3.3 \times 10^{-4} \times 40 \times 60} = 1.25A$$

Ammeter correction $\approx 1.25A - 1.2A = 0.05A$

40. B: After 4 days, the count rate will be 800 count/min; after 8 days, it will be 400 cpm; after 12 days, it will be 200cpm and after 16 days it will be 100 cpm (count per minute).

41. D: $E = BANW$
 $= 0.4 \times 0.4 \times 50 \times 10 = 80V$

42. C: $\Delta p \cdot \Delta x = h$

(Δp = uncertainty in the measurement of momentum, Δx = uncertainty in the measurement of position, h = Planck's constant)
 $5 \times 10^{-10} \times \Delta p \geq 6.6 \times 10^{-34}$

$$\Delta p = \left(\frac{6.6 \times 10^{-34}}{5 \times 10^{-10}}\right) NS = 1.32 \times 10^{-24} NS$$

43. C: When $\theta = 90^\circ$, F (from $F = qvB \sin\theta$) is maximum; this is because $\sin 90^\circ = 1$. To get exactly half of this maximum value, we need an angle whose sine $= \frac{1}{2} = 0.5$; if other things are to be constant.

$$\sin\theta = 0.5; \theta = \sin^{-1} 0.5 = 30^\circ$$

44. D: The stopping potential equals the kinetic energy.

45. B: $I_{r.m.s} = \frac{I_0}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 7.071A$

$$P = I_{r.m.s}^2 R = 7.071^2 \times 12 = 600W$$

46. A: Decrease in mass $= \frac{0.01}{100} \times 1g = 0.0001g$

$$= 10^{-7}kg$$

$$E = mc^2 = 10^{-7} \times (2 \times 10^8)^2 = 9 \times 10^9 J$$

47. B: Forward biased arrangement associated with narrow depletion layer while the reverse biased is associated with wide depletion layer.

48. B: $E = hf$ (E = energy, f = frequency, h = Planck's constant)

$$E = (6.6 \times 10^{-34} \times 8 \times 10^{14}) J = 5.28 \times 10^{-19} J$$

49. C: The resistance of metals increases as temperature increases while that of semi-conductors decreases with temperature rise.

50. C: The energy equivalent of the mass difference is the binding energy. The two are related by the equation

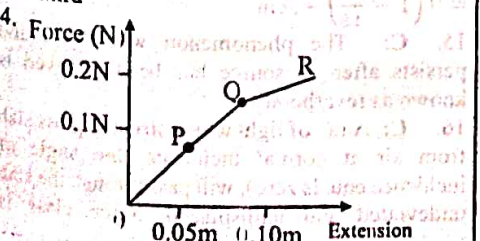
$$E = mc^2 \quad (E = \text{energy, } m = \text{mass and } c = \text{speed of light})$$

2002 UME PHYSICS QUESTIONS

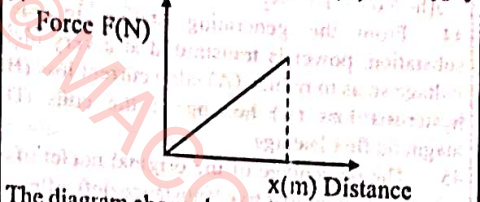
1. If the total force acting on a particle is zero, the linear momentum will (A) increase then decrease (B) be constant (C) increase (D) decrease.

2. The effect of a particle in a fluid attaining its terminal velocity is that the (A) weight is equal to the retarding force (B) acceleration is maximum (C) buoyancy force is more than the weight of the fluid displaced (D) buoyancy force is equal to the viscous retarding force.

3. If the distance between two suspended masses 10kg each is tripled, the gravitational force of attraction between them is reduced by (A) one quarter (B) one ninth (C) one half (D) one third



The diagram above shows the force-extension curve of a piece of wire. The energy stored when the wire is stretched from E to F is (A) $1.5 \times 10^{-2} J$ (B) $7.5 \times 10^{-2} J$ (C) $7.5 \times 10^{-3} J$ (D) $2.5 \times 10^{-2} J$



The diagram above shows the force (F) acting on an object through a distance (x). The work done on this object is expressed as (A) $Fx^2 J$ (B) $Fx J$ (C) $\frac{F}{x} J$ (D) $\frac{Fx}{2} J$

6. A wheel and axle is used to raise a load of 500 N by the application of an effort of 250N. If the radii of the wheel and the axle are 0.4cm and 0.1 cm respectively, the efficiency of the machine is (A) 60% (B) 50% (C) 40% (D) 20%

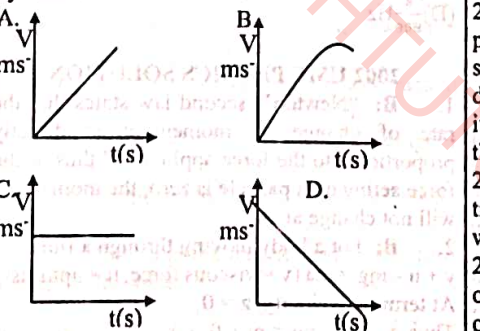
7. Two forces each of 10N act on a body, one towards the north and the other towards the east. The magnitude and the direction of the resultant force are (A) 10 2N, $45^\circ E$ (B) 10 2N, $45^\circ W$ (C) 20N, $45^\circ W$ (D) 20N, $45^\circ E$

8. The hydrostatic blood pressure difference between the head and feet of a boy standing straight is $1.65 \times 10^4 Nm^{-2}$. Find the height of the boy. (A) 0.6m (B) 0.5m (C) 2.0m (D) 1.5m [Density of blood $= 1.1 \times 10^3 kg m^{-3}$, $g = 10ms^{-2}$]

9. A body weighing 80N stands in an elevator that is about to move. The force exerted by the floor on the body as the elevator moves upwards with an acceleration of $5ms^{-2}$ is (A) 160 N (B) 120N (C) 80N (D) 40N [$g = 10ms^{-1}$]

10. A copper cube weighs 0.25N in air, 0.17N when completely immersed in paraffin oil and 0.15N when completely immersed in water. The ratio of upthrust in oil to upthrust in water is (A) 4:5 (B) 3:5 (C) 13:10 (D) 7:10

11. Which of the following is the correct shape of the velocity-time graph of a spherical steel ball dropped into a viscous fluid in a tall cylinder?



12. A particle in circular motion performs 30 oscillations in 6 seconds. Its angular velocity is (A) $10\pi rad s^{-1}$ (B) $5\pi rad s^{-1}$ (C) $6\pi rad s^{-1}$ (D) $5\pi rad s^{-1}$

13. I. Temperature. II. Density of air molecules. III. Pressure. IV. Pitch. Which of the above will affect the velocity of sound in air? (A) I, II, III and IV. (B) I, II and IV only. (C) II and IV only. (D) I and II only.

14. A coin placed below a rectangular glass block of thickness 9 cm and refractive index 1.5 is viewed vertically above the block. The

apparent displacement of the coin is (A) 8cm (B) 6 cm (C) 5 cm (D) 3cm

15. The phenomenon that makes sound persist when its source has been removed is known as (A) rarefaction (B) acoustic vibration (C) reverberation (D) echo.

16. A ray of light which strikes a glass slab from air at normal incidence passes through the slab (A) deviated and undisplaced at a lower speed (B) undeviated and undisplaced at a faster speed (C) undeviated and undisplaced at a lower speed (D) deviated and displaced at a lower speed

17. The colours seen in soap bubbles are due to (A) interference (B) dispersion (C) diffraction (D) refraction.

18. The pressure of 3 moles of an ideal gas at a temperature of $27^\circ C$ having a volume of $10^{-3} m^3$ is (A) $2.49 \times 10^6 Nm^{-2}$ (B) $7.47 \times 10^6 Nm^{-2}$ (C) $2.49 \times 10^5 Nm^{-2}$ (D) $7.47 \times 10^5 Nm^{-2}$ [$R = 8.3 J mol^{-1} K^{-1}$]

19. To produce an enlarged and erect image with a concave mirror, the object must be positioned (A) between the principal focus and the centre of curvature (B) at the principal focus (C) between the principal focus and the pole (D) beyond the centre of curvature

20. Blowing air over a liquid aids evaporation by (A) increasing its temperature (B) increasing its surface area (C) decreasing its density (D) decreasing its vapour pressure.

21. Water is a poor thermometric liquid because it (A) has low vapour pressure (B) is opaque (C) is a poor conductor (D) wets glass.

22. Which of the following eye defects can be corrected using a cylindrical lens? (A) Astigmatism (B) Presbyopia. (C) Chromatic aberration (D) Myopia.

23. The radiator of a motor car is cooled by (A) radiation and conduction (B) convection (C) conduction (D) radiation.

24. Vibrations in a stretched spring cannot be polarized because they are (A) transverse waves (B) mechanical waves (C) stationary waves (D) longitudinal waves.

25. The time rate of loss of heat by a body is proportional to the (A) temperature of its surroundings (B) temperature of the body (C) difference in temperature between the body and its surroundings (D) ratio of the temperature of the body to that of its surroundings.

26. The property that is propagated in a travelling wave is (A) amplitude (B) energy (C) wavelength (D) frequency.

27. Which of the following is a characteristic of stationary waves? (A) The antinode is a point of minimum displacement. (B) The distance between two successive nodes is one wavelength. (C) They are formed by two identical waves travelling in opposite directions. (D) They can be transverse or longitudinal.

28. A concave mirror of radius of curvature 40cm forms a real image twice as large as the object. The object distance is (A) 30cm (B) 40cm (C) 60cm (D) 10cm

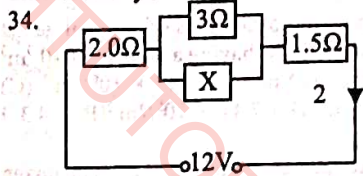
29. If tension is maintained on a stretched string of length 0.6m, such that its fundamental frequency of 220Hz is excited, determine the velocity of the transverse wave in the string. (A) $66ms^{-1}$ (B) $132ms^{-1}$ (C) $264ms^{-1}$ (D) $528ms^{-1}$

30. The energy stored in a capacitor of capacitance $10\mu\text{F}$ carrying a charge of $100\mu\text{C}$ is (A) $4 \times 10^{-3}\text{J}$ (B) $5 \times 10^{-4}\text{J}$ (C) $5 \times 10^4\text{J}$ (D) $4 \times 10^2\text{J}$

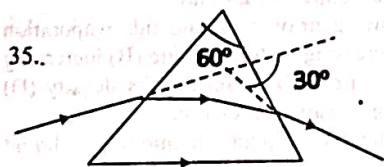
31. An electric iron is rated 1000W , 230V . What is the resistance of its element? (A) 57.6Ω (B) 55.9Ω (C) 52.9Ω (D) 51.9Ω

32. An electric cell with nominal voltage E has a resistance of 32 connected across it. If the voltage falls to $0.6E$, the internal resistance of the cell is (A) 4Ω (B) 3Ω (C) 2Ω (D) 1Ω

33. The electromagnetic wave that can produce a heating effect on the environment is (A) gamma rays (B) infrared rays (C) x-rays (D) ultraviolet rays



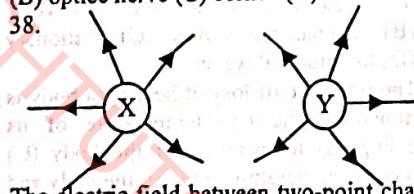
34. From the diagram above, determine the value of the resistance X . (A) 9Ω (B) 12Ω (C) 15Ω (D) 6Ω



35. Calculate the refractive index of the material for the glass prism in the diagram above. (A) $\sqrt{2}$ (B) $\frac{3}{2}$ (C) $\frac{2}{3}$ (D) $\frac{4}{3}$

36. When connected to a mains of 250V , the fuse rating in the plug of an electric device of 1kW is (A) 4A (B) 2A (C) 5A (D) 3A

37. The eye controls the amount of light reaching the retina by adjusting the (A) retina (B) optic nerve (C) cornea (D) iris.



38. The electric field between two-point charges is shown in the diagram above. What types of charges are at X and Y ? (A) X is positive and Y is negative. (B) X is negative and Y is positive. (C) Both X and Y are positive. (D) Both X and Y are negative.

39. A transistor is used in the amplification of signals because it (A) allows doping (B) contains electron and hole carriers (C) consumes a lot of power (D) controls the flow of current.

40. A current of 0.5A flowing for 3h deposits 2g of a metal during electrolysis. The quantity of the same metal that would be deposited by a current of 1.5A flowing in 1h is (A) 10g (B) 18g (C) 2g (D) 6g

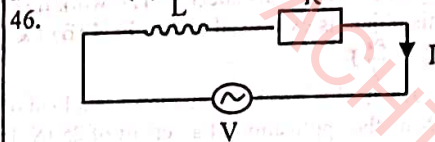
41. The particle that is responsible for nuclear fission in a nuclear reactor is (A) electron (B) photon (C) neutron (D) proton.

42. The carbon-granule microphone works on the principle of change in (A) voltage (B) inductance (C) resistance (D) capacitance.

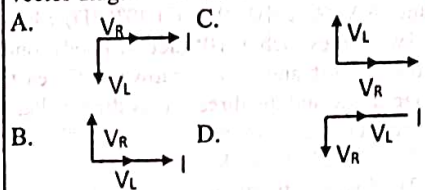
43. The energy associated with the photon of a transmission at $3 \times 10^8\text{Hz}$ is (A) $1.30 \times 10^{-29}\text{J}$ (B) $2.00 \times 10^{-29}\text{J}$ (C) $1.30 \times 10^{-18}\text{J}$ (D) $2.00 \times 10^{-18}\text{J}$ [$h=6.63 \times 10^{-34}\text{Js}$]

44. From the generating station to each substation, power is transmitted at a very high voltage so as to reduce (A) eddy current loss (B) hysteresis loss (C) heating in the coils (D) magnetic flux leakage.

45. The percentage of the original nuclei of a sample of a radioactive substance left after 5 half-lives is (A) 1% (B) 8% (C) 5% (D) 3%



46. Which of the following graphs shows the correct vector diagram for the circuit above?



47. Which of the following statements is true of the properties of a moving coil galvanometer? (A) There are strong hair springs to give a large control couple. (B) It has a small number of turns of coil. (C) The coil has a small area. (D) There is a strong permanent magnet to give high magnetic flux.

48. Pure silicon can be converted to a p-type material by adding a controlled amount of (A) pentavalent atoms (B) hexavalent atoms (C) tetravalent atoms (D) trivalent atoms

49. $\text{Na} + X \rightarrow {}^{20}_{10}\text{F} + {}^4_2\text{He}$ What particle is X in the reaction above? (A) Beta (B) Gamma (C) Alpha (D) Neutron

50. At what frequency would a capacitor of $2.5\mu\text{F}$ used in a radio circuit have a reactance of 25Ω (A) $\frac{800}{\pi}\text{Hz}$ (B) $200\pi\text{Hz}$ (C) $2000\pi\text{Hz}$ (D) $\frac{\pi}{800}\text{Hz}$

2002 UME PHYSICS SOLUTION

1. B: "Newton's second law states that the rate of change of momentum is directly proportional to the force applied ..." thus, if the force acting on a particle is zero, the momentum will not change at all.

2. B: For a body moving through a fluid, $v + u - mg = ma$ (v = viscous force, u = upthrust). At terminal velocity, $a = 0$. Thus, $v + u - mg = m \times 0 = 0$
 $v + u = mg$; $v + u = W$ ($W = mg$)
Thus, the retarding force will be equal to the weight at the terminal velocity

3. B: $F = \frac{Gm_1m_2}{r^2}$ From the equation $F \propto \frac{1}{r^2}$. Then, we have, $F_1r_1^2 = F_2r_2^2$
 $r_2 = 3r_1$
 $F_1r_1^2 = F_2(3r_1)^2 = F_2 \times 9r_1^2$
 $F_2 = \frac{F_1r_1^2}{9r_1^2} = \frac{F_1}{9} = \frac{1}{9} \times F_1$

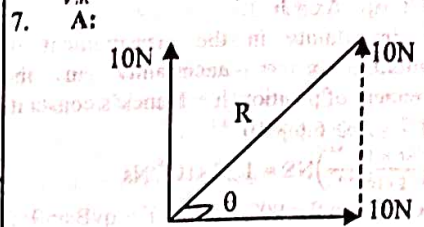
4. C: The energy equals the area of the trapezium: $PQF = \frac{1}{2}(0.1 + 0.2)(0.1 - 0.05) = 7.5 \times 10^{-3}\text{J}$

5. D: The work done equals the area under the graph. Since the shape is triangular, $A = \frac{1}{2}bh = \frac{1}{2} \times x \times F = \frac{1}{2}Fx = \frac{Fx}{2}$

6. B: $V.R = \frac{\text{Radius of wheel}}{\text{Radius of axle}} = \frac{0.4\text{cm}}{0.1\text{cm}} = 4$

$M.A = \frac{\text{Load}}{\text{Effort}} = \frac{500\text{N}}{250\text{N}} = 2$

$\epsilon = \frac{M.A}{V.R} \times 100\% = \frac{2}{4} \times 100\% = 50\%$



$R^2 = 10^2 + 10^2 = 200$

$R = \sqrt{200} = \sqrt{100} \times \sqrt{2} = 10\sqrt{2}$

$\tan\theta = \frac{10}{10} = 1$

$\theta = \tan^{-1}1 = 45^\circ$

Thus, the resultant is $10\sqrt{2}\text{N}$, $N45^\circ\text{E}$

8. D: $P = h\rho g$ (P = pressure, h = height, ρ = density, g = acceleration due to gravity)

$h = \frac{P}{\rho g} = \frac{1.65 \times 10^4}{1.1 \times 10^3 \times 10} = 1.5\text{m}$

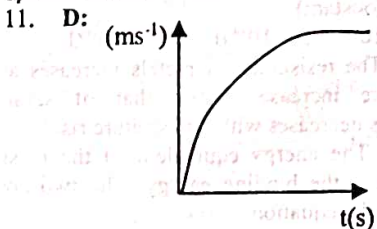
9. B: Since the elevator is moving upward, $R = mg + ma$

$R = 80 + 8(5) \Rightarrow 120\text{N}$ ($mg = w = 80\text{N}$. Then, $m = \frac{80}{g} = \frac{80}{10} = 8\text{kg}$)

10. A: Upthrust in water = $0.25\text{N} - 0.15\text{N} = 0.01\text{N}$

Upthrust in oil = $0.25\text{N} - 0.17\text{N} = 0.08\text{N}$

$\frac{\text{Upthrust in oil}}{\text{Upthrust in water}} = \frac{0.08\text{N}}{0.01\text{N}} = 8 = \frac{8}{10} = \frac{4}{5}$



As the ball accelerates down the cylinder, its velocity increases. However, an increase in velocity will always provoke an increase in the retarding force. A point will be reached where the retarding force will be so high that it balances the net force on the ball so that the velocity is now constant. The velocity attained is known as terminal velocity.

12. A: Frequency = $\frac{\text{number of oscillations}}{\text{time taken}} = \frac{30}{6} = 5\text{Hz}$

$w = 2\pi f \times 5 = 10\pi\text{rads}^{-1}$

13. D: The velocity of sound in air is affected by temperature and density of air molecules. Pressure does not affect the velocity at all.

14. D: $D = t \left(1 - \frac{1}{\mu}\right)$ (D = displacement, t = thickness, μ = refractive index)

$= 9 \left(1 - \frac{1}{1.5}\right) = 3\text{cm}$

15. C: The phenomenon whereby sound persists after its source has been removed is known as reverberation.

16. C: A ray of light which strikes a glass slab from air at normal incidence (the angle of incidence equals zero), will pass through the slab undeviated and undisplaced. Since glass is

thicker than air ($n_g = 1.5$), the speed of the light ray will also be lower than its initial value.

17. B: The colours seen in soap bubbles are due to dispersion.

18. B: $P = \frac{nR}{V} = \frac{3 \times 8.3 \times (27 + 273)}{10^{-3}} = 7.47 \times 10^6 \text{ Nm}^{-2}$

19. C: To produce an enlarged and erect image with a concave mirror, the object must be positioned between the pole and the principal focus. It must be noted that such an image is not real (it is virtual).

20. D: Blowing air over a liquid aids evaporation by decreasing the vapour pressure of the liquid.

21. D: Water wets glass and is colourless, making the meniscus in glass difficult to read.

22. A: Astigmatism is corrected with cylindrical lens

Presbyopia is corrected with bifocal lens

Myopia is corrected with concave or diverging lens

Hypermetropia is corrected with convex or converging lens

23. B: It is by convection

24. D: Longitudinal waves cannot be polarized, only transverse waves can.

25. C: $\frac{\Delta Q}{\Delta t} = kA \frac{(\theta_2 - \theta_1)}{l}$

$\frac{\Delta Q}{\Delta t}$ = rate of heat flow

k = thermal conductivity

A = Area

$\frac{(\theta_2 - \theta_1)}{l}$ = Temperature gradient

26. B: The property that is propagated in a travelling wave is energy. This is evident from the definition of wave: "A wave is a disturbance which travels through a medium transferring energy from one point to another without causing any permanent displacement of the medium".

27. C: Stationary waves are formed by two identical waves travelling in opposite directions. A node is the point of minimum point of maximum displacement.

The distance between two successive nodes is half of the wavelength.

The distance between the successive antinodes is also half of the wavelength.

28. A: $r = 40 \text{ cm}$, $f = \frac{r}{2} = \frac{40 \text{ cm}}{2} = 20 \text{ cm}$

$M = 2$, $m = \frac{v}{u}$; $2 = \frac{v}{u}$; $v = 2u$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$; $\frac{1}{20} = \frac{1}{u} + \frac{1}{2u} = \frac{2+1}{2u} = \frac{3}{2u}$

$\frac{1}{20} = \frac{3}{2u}$; $u = \frac{3 \times 20}{2} = 30 \text{ cm}$

29. C: For a fundamental string wave, $l = \frac{\lambda}{2}$

$0.6 = \frac{\lambda}{2}$; $\lambda = 2 \times 0.6 = 1.2 \text{ m}$

Frequency (f) = $\frac{\text{velocity } (v)}{\text{wavelength } (\lambda)}$

$220 = \frac{v}{1.2}$; $v = (220 \times 1.2) \text{ m/s}$

30. B: $E = \frac{1}{2} \frac{Q^2}{C}$ (Q = charge = $100 \mu\text{C} = 1 \times 10^{-4} \text{ C}$)

C = capacitance = $10 \mu\text{f} = 1 \times 10^{-5} \text{ f}$

$= \frac{1}{2} \times \frac{(10^{-4})^2}{10^{-5}} = 5 \times 10^{-4} \text{ J}$

31. C: $P = \frac{I^2}{R}$; $R = \frac{V^2}{P} = \frac{230^2}{1000} = 52.9 \Omega$

32. C: $I = \frac{V}{R+r}$; $E = IR + Ir = V + V$

V = terminal p.d. = 0.6 E

But $V = IR$

Thus, $I = \frac{V}{R} = \frac{0.6E}{3} = 0.2E$

$0.2E = \frac{E}{3+r}$

$0.2E \times (3+r) = E$ (E cancels out), we have

$0.2(3+r) = 1$

$3+r = \frac{1}{0.2} = 5$

$r = 5 - 3 = 2 \Omega$

33. B: The electromagnetic waves that can produce a heating effect on its environment are the infra-red rays.

34. C: $R = \frac{V}{I} = \frac{12}{2} = 6 \Omega$

$R = 2 + \left(\frac{3 \times x}{3+x}\right) + 1.5 = 3.5 + \left(\frac{3x}{3+x}\right)$

$3.5 + \left(\frac{3x}{3+x}\right) = 6$; $\frac{3x}{3+x} = 6 - 3.5 = 2.5$

$3x = 2.5(3+x) = 7.5 + 2.5x$

$3x = 7.5 + 2.5x$

$3x - 2.5x = 7.5$

$0.5x = 7.5$; $x = 15 \Omega$

35. A: $n = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

From the diagram, $A = 60^\circ$; $D_m = 30^\circ$

$n = \frac{\sin\left(\frac{60+30}{2}\right)}{\sin\left(\frac{60}{2}\right)} = \frac{\sin 45^\circ}{\sin 30^\circ}$

$= \frac{1}{\sqrt{2}} \div \frac{1}{2}$
 $= \frac{1}{\sqrt{2}} \times \frac{2}{1} = \frac{2}{\sqrt{2}}$

$\frac{2}{\sqrt{2}} = \frac{2}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}$

$= \frac{2\sqrt{2}}{\sqrt{2}} = \sqrt{2}$

36. A: $P = 1 \text{ KW} = 1000 \text{ W}$

$V = 250 \text{ V}$

$I = \frac{P}{V} = \left(\frac{1000}{250}\right) A = 4 A$

37. D: The eye controls the amount of light reaching the retina by adjusting the iris.

38. C: Both X and Y are positive. If they were negative, the arrows would be pointing inward and if they were of opposite signs, the arrows will point from the positive charge to the negative charge.

39. D: It controls the flow of current

40. C: $Q_1 = I_1 t_1 = (0.5 \times 3 \times 3600) \text{ C} = 5400 \text{ C}$

$Q_2 = I_2 t_2 = (1.5 \times 1 \times 3600) \text{ C} = 5400 \text{ C}$

Since the quantities of electricity are the same, the mass of the same element produced will also be the same (Faradays First Law).

41. C: The bombardment of a heavy nucleus by neutron may cause nuclear fission.

42. C: It works on the principle of change in resistance.

43. D: $E = hf = (6.63 \times 10^{-34} \times 3 \times 10^5) \text{ J} = 2 \times 10^{-28} \text{ J}$

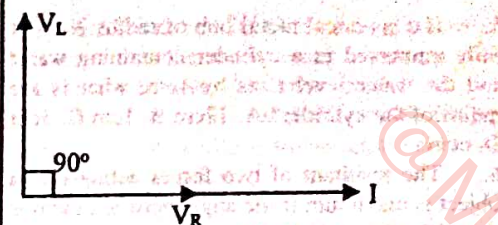
44. C: This is to reduce the heat loss in form of heat in the wire.

45. D: $N \rightarrow \frac{7}{2} N \rightarrow \frac{27}{4} N \rightarrow \frac{37}{8} N \rightarrow \frac{47}{16} N \rightarrow \frac{57}{32} N$

Thus, if the original amount of the radioactive substance is N , only $\frac{N}{32}$ will be left after five half-lives

$\% \text{ left} = \frac{\frac{N}{32}}{N} \times 100\% = \frac{1}{32} \times 100\% = 3\%$

46. D: This is an R-L circuit. Here, the voltage leads the current by $\frac{\pi}{2}$ or 90° . In other words, the current lags the voltage by $\frac{\pi}{2}$ or 90° . the phase diagram is as shown below



47. D: The sensitivity of a moving coil galvanometer can be increased by:

(i) Making the magnetic field stronger
(ii) Increasing the number of turns in the rectangular coil.

(iii) Making the springs with thinner wire to enable them to twist more easily.

(iv) Increasing the area of the coil.

48. D: When a pure semi-conductor is doped with a trivalent element, P-type semi-conductor is formed. If it is doped with a pentavalent element, n-type semi-conductor is formed.

49. D: ${}_{11}^{23}\text{Na} + {}_0^1\text{X} \rightarrow {}_{11}^{20}\text{F} + {}_2^4\text{He}$

$23 + a = 20 + 4$; $a = 24 - 23 = 1$

$11 + b = 9 + 2$; $b = 11 - 11 = 0$

Thus,

${}_0^1\text{X} = {}_0^1\text{X} \Rightarrow \text{Neutron}$

50. A: $X_C = 250 \Omega$

$X_C = \frac{1}{2\pi f C}$

$250 = \frac{1}{2\pi \times f \times 2.5 \times 10^{-6}}$

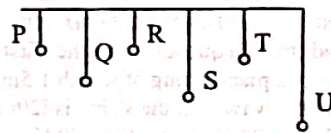
$f = \frac{1}{2 \times 250 \times \pi \times 2.5 \times 10^{-6}}$

$= \frac{1}{1.25 \times 10^{-3} \pi}$

$= \frac{1}{1.25 \times 10^{-3}} \times \frac{1}{\pi} = 800 \times \frac{1}{\pi} = \frac{800}{\pi}$

2001 UME PHYSICS QUESTIONS

1.

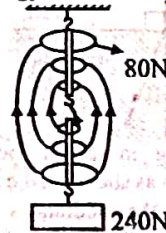


In the diagram above, which of the simple pendula will resonate with P when set into oscillation? A. T B. U C. R and T D. Q and R.

2. The height at which the atmosphere ceases to exist is about 80km. If the atmospheric pressure on the ground level is 760 mmHg, the pressure at a height of 20 km above the ground level is A. 380 mmHg B. 570mmHg C. 190 mmHg D. 480 mmHg

3. A stone of mass 1 kg is dropped from a height of 10m above the ground and falls freely under gravity. Its kinetic energy 5m above the ground is then equal to A. its kinetic energy on the ground B. twice its initial potential energy C. its initial potential energy D. half its initial potential energy.

4.



The diagram above is a block-and-tackle pulley system in which an effort of 80 N is used to lift a load of 240 N. The efficiency of the machine is A. 60% B. 50% C. 40% D. 33%

5. If a spherical metal bob of radius 3 cm is fully immersed in a cylinder containing water and the water level rises by 1cm, what is the radius of the cylinder? A. 12cm B. 1cm C. 3cm D. 6cm

6. The resultant of two forces acting on an object is maximum if the angle between them is A. 45° B. 0° C. 90° D. 180°

7. I. The earth is not spherical but elliptical in shape. II. Variation in latitude and longitude. III. Rotation of the earth on its axis. IV. Variation in the density of the earth. On which combination of the above does the weight of an object vary on the earth's surface? A. I, II, III and IV. B. II, III and IV only C. I, II and III only D. I and II only

8. The efficiency of a machine is always less than 100% because the A. work output is always greater than the work input B. load lifted is always greater than the effort applied C. effort applied is always greater than the load lifted D. velocity ratio is always greater than the mechanical advantage.

9. Which of the following consists entirely of vector quantities? A. Velocity, magnetic flux and reaction B. Tension, magnetic flux and mass C. Displacement, impulse and power D. Work, pressure and moment.

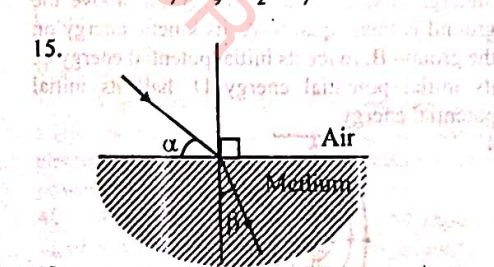
10. Ice cubes are added to a glass of warm water. The glass and water are cooled by A, conduction only B. convection only C. conduction and convection D. convection and radiation

11. A ray of light strikes a plane mirror at an angle of incidence of 35°. If the mirror is rotated through 10°, through what angle is the reflected ray rotated? A. 70° B. 45° C. 25° D. 20°

12. Find the frequencies of the first three harmonics of a piano string of length 1.5m, if the velocity of the waves on the string is 120ms⁻¹. A. 40 Hz, 80 Hz, 120 Hz B. 80 Hz, 160 Hz, 240 Hz C. 180 Hz, 360 Hz, 540 Hz D. 360 Hz, 240Hz, 90 Hz

13. The terrestrial telescope has one extra lens more than the astronomical telescope. The extra lens is for A. improving the sharpness B. creating an inverted image C. magnification of the image D. erection of the image

14. The driving mirror of a car has a radius of curvature of 1m. A vehicle behind the car is 4m from the mirror. Find the image distance behind the mirror. A. $\frac{8}{7}$ B. $\frac{4}{9}$ C. $\frac{2}{2}$ D. $\frac{4}{7}$



15. If a ray travelling in air is incident on a transparent medium as shown in the diagram, the refractive index of the medium is given as A. $\frac{\cos \alpha}{\sin \beta}$ B. $\frac{\sin \alpha}{\sin \beta}$ C. $\frac{\cos \beta}{\sin \alpha}$ D. $\frac{\sin \beta}{\sin \alpha}$

16. The pressure of a given mass of a gas changes from 300 Nm⁻² to 120 Nm⁻² while the temperature drops from 127°C to -73°C. The ratio of the final volume to the initial volume is A. 2:5 B. 5:4 C. 5:2 D. 4:5

17. A plane sound wave of frequency 85.5 Hz and velocity 342 ms⁻¹ is reflected from a vertical wall. At what distance from the wall does the wave have an antinode? A. 2m B. 4m C. 1m D. 3m

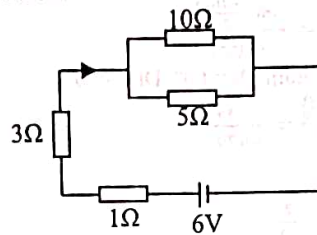
18. A string is fastened tightly between two walls 24 cm apart. The wavelength of the second overtone is A. 24cm B. 16cm C. 12cm D. 8cm

19. A gas with initial volume 2 × 10⁻⁶m³ is allowed to expand to six times its initial volume at constant pressure of 2 × 10⁵Nm⁻². The work done is A. 2.0 J B. 4.0 J C. 12.0 J D. 1.2 J

20. The thermometric substance of an absolute thermometer is A. alcohol B. mercury C. helium D. platinum

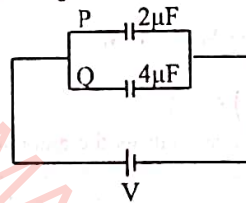
21. A cell of internal resistance r supplies current to a 6.0Ω resistor and its efficiency is 75%. Find the value of r. A. 4.5Ω B. 1.0Ω C. 8.0Ω D. 2.0Ω

22.



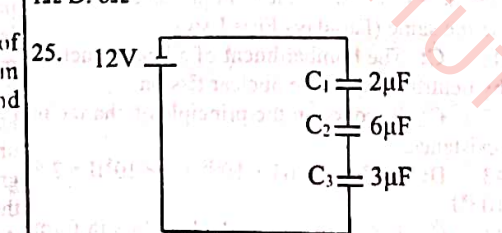
In the diagram above, the current I is A. $\frac{3}{8}$ A B. $\frac{9}{11}$ A C. $\frac{11}{9}$ A D. $\frac{8}{3}$ A

23.



The diagram above shows two capacitors P and Q of capacitances 2μF and 4μF respectively connected to a d.c. source. The ratio of energy stored in P to Q is A. 4:1 B. 2:1 C. 1:4 D. 1:2

24. A resistance R is connected across the terminal of an electric cell of internal resistance 2Ω and the voltage was reduced to 3/5 of its nominal value. The value of R is A. 3Ω B. 2Ω C. 1Ω D. 6Ω



The diagram above shows three capacitors C₁, C₂ and C₃ of capacitances 2μF, 6μF and 3μF respectively. The potential differences across C₁, C₂ and C₃ respectively are A. 4V, 6V and 2V B. 2V, 6V and 4V C. 6V, 4V and 2V D. 6V, 2V and 4V

26. A student is at a height 4m above the ground during a thunderstorm. Given that the potential difference between the thundercloud and the ground is 10⁷V, the electric field created by the storm is A. 2.0 × 10⁶NC⁻¹ B. 2.5 × 10⁶NC⁻¹ C. 1.0 × 10⁷NC⁻¹ D. 4.0 × 10⁷NC⁻¹

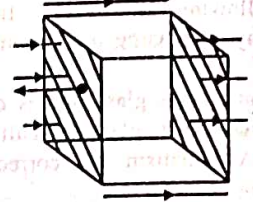
27. A working electric motor takes a current of 1.5 A when the p.d. across it is 250 V. If its

efficiency is 80%, the power output is A. 300.0 W B. 469.0 W C. 133.0 W D. 4.8 W

28. The cost of running five 60 W lamps and four 100W lamps for 20 hours if electrical energy costs N10.00 per kWh is A. N280.00 B. N160.00 C. N120.00 D. N140.00

29. In a Daniel cell, the depolarizer, positive and negative electrodes are respectively A. copper sulphate, copper and zinc B. manganese dioxide, carbon and zinc C. sulphuric acid, lead oxide and lead D. potassium hydroxide, nickel and iron.

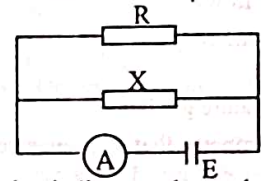
30.



The diagram above shows a closed square box of side 0.5 m in a uniform electric field E in the direction shown by the arrows. What is the flux φ for the box? A. 0.5 E B. 2.0 E C. 0.2 E D. 0.0 E

31. A bread toaster uses a current of 4A when plugged in a 240 volts line. It takes one minute to toast slices of bread. What is the energy consumed by the toaster? A. 5.76 × 10⁴J B. 1.60 × 10⁴J C. 3.60 × 10³J D. 1.60 × 10³J

32.



In the circuit diagram above, the ammeter reads a current of 3A when R is 5Ω and 6A when R is 2Ω Determine the value of x. A. 8Ω B. 2Ω C. 10Ω D. 4Ω

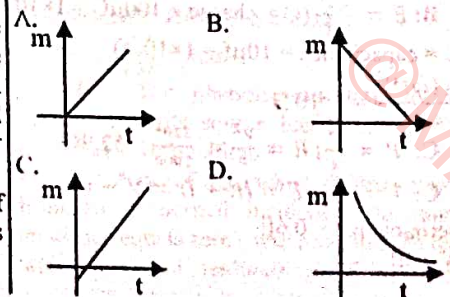
33. When a piece of rectangular glass block is inserted between two parallel plate capacitor, at constant plate area and distance of separation, the capacitance of the capacitor will A. increase B. decrease C. decrease, then increase D. remain constant

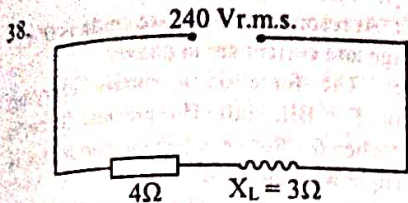
34. The ratio of electrostatic force F_E to gravitational force F_G between two protons each of charge e and mass m, at a distance d is A. $\frac{e}{4\pi\epsilon_0 Gm}$ B. $\frac{e^2}{Gm^2}$ C. $\frac{Gm^2}{4\pi\epsilon_0 e^2}$ D. $\frac{e^2}{4\pi\epsilon_0 Gm^2}$

35. What is the angle of dip at the magnetic equator? A. 45° B. 0° C. 90° D. 180°

36. A cell can supply currents of 0.4A and 0.2A through a 4.0Ω and 10.0Ω resistors respectively. The internal resistance of the cell is A. 2.0Ω B. 1.0Ω C. 2.5Ω D. 1.5Ω

37. Which of the following graphs correctly represents the variation of mass of a given material deposited with time for constant current in Faraday's law of electrolysis?





In the diagram above, determine the r.m.s. current A. 31 A B. 48 A C. 60 A D. 80 A

39. The particle emitted when K decays to K is A. gamma B. beta C. electron D. alpha

40. The current through a resistor in an ac. circuit is given as $2 \sin \omega t$. Determine the d.c. equivalent of the current. A. $\frac{1}{\sqrt{2}} \text{ A}$ B. $2\sqrt{2} \text{ A}$ C. 2 A

D. $\sqrt{2} \text{ A}$

41. I. Low pressure II. High pressure III. High p.d. IV. Low p.d. Which combination of the above is true of the conduction of electricity through gases? A. I and IV only B. I and III only C. II and IV only D. II and III only

42. Which of the following metals will provide the greatest shield against ionizing radiation? A. Iron B. Manganese C. Aluminium D. Lead

43. The primary coil of a transformer has N turns and is connected to a 120 V a.c. power line. If the secondary coil has 1,000 turns and a terminal voltage of 1,200 volts, what is the value of N ? A. 120 B. 100 C. 1,000 D. 1,200

44. The process of energy production in the sun is A. nuclear fission B. nuclear fusion C. electron collision D. radioactive decay

45. At resonance, the phase angle in an ac. circuit is A. 90° B. 60° C. 0° D. 180°

46. The force on a current carrying conductor in a magnetic field is greatest when the A. conductor makes an angle of 60° with the field B. force is independent of the angle between the field and the conductor C. conductor is parallel with the field D. conductor is at right angles with the field.

47. A transistor functions mainly as a A. switch and an amplifier B. rectifier and an amplifier C. charge storer and an amplifier D. charge storer and a switch.

48. Energy losses through eddy currents are reduced by using A. low resistance wires B. insulated soft iron wires C. few turns of wire D. high resistance wires.

49. A capacitor of $20 \times 10^{-12} \text{ F}$ and an inductor are joined in series. The value of the inductance that will give the circuit a resonant frequency of 200 kHz is A. $\frac{1}{16} \text{ H}$ B. $\frac{1}{8} \text{ H}$ C. $\frac{1}{64} \text{ H}$ D. $\frac{1}{32} \text{ H}$ [$\pi^2 = 10$]

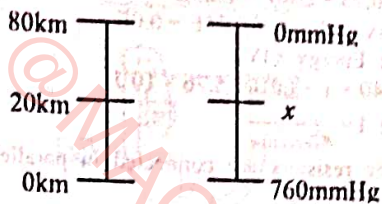
50. The magnetic force on a charged particle moving with velocity v is A. proportional to both the magnitude of the charge and the velocity v B. independent of the magnitude of the charge C. proportional to the velocity v only D. proportional to the magnitude of the charge only.

2001 JME PHYSICS SOLUTION

1. A: When P is set into oscillation, T will resonate with it since they are of the same length.

2. B: KEY \Rightarrow At the point where the atmosphere ceases to exist, there is not atmospheric pressure at all. In contrast, on the ground, the atmospheric pressure is suffered to the greatest extent (this is because the whole length of the atmosphere rest on the ground). We

can therefore get the pressure at any altitude by extrapolation:



$$\frac{80-20}{20-0} = \frac{0-x}{x-760}; \quad \frac{60}{20} = \frac{-x}{x-760}$$

$$60(x-760) = -20x$$

$$3(x-760) = -x$$

$$3x - 2280 = -x$$

$$3x + x = 2280$$

$$\frac{4x}{4} = \frac{2280}{4} = 570 \text{ mmHg}$$

3. D: P.E = $mgh = (1 \times 10 \times 10) \text{ J} = 100 \text{ J}$

Since it was initially 10m above the ground, at a point when it is 5m above the ground, distance travelled = $10\text{m} - 5\text{m} = 5\text{m}$. To get the kinetic energy, we need the velocity at this point.

$$U = 0$$

$$a = +g = +10 \text{ m/s}^2$$

$$S = 5 \text{ m}$$

$$V = ?$$

$$V^2 = U^2 + 2aS = 0^2 + 2 \times 10 \times 5 = 100$$

$$V = \sqrt{100} = 10 \text{ m/s}$$

$$\text{K.E} = \frac{1}{2}mv^2 = \frac{1}{2} \times 1 \times 10^2 = 50 \text{ J}$$

Thus, the K.E at a point which is 5m above the ground level is half of its initial potential energy.

4. B: V.R = Number of pulleys = 6

$$\text{M.A} = \frac{\text{Load}}{\text{Effort}} = \frac{240}{80} = 3$$

$$\epsilon = \frac{\text{M.A}}{\text{V.R}} \times 100\% = \frac{3}{6} \times 100\% = 50\%$$

5. D: Since the bob is spherical, its volume is obtained using the formula for the volume of a sphere.

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3} \times 3.142 \times 3^3 = 113.112 \text{ cm}^3$$

Volume of the bob immersed = Rise in volume of water in the cylinder

$$113.112 \text{ cm}^3 = \pi r^2 h \quad (r = \text{radius of the cylinder})$$

$$113.112 \text{ cm}^3 = 3.142 \times r^2 \times 1 \text{ cm}$$

$$r^2 = \frac{113.112}{3.142 \times 1} = 36; \quad r = \sqrt{36} = 6 \text{ cm}$$

6. B: The resultant of two vectors will be maximum when they are acting in the same direction i.e. when the angle between them is 0° .

7. C: The elliptical shape of the earth is not dictated by the variation in the density of the earth. I, II and III are correct.

8. D: It is because the velocity ratio is always greater than the mechanical advantage. Recall that:

$$\text{Efficiency} = \frac{\text{mechanical advantage}}{\text{velocity ratio}} \times 100\%$$

9. A: Velocity, magnetic flux and reaction (which is a force) are all vectors.

10. C: It is by conduction and convection.

11. D: When a plane mirror is rotated through angle θ , the reflected ray will be rotated through 2θ . Here, $\theta = 10^\circ$; $2\theta = 2 \times 10^\circ = 20^\circ$.

12. A: The fundamental frequency = $f_0 = \frac{v}{2l}$

$$f_0 = \frac{120}{2 \times 1.5} = 40 \text{ Hz}$$

$$\text{Second harmonic} = 2f_0 = 2 \times 40 \text{ Hz} = 80 \text{ Hz}$$

$$\text{Third harmonic} = 3f_0 = 3 \times 40 \text{ Hz} = 120 \text{ Hz}$$

13. D: The terrestrial telescope has one extra lens more than the astronomical telescope. The extra lens is to make the image upright.

14. B: KEY \Rightarrow Be careful here! A driving mirror is a convex mirror and as such must have a negative focal length.

$$f = -\frac{1}{2} \text{ m} = -0.5 \text{ m}$$

$$U = 4 \text{ m}$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}; \quad \frac{1}{-0.5} = \frac{1}{4} + \frac{1}{v}$$

(Instead of finding the LCM, you can proceed as illustrated below)

$$\frac{1}{-0.5} = \frac{1}{4} + \frac{1}{v}$$

$$-2 = 0.25 + \frac{1}{v}$$

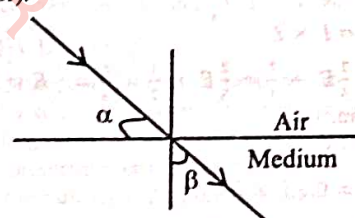
$$-2 - 0.25 = \frac{1}{v}$$

$$-2.25 = \frac{1}{v}$$

$$\frac{1}{v} = -2.25; \quad v = \frac{1}{-2.25} = -\frac{1}{2.25} \times \frac{4}{4} = -\frac{4}{9} \text{ cm}$$

Thus, the image is $\frac{4}{9} \text{ cm}$ behind the mirror (the negative sign indicates that the image is behind the mirror).

15. A:



Always remember that both the angle of incidence and that of refraction are the angles that the respective rays make with the normal.

Thus, angle of incidence, $i^\circ = 90 - \alpha$

Angle of refraction, $r^\circ = \beta$

$$\text{Refractive index} = \frac{\sin i^\circ}{\sin r^\circ} = \frac{\sin(90 - \alpha)}{\sin \beta}$$

From trigonometry,

$$\cos \alpha = \sin(90 - \alpha)$$

Thus,

$$n = \frac{\sin i^\circ}{\sin r^\circ} = \frac{\sin(90 - \alpha)}{\sin \beta} = \frac{\cos \alpha}{\sin \beta}$$

16. B: $P_1 = 300 \text{ Nm}^{-2}$, $T_1 = 127^\circ \text{C} = (127 + 273) \text{ K} = 400 \text{ K}$, $P_2 = 120 \text{ Nm}^{-2}$, $T_2 = -73^\circ \text{C} = (-73 + 273) \text{ K} = 200 \text{ K}$. Using the general gas equation

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}; \quad P_1 V_1 T_2 = P_2 V_2 T_1$$

$$\frac{V_2}{V_1} = \frac{P_1 T_2}{P_2 T_1} = \frac{300 \times 200}{120 \times 400} = \frac{300 \times 1}{120 \times 2} = \frac{300}{240} = \frac{5}{4}$$

17. C: KEY \Rightarrow At the wall, minimum displacement is recorded i.e. the wall serves as the node here. Thus, the distance between the wall and the next antinode = distance between a node and the adjacent antinode = $\frac{1}{4}$ of the wavelength.

$$\text{Frequency} = \frac{\text{velocity}}{\text{wavelength}}$$

$$85.5 = \frac{342}{\text{wavelength}}$$

$$\text{wavelength} = \left(\frac{342}{85.5}\right) \text{ m} = 4 \text{ m}$$

$$\text{Required distance} = \frac{1}{4} \times 4 \text{ m} = 1 \text{ m}$$

18. B: The second overtone corresponds to the third harmonic.

$$l = \frac{3\lambda}{2}; \quad \lambda = \frac{2l}{3} = \left(\frac{2 \times 24}{3}\right) \text{ cm} = 16 \text{ cm}$$

19. A: $W \cdot P \Delta V = 2 \times 10^5 \times [6 \times 2 \times 10^{-6} - 2 \times 10^{-6}]$
 $= 2 \times 10^5 (1.2 \times 10^{-5} - 2 \times 10^{-6})$
 $= 2 \text{ J}$

20. C: It is helium (other gases like nitrogen and hydrogen are sometimes used too)

21. D: $E = \frac{R}{R+r} \times 100\%$
 $75\% = \frac{6}{6+r} \times 100\%$
 $0.75 = \frac{6}{6+r}$
 $6+r = \frac{6}{0.75} = 8$
 $r = 8 - 6 = 2\Omega$

22. B: $R = 1 + 3 + \left(\frac{10 \times 5}{10+5}\right) = 4 + \frac{50}{15} = 4 + \frac{10}{3}$
 $\frac{10}{3} = \frac{22}{3}\Omega$
 $I = \frac{V}{R} = \frac{6}{\frac{22}{3}} = 6 \times \frac{3}{22} = \frac{18}{22} = \frac{9}{11}$

23. D: $E = \frac{1}{2}CV^2$
 $E_P = \frac{1}{2}C_P V^2 = \frac{1}{2} \times 2 \times 10^{-6} V^2 = 10^{-6} V^2$
 $E_Q = \frac{1}{2}C_Q V^2 = \frac{1}{2} \times 4 \times 10^{-6} V^2 = 2 \times 10^{-6} V^2$
 $\frac{E_P}{E_Q} = \frac{10^{-6} V^2}{2 \times 10^{-6} V^2} = \frac{1}{2}$

24. A: Let the emf be E
 $V = \frac{3}{5}E$ (V = terminal p.d.)
 $V = E - \frac{3}{5}E$ (V = lost voltage)
 $= \frac{2}{5}E$
 $V = Ir$
 $\frac{2}{5}E = I \times 2$
 $I = \frac{2}{5}E \div 2 = \frac{2}{5}E \times \frac{1}{2} = \frac{E}{5} = \frac{1}{5}E = 0.2E$

Again,
 $V = IR$
 $\frac{3}{5}E = 0.2E \times R$
 $0.6E = 0.2E \times R$
 $R = \frac{0.6E}{0.2E} = 3\Omega$

25. D: Since the capacitors are connected in series, the same charge passes through them. The effective capacitance, C is given by
 $\frac{1}{C} = \frac{1}{2} + \frac{1}{6} + \frac{1}{3} = \frac{3+1+2}{6} = \frac{6}{6}$
 $C = \frac{6}{6} = 1\mu f = 1 \times 10^{-6} f$

Potential difference = $\frac{\text{charge}}{\text{capacitance}}$
 $V_T = \frac{Q_T}{C_T}$
 $Q_T = V_T C_T = (12 \times 1 \times 10^{-6}) C = 1.2 \times 10^{-5} C$

$V_1 = \frac{Q_1}{C_1} = \left(\frac{1.2 \times 10^{-5}}{2 \times 10^{-6}}\right) V = 6V$
 $V_2 = \frac{Q_2}{C_2} = \left(\frac{1.2 \times 10^{-5}}{6 \times 10^{-6}}\right) V = 2V$
 $V_3 = \frac{Q_3}{C_3} = \left(\frac{1.2 \times 10^{-5}}{3 \times 10^{-6}}\right) V = 4V$

26. B: $V = Ed$; $E = \frac{V}{d}$
 $= \left(\frac{10^7}{4}\right) NC^{-1} = 2.5 \times 10^6 NC^{-1}$

27. B: Power input = $(1.5 \times 250)W = 375W$
 Power output = ?
 $\epsilon = \frac{\text{Power output}}{\text{Power input}} \times 100\%$
 $80\% = \frac{\text{Power output}}{375} \times 300W$

28. D: Total power = $5 \times 60W + 4 \times 100W = 700W = \left(\frac{700}{1000}\right)KW = 0.7KW$
 Time = 20hrs
 Energy = $(0.7 \times 20)Kwh = 14kwh$
 Since 1Kwh costs ₦10, the energy consumed will cost $\text{₦}(14 \times 10) = \text{₦}140$

29. A: In a Daniel cell, the depolarizer is copper sulphate, the negative electrode is zinc while the positive electrode is copper.

30. D: Area = $0.5m \times 0.5m = 0.25m^2$
 Flux $\phi = E.A \cos\theta$
 For the left face, $\theta = 180^\circ$

$\phi = E \times 0.25 \times \cos 180^\circ = -0.25E$
 For the right face, $\theta = 0^\circ$
 $\phi = E \times 0.25 \times \cos 0^\circ = 0.25E$
 Total flux = $-0.25E + 0.25E = 0.0E$

31. A: Energy = IVt
 $= (4 \times 240 \times 1 \times 60)J = 5.76 \times 10^4 J$

32. C: $I = \frac{V}{R_{\text{effective}}}$
 Since the resistors are connected in parallel,
 $R_{\text{effective}} = \frac{R \times x}{R+x}$
 When $I = 3A$, $R = 5\Omega$
 $I = \frac{E}{\left(\frac{R \times x}{R+x}\right)}$; $3 = \frac{E}{\frac{5x}{5+x}}$; $3 = \frac{E(5+x)}{5x}$
 When $I = 6A$, $R = 2\Omega$
 $6 = \frac{E}{\frac{2x}{2+x}}$; $6 = \frac{E(2+x)}{2x}$

Then,
 $\frac{12x}{2+x} = \frac{15x}{5+x}$; $x = 10\Omega$

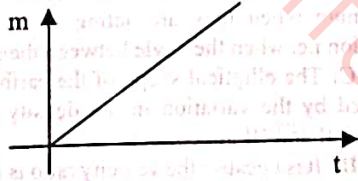
33. A: The glass block will serve as a dielectric material and consequently cause an increase in capacitance.

34. D: $F_g = \frac{Gm_1 m_2}{r^2}$; $F_E = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}$
 $\frac{F_E}{F_g} = \frac{e^2}{4\pi\epsilon_0 r^2} \div \frac{Gm^2}{r^2}$
 $= \frac{e^2}{4\pi\epsilon_0 r^2} \times \frac{r^2}{Gm^2} = \frac{e^2}{4\pi\epsilon_0 Gm^2}$

35. B: The angle of dip is 0° at the equator and 90° at the poles.

36. A: $I = \frac{E}{R+r}$
 When $I = 0.4A$, $R = 4\Omega$
 $0.4 = \frac{E}{4+r}$; $E = 0.4(4+r)$ (i)
 When $I = 0.2A$, $R = 10\Omega$
 $0.2 = \frac{E}{10+r}$; $E = 0.2(10+r)$ (ii)
 From equations (i) and (ii)
 $0.4(4+r) = 0.2(10+r)$
 $1.6 + 0.4r = 2 + 0.2r$
 $0.4r - 0.2r = 2 - 1.6 = 0.4$
 $0.2r = 0.4$; $r = \frac{0.4}{0.2} = 2\Omega$

37. C: $M \propto Q$
 $m = ZQ$, $Q = It$. Then, $m = ZIt$
 Thus, it is established that the relationship between m and t is a direct one, with zero intercept.



38. B: $Z = \sqrt{R^2 + X_L^2} = \sqrt{4^2 + 3^2} = 5\Omega$
 $I_{r.m.s} = \frac{V_{r.m.s}}{Z} = \frac{240}{5} = 48A$

39. A: Since the mass number and the atomic number are constant, it is a gamma decay.
 40. D: the d.c equivalent of an alternating current is the root mean square value
 $I_{r.m.s} = \frac{I_0}{\sqrt{2}} = \frac{2}{\sqrt{2}} = \sqrt{2}A$

41. B: Gases conduct electricity under a very low pressure and a very high p.d.

42. D: Lead is able to provide proper shield against ionizing radiation.

43. B: $\frac{N_p}{N_s} = \frac{V_p}{V_s}$; $\frac{N}{1000} = \frac{120}{1200}$; $N = \frac{120 \times 1000}{1200} = 100$

44. B: Energy production in the sun is by nuclear fusion.

45. C: At resonance, the phase angle is 0° i.e. the voltage and current are in phase.

46. D: The force on a current carrying conductor, $F = BIL \sin\theta$. The greatest force is recorded when $\theta = 90^\circ$ i.e. when the conductor is at right angle with the field.

47. A: A transistor is used as an amplifier and as a switch.

48. B: Eddy current losses are reduced by using laminated or insulated wires.

49. D: $F_0 = \frac{1}{2\pi\sqrt{LC}}$, $F_0 = 200KHz = 2 \times 10^5 Hz$
 $2 \times 10^5 = \frac{1}{2 \times 3.142 \sqrt{20 \times 10^{-12} \times L}}$
 $\sqrt{20 \times 10^{-12} \times L} = \frac{1}{2 \times 3.142 \times 2 \times 10^5} = 7.957 \times 10^{-7}$

$20 \times 10^{-12} L = (7.957 \times 10^{-7})^2 = 6.33 \times 10^{-13}$
 $L = \frac{6.33 \times 10^{-13}}{20 \times 10^{-12}} \approx \frac{1}{32} H$

50. A: $F = qVB \sin\theta$
 Thus, the force depends on:
 (i) The magnitude of the charge (q)
 (ii) The magnitude of the velocity (v)
 (iii) The magnetic flux density (B)
 (iv) The angle between the charge and the field (theta)

2000 UME PHYSICS QUESTIONS

1. A catapult used to hold a stone of mass 500g is extended by 20 cm with an applied force F. If the stone leaves with a velocity of 40 ms⁻¹, the value of F is A. $4.0 \times 10^4 N$ B. $4.0 \times 10^3 N$ C. $2.0 \times 10^3 N$ D. $4.0 \times 10^2 N$

2. A hand bag containing some load weighing 162 N is carried by two students each holding the handle of the bag next to him. If each handle is pulled 60° to the vertical, find the force on each student's arm. A. 324 N B. 162 N C. 121 N D. 81 N

3. I. The frictional force is independent of the area of the surfaces in contact. II. The frictional force depends on the nature of the surfaces in contact III. The frictional force depends on the speed of sliding IV. The frictional force is directly proportional to the normal reaction. Which combination of the above is true of sliding friction? A. I, II and IV B. I, II and III C. I, III and IV D. II, III and IV

4. When a ship sails from salt water into fresh water, the fraction of its volume above the water surface will A. remain the same B. increase C. decrease D. increase then decrease.

5. A simple pendulum has a period of 17.0s. When the length is shortened by 1.5m, its period is 85s. Calculate the original length of the pendulum A. 1.5m B. 2.0m C. 3.0m D. 4.0m

6. At a fixed point below a liquid surface, the pressure downward is P₁ and the pressure upward is P₂. It can be deduced that A. P₁ = P₂ B. P₁ > P₂ C. P₁ < P₂ D. P₁ ≥ P₂

7. I. Its velocity is constant II. No work is done on the body. III. It has constant acceleration directed away from the centre. IV. The centripetal force is directed towards the centre. Which combination of the above is true of a body moving with constant speed in a circular track? A. I and III B. I and IV C. II and III D. II and IV

8. The velocity v of a particle in a time t is given by the equation $v = 10 + 2t^2$. Find the

instantaneous acceleration after 5 seconds A. 10ms^{-2} B. 15ms^{-2} C. 20ms^{-2} D. 60ms^{-2}

9. If the force and the velocity on a system are each reduced simultaneously by half, the power of the system is A. doubled B. constant C. reduced to a quarter D. reduced by half.

10. The velocity ratio of a machine is 5 and its efficiency is 75%. What effort would be needed to lift a load of 150 N with the machine? A. 50 N B. 40 N C. 30 N D. 20 N

11. A rope is being used to pull a mass of 10 kg vertically upward. Determine the tension in the rope if, starting from rest, the mass acquires a velocity of 4ms in 8s. A. 105 N B. 95 N C. 50 N D. 5 N [$g=10\text{ms}^{-2}$]

12. A stream is flowing at 0.75ms^{-1} and a boat heading perpendicular for the stream landed at the opposite bank at an angle 30° . Calculate the velocity of the boat. A. 0.65ms^{-1} B. 0.86ms^{-1} C. 1.00ms^{-1} D. 1.50ms^{-1}

13. I. Coherence II. Same frequency III. Same wavelength IV Same intensity. Which of the conditions above are necessary to produce interference fringes? A. I, II, and III B. I and III C. I, II and IV D. II and III

14. An engineer intends to deviate a light ray from its path by 120° through reflection from a plane mirror. Calculate the angle of incidence. A. 20° B. 30° C. 40° D. 60°

15.

	Day 1	Day 2	Day 3
Dry	30°C	29°C	25°C

The readings above are for three consecutive days from a wet and dry bulb hygrometer. It can be concluded that the relative humidity for the three days A. increased steadily B. remained unchanged C. was least on Day 1 D. decreased Steadily

16. Total internal reflection occurs when light moves from A. air to water B. water to glass C. a dense medium to a less dense medium D. a less dense medium to a dense medium.

17. One end of a long wire is fixed while a vibrator is attached to the other end. When the vibrator is energized, the types of waves generated in the wire are A. stationary and transverse B. progressive and transverse C. stationary and longitudinal D. progressive and longitudinal

18. A sonometer wire is vibrating at frequency f_0 . If the tension in the wire is doubled while the length and the mass per unit length are kept constant, the new frequency of vibration is A. $\frac{f_0}{2}$

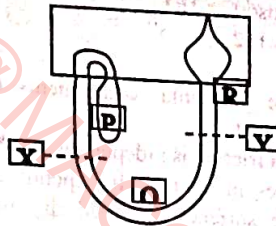
B. $2f_0$ C. $\frac{f_0}{\sqrt{2}}$ D. $f_0\sqrt{2}$

19. A boy observes a piece of stone at the bottom of a river 6.0m deep. If he looks from the surface of the river, what is the apparent distance of the stone from him? A. 4.5 m B. 5.0 m C. 5.5 m D. 8.0 m [Refractive index of water = $\frac{4}{3}$]

20. A metal of mass 0.5 kg is heated to 100°C and then transferred to a well-lagged calorimeter of heat capacity 80JK^{-1} containing water of heat capacity 420JK at 15°C . If the final steady temperature of the mixture is 25°C , find the specific heat capacity of the metal. A. 92JKg^{-1}

K^{-1} B. $133\text{JKg}^{-1}\text{K}^{-1}$ C. $286\text{JKg}^{-1}\text{K}^{-1}$ D. $877\text{JKg}^{-1}\text{K}^{-1}$

21.



The diagram above shows a maximum and minimum thermometer divided into three portions P, Q and R. Which of the following is true about the respective contents of P, Q and R?

A. Alcohol, mercury and alcohol B. Air, alcohol and mercury C. Mercury, alcohol and mercury D. Air, mercury and alcohol.

22. The main reason for making the cover of a vacuum flask airtight is to prevent heat loss by A. conduction B. evaporation C. radiation D. convection

23. A travelling wave moving from left to right has an amplitude of 0.15 m, a frequency of 550 Hz and a wavelength of 0.01 m. The equation describing the wave is A. $y = 0.15 \sin 200\pi(x - 5.5t)$ B. $y = 0.15 \sin \pi(0.01x - 5.5t)$ C. $y = 0.15 \sin 5.5\pi(x - 200t)$ D. $y = 0.15 \sin \pi(550x - 0.01t)$

24. A transverse wave is, applied to a string whose mass per unit length is $3 \times 10^{-2}\text{kgm}^{-1}$. If the string is under a tension of 12N, the speed of propagation of the wave is A. 40ms^{-1} B. 30ms^{-1} C. 20ms^{-1} D. 5ms^{-1}

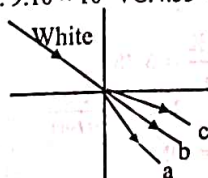
25. A quantity of water at 0°C is heated to about 30°C . At each degree rise in temperature, its density will A. rise steadily B. rise then fall C. fall steadily D. fall then rise.

26. A thin wire with heavy weights attached to both ends is hung over a block of ice resting on two supports: If the wire cuts through the ice block while the block remains solid behind the wire, the process is called A. fusion B. sublimation C. condensation D. regulation.

27. A cell of internal resistance 0.01Ω can be measured accurately using the A. Ohm-meter B. potentiometer C. electroscopes D. metre bridge

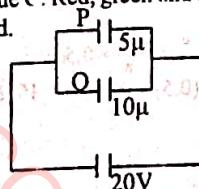
28. An electron of charge $1.6 \times 10^{-19}\text{C}$ and mass $9.1 \times 10^{-31}\text{kg}$ is accelerated between two metal plates with a velocity of $4 \times 10^7\text{ms}^{-1}$, the potential difference between the plates is A. $4.55 \times 10^1\text{V}$ B. $9.10 \times 10^1\text{V}$ C. $4.55 \times 10^2\text{V}$ D. $4.55 \times 10^3\text{V}$

29.



In the diagram above, a beam of white light travels from a rare to a dense medium. What colours of light do the rays a, b, and c respectively represent? A. Blue, yellow and red B. Green, red and blue C. Red, green and blue D. Yellow, blue and red.

30.



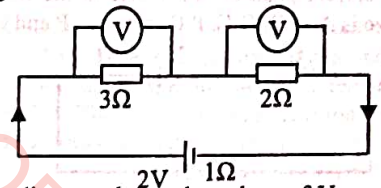
The diagram above shows two capacitors P and Q of capacitances $5\mu\text{F}$ and $10\mu\text{F}$. Find the charges stored in P and Q respectively. A. $200\mu\text{C}$ and $100\mu\text{C}$ B. $100\mu\text{C}$ and $200\mu\text{C}$ C. $4\mu\text{C}$ and $2\mu\text{C}$ D. $2\mu\text{C}$ and $4\mu\text{C}$.

31. What optical instrument can best be constructed with converging lenses of focal lengths 50cm and 5cm? A. Compound microscope B. Terrestrial telescope C. Astronomical telescope D. Galileo's telescope

32. If a charged ion goes through combined electric and magnetic fields, the resultant emergent velocity of the ion is A. $\frac{E}{B}$ B. EB C. $\frac{B}{E}D$.

E - B

33.



In the diagram above, the values of V_1 and V_2 are respectively. A. IV and $\frac{1}{3}\text{V}$ B. $\frac{1}{3}\text{V}$ and IV

C. $\frac{1}{3}\text{V}$ and $\frac{2}{3}\text{V}$ D. IV and $\frac{2}{3}\text{V}$

34. A projection lantern is used to give the image of a slide on a screen. If the image is 24 times as large as the slide and the screen is 72.0m from the projecting lens, what is the position of the slide from the lens? A. 4.0m B. 3.5m C. 3.0m D. 0.3m

35. A radio is operated by eight cells each of e.m.f. 2.0V connected in series. If two of the cells are wrongly connected, the net e.m.f. of the radio is A. 16V B. 12V C. 10V D. 8V

36. A 2 H inductor has negligible resistance and is connected to a $\frac{50}{\pi}$ Hz a.c supply. The reactance of the inductor is A. 200Ω B. 50Ω C. $\frac{100}{\pi}\Omega$ D. $\frac{25}{\pi}\Omega$

37. If the fraction of the atoms of a radioactive material left after 120 years is $\frac{1}{64}$, what is the half-life of the material? A. 2 years B. 10 years C. 20 years D. 24 years.

38. A certain radioactive source emits radiations that were found to be deflected by both magnetic and electric fields. The radiations are A. x-rays B. beta rays C. gamma rays D. ultra-violet rays.

39. In a pure semiconductor, the number of electrons in the conduction band is A. equal to the number of holes in the valence band B. greater than the number of holes in the valence band C. less than the number of holes in the valence band D. twice the number of holes in the valence band.

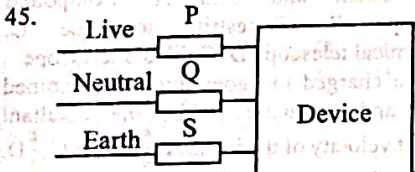
40. A cell of internal resistance 1Ω supplies current to an external resistor of 3Ω . The efficiency of the cell is A. 75% B. 50% C. 33% D. 25%

41. Light energy 5 eV falls on a metal of work function 3 eV and electrons are liberated. The stopping potential is A. 15.0 V B. 8.0 V C. 2.0 V D. 1.7 V

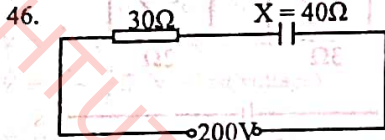
42. In a thermonuclear reaction, the total initial mass is $5.02 \times 10^{-27}\text{kg}$ and the total final mass is $5.01 \times 10^{-27}\text{kg}$. The energy released in the process is A. $9.0 \times 10^{13}\text{J}$ B. $9.0 \times 10^{11}\text{J}$ C. $9.0 \times 10^{12}\text{J}$ D. $9.0 \times 10^{13}\text{J}$

43. The magnetic flux in a coil having 200 turns changes at the time rate of 0.08 Wb s^{-1} . The induced e.m.f. in the coil is A. 1.6V B. 16.0V C. 25.0V D. 250.0V

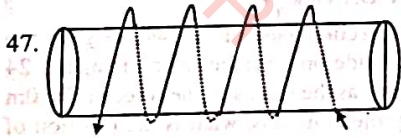
44. If the frequency of an emitted x-rays is $1.6 \times 10^{16} \text{ Hz}$, the accelerating potential is A. 6.6 V B. 66.3 V C. 663.0 V D. 6630.0 V [$e = 1.6 \times 10^{-19} \text{ C}$, $h = 6.63 \times 10^{-34} \text{ Js}$]



The correct position for a fuse in the diagram above is A. S B. Q C. P D. between P and Q



In the a.c circuit above, the current value is A. 6.67 A B. 4.00 A C. 3.00 A D. 0.58 A



If current flows in the direction of the arrows in the solenoid above, the North pole is at A. P B. X C. Q D. Y.

48. A gas would serve as an electrical conductor under A. reduced pressure and reduced potential B. reduced pressure and high current C. increased magnetic field D. exposure to visible light.

49. An electric generator with a power output of 3.0 kW at a voltage of 1.5kV distributes power along cables of total resistance 20.0Ω. The power loss in the cable is A. 0.1 W B. 10.0 W C. 40.0 W D. 80.0 W

50. A conductor of length 2m carries a current of 0.8A while kept in a magnetic field of magnetic flux density 0.5 T. The maximum force acting on it is A. 8.0 N B. 3.2 N C. 0.8 N D. 0.2 N

2000 UME PHYSICS SOLUTION

1. B: KEY \Rightarrow The elastic potential energy stored in the catapult when it is stretched will be converted into the kinetic energy of the stone.

$$\text{Mass, } m = 500\text{g} = \left(\frac{500}{1000}\right) \text{kg} = 0.5\text{kg}$$

$$\text{Extension, } e = 20\text{cm} = \left(\frac{20}{100}\right) \text{m} = 0.2\text{m}$$

$$\text{Velocity, } V = 40\text{m/s}$$

$$\text{Elastic potential energy} = \text{kinetic energy}$$

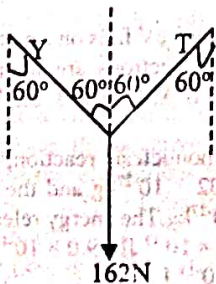
$$\frac{1}{2}Fe = \frac{1}{2}mv^2$$

$$\frac{1}{2} \times F \times 0.2 = \frac{1}{2} \times 0.5 \times 40^2$$

$$0.1F = 400;$$

$$F = \left(\frac{400}{0.1}\right) \text{N} = 4000\text{N} = 4 \times 10^3 \text{N}$$

2. B:



The total upward force must equal the downward force.

$$T \cos 60^\circ + T \cos 60^\circ = 162$$

$$0.5T + 0.5T = 162$$

$$T = 162\text{N}$$

Note that the horizontal components of the tension cancel out.

3. A: Solid friction is independent of the area of the surfaces in contact. It depends on the nature of the surfaces involved dry or wet, polished or unpolished, smooth or rough. It is directly proportional to the normal reaction.

4. C: If an object floating in a dense liquid is transferred into a less dense liquid, the fraction of the object under the liquid will increase causing the fraction above the liquid to decrease. Note that salt water is denser than fresh water.

$$5. \text{ B: } \frac{T_1}{\sqrt{L_1}} = \frac{T_2}{\sqrt{L_2}}$$

$$\text{Let } L_1 = x. \text{ Then, } L_2 = x - 1.5$$

$$\frac{17}{\sqrt{x}} = \frac{8.5}{\sqrt{x-1.5}}. \text{ By squaring both sides:}$$

$$\left(\frac{17}{\sqrt{x}}\right)^2 = \left(\frac{8.5}{\sqrt{x-1.5}}\right)^2; \frac{17^2}{x} = \frac{8.5^2}{x-1.5}$$

$$289(x-1.5) = 72.25x$$

$$289x - 433.5 = 72.25x$$

$$289x - 72.25x = 433.5$$

$$216.25x = 433.5$$

$$x = 2\text{m}$$

6. A: Pressure at a point below a liquid surface is the same in all directions

7. D: KEY \Rightarrow An object moving with a constant speed in a circular tract does not have a constant velocity! This is because the direction is always changing. It is therefore accelerating despite the fact that its speed is not changing. Its velocity is not constant.

No work is done on it.

Its acceleration is directed towards the centre.

The centripetal force is directed towards the centre.

$$8. \text{ C: } V = 10 + 2t^2$$

$$a_{\text{instantaneous}} = \frac{dv}{dt} = 4t$$

$$\text{When } t = 5\text{s}$$

$$a_{\text{inst}} = (4 \times 5) \text{m/s}^2 = 20 \text{m/s}^2$$

9. C: Power = Force \times Velocity

$$P_1 = F_1 V_1. F_1 = \frac{1}{2}F_1 \text{ and } V_2 = \frac{1}{2}V_1. \text{ Then, } P_2 =$$

$$F_2 V_2 = \frac{1}{2}F_1 \times \frac{1}{2}V_1 = \frac{1}{4}F_1 V_1$$

$$\text{But } F_1 V_1 = P. \text{ Thus, } P_2 = \frac{1}{4}P_1$$

$$10. \text{ B: } \epsilon = \frac{M.A}{V.R} \times 100\%$$

$$75\% = \frac{M.A}{5} \times 100\%$$

$$M.A = \frac{100\%}{5} = 3.75$$

$$M.A = \frac{\text{Load}}{\text{Effort}}; 3.75 = \frac{150}{\text{Effort}}$$

$$\text{Effort} = \frac{150}{3.75} = 40\text{N}$$

11. A: $T - mg = ma$

$$T = ma + mg$$

$$u = 0$$

$$v = 4\text{m/s}$$

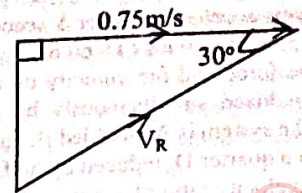
$$t = 8\text{s}$$

$$a = ?$$

$$a = \frac{v-u}{t} = \frac{4-0}{8} = 0.5\text{m/s}^2$$

$$T = 10(0.5) + 10(10) = 105\text{N}$$

12. B:



$$\cos 30^\circ = \frac{0.75}{V_R}$$

$$V_R = \frac{0.75}{\cos 30^\circ}$$

$$= 0.866\text{m/s}$$

13. A: I, II and III are necessary

14. B: $D = 180 - 2i$

($D =$ angle of deviation, $i =$ angle of incidence)

$$120^\circ = 180 - 2i$$

$$i = \frac{180^\circ - 120^\circ}{2} = \frac{60^\circ}{2} = 30^\circ$$

15. C: KEY \Rightarrow The relative humidity is a function of the temperature difference between the wet bulb and the dry bulb. If the difference is big, the relative humidity is low and vice-versa. For day 1, the temperature difference = $30^\circ\text{C} - 22^\circ\text{C} = 8^\circ\text{C}$.

Similarly, the temperature differences for days 2 and 3 are respectively 7°C and 4°C since the highest difference in temperature was recorded on day 1, the relative humidity was the least.

16. C: Total internal reflection occurs when light moves from a dense medium to a less dense medium.

17. A: The waves will be stationary and transverse.

$$18. \text{ D: } F \propto \frac{1}{2l} \sqrt{T}$$

$$\text{Thus, } F \propto \sqrt{T}; K = \frac{F_1}{\sqrt{T_1}} = \frac{F_2}{\sqrt{T_2}}$$

$$T_2 = 2T_1. \text{ Then,}$$

$$\frac{F_1}{\sqrt{T_1}} = \frac{F_2}{\sqrt{T_2}}; F_2 = \frac{F_1 \times \sqrt{2T_2}}{\sqrt{T_1}}$$

$$= \frac{F_1 \times \sqrt{2} \times \sqrt{2}}{\sqrt{T_1}} = F_1 \times \sqrt{2}$$

19. A: Refractive index (n) =

$$\frac{\text{Real depth (RD)}}{\text{Apparent depth (AD)}}$$

$$\frac{4}{3} = \frac{6}{A.D}; A.D = \left(\frac{3 \times 6}{4}\right) \text{m} = 4.5\text{m}$$

20. B: Heat lost by the metal = Heat gained by water \rightarrow heat gained by calorimeter

$$mc\Delta\theta = C_w\Delta\theta_w + C_c\Delta\theta_c$$

$$0.5 \times C \times (100 - 25) = 420 \times (25 - 5) + 80 \times (25 - 15)$$

$$37.5C = 5000$$

$$C = \left(\frac{5000}{37.5}\right) \text{Jkg}^{-1}\text{K}^{-1} = 133.33 \text{Jkg}^{-1}\text{K}^{-1}$$

21. A: P and R contain alcohol

Q contains mercury

22. D: The main reason is to prevent heat loss by convection.

23. A: For a wave travelling in the positive x-direction (i.e. from left to right)

$$y = A \sin\left(\frac{2\pi x}{\lambda} - 2\pi ft\right)$$

$$A = 0.15\text{m}, f = 550\text{Hz}, \lambda = 0.01\text{m}$$

$$y = 0.15 \sin\left(\frac{2\pi xx}{0.01} - 2\pi \times 550t\right)$$

$$= 0.15 \sin(200\pi x - 1100\pi t)$$

$$= 0.15 \sin(200\pi(x - 5.5t))$$

$$24. \text{ C: } V = \sqrt{\frac{T}{\mu}}$$

($V =$ velocity of the wave, $T =$ tension and $\mu =$ mass per unit length)

$$v = \sqrt{\frac{12}{3 \times 10^{-2}}} = \sqrt{400} = 20 \text{ m/s}$$

25. B: Water displays an anomalous behavior between 0°C and 4°C. Its density increases as it is heated between these values (instead of the density to decrease as expected of a normal liquid when heated). At any temperature above 4°C, water now behaves normally i.e. the density now decreases as it is being heated.

26. D: This is known as regelation

27. A: Resistance can be measured with a metre bridge or ohm meter but ohm meter is more appropriate for measuring small resistances

28. D: $qv = \frac{1}{2}mv^2$

(V = potential different, v = velocity)

$$1.6 \times 10^{-19} \times V = \frac{1}{2} \times 9.1 \times 10^{-31} \times (4 \times 10^7)^2 = 7.28 \times 10^{-16}$$

$$V = \frac{7.28 \times 10^{-16}}{1.6 \times 10^{-19}} = 4550 \text{ V} = 4.55 \times 10^3 \text{ V}$$

29. A: Of the three components of white light shown, 'a' suffers the greatest deviation while 'c' shows the least deviation. Thus, the arrangement a, b, c signifies decreasing angle of deviation.

ROYGBIV

Increasing deviation →

Then, →

VIBGYOR

Decreasing deviation

Of the various colour combinations given, only 'blue, yellow and red' follows decreasing deviation pattern.

30. B: $Q_p = V_p C_p = (20 \times 5 \times 10^{-6}) \text{ C} = 1 \times 10^{-4} \text{ C} = 100 \mu\text{C}$

$Q_q = V_q C_q = (20 \times 10 \times 10^{-6}) \text{ C} = 2 \times 10^{-4} \text{ C} = 200 \mu\text{C}$

31. C: Although the eyepiece lens of a compound microscope has longer focal length than the object lens, both must still be of relatively small focal length (like 5cm and 1cm) A terrestrial telescope uses three lenses, so it is not appropriate.

An astronomical telescope (a device for viewing heavenly bodies) may use lenses of focal length 50cm (for objective) and 5cm (for eyepiece).

A Galilean telescope uses a concave lens and a convex lens.

32. A: If a charged particle goes through combined electric and magnetic fields, the resultant emergent velocity of the ion = $\frac{E}{B}$

Where E = electric field intensity

B = magnetic flux density

33. D: Since the resistors are connected in series, the same current passes through them.

$$R = 3\Omega + 2\Omega = 5\Omega$$

$$r = 1\Omega, E = 2\text{V}$$

$$I = \frac{E}{R+r} = \frac{2}{5+1} = \frac{2}{6} = \frac{1}{3} = 0.333 \text{ A}$$

$$V_1 = IR_1 \Rightarrow \frac{1}{3} \times 2 = \frac{2}{3} \text{ V}$$

$$34. C: M = \frac{v}{u} = \frac{72}{3} = 24$$

The image is 24 times the object i.e. $M = 24$

$$24 = \frac{72}{u}; u = \frac{72}{24} = 3 \text{ m}$$

35. B: The e.m.f values of the two cells that are wrongly will cannot each other out. Hence, only six cells are delivering.

$$\text{Total emf} = 6 \times 2\text{V} = 12\text{V}$$

36. A: $X_L = 2\pi FL = 2 \times \pi \times \frac{50}{\pi} \times 2 = 200\Omega$

37. C: $\frac{Nt}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{t_1}}; \frac{1}{64} = \left(\frac{1}{2}\right)^{\frac{120}{t_1}}; \left(\frac{1}{2}\right)^6 = \left(\frac{1}{2}\right)^{\frac{120}{t_1}}$

Then, $6 = \frac{120}{t_1}; t_1 = \left(\frac{120}{6}\right) \text{ years} = 20 \text{ years}$

38. B: Beta particles are deflected towards the positive plate in an electric field and towards the north pole in a magnetic field.

39. A: In a pure semi-conductor, the number of electrons in the conduction band is equal to the number of holes in the valence band.

40. A: Efficiency = $\frac{R}{R+r} \times 100\% = \frac{3}{3+1} \times 100\% = 75\%$

41. C: Kinetic energy of the electrons = 5eV - 3eV = 2eV

The stopping potential equals the kinetic energy.

42. D: Change in mass, $\Delta m = 5.02 \times 10^{-27} \text{ kg} - 5.01 \times 10^{-27} \text{ kg} = 1 \times 10^{-29} \text{ kg}$
 $E = mc^2 = 1 \times 10^{-29} \times (3 \times 10^8)^2 = 9 \times 10^{-13} \text{ J}$

43. B: $E.m.f = \frac{N\Delta\phi}{\Delta t} = (200 \times 0.08)v = 16\text{V}$

44. B: $qV = hf$
 $v = \frac{hf}{q} = \left(\frac{6.63 \times 10^{-34} \times 1.6 \times 10^{16}}{1.6 \times 10^{-19}}\right) \text{ V} = 66.3 \text{ V}$

45. C: The fuse should be connected to the live wire.

46. B: $Z = \sqrt{R^2 + X_C^2} = \sqrt{30^2 + 40^2} = 50$
 $I = \frac{V}{Z} = \left(\frac{200}{50}\right) \text{ A} = 4 \text{ A}$

47. C: The end Q will become the north pole while P will become the south pole.

48. B: Gases conduct electricity under reduced pressure and high potential difference.

49. D: $I = \frac{\text{Power}}{\text{Voltage}} = \frac{3 \times 10^3 \text{ W}}{1.5 \times 10^3 \text{ V}} = 2 \text{ A}$
 Power loss = $I^2 R = 2^2 \times 20 = 80 \text{ W}$

50. C: $F = BIL \sin \theta$
 (F = Force, B = Magnetic flux density, I = current, L = Length, θ = angle made with the field)

For maximum force to act on the conductor, it must be perpendicular to the field i.e. θ must be 90°

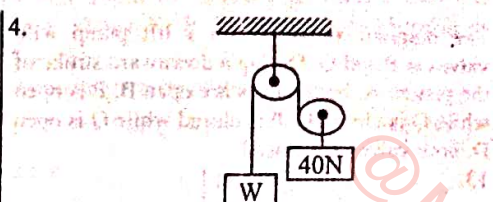
$$F = 0.5 \times 0.8 \times 2 \times \sin 90^\circ = 0.8 \text{ N}$$

1999 UME PHYSICS QUESTIONS

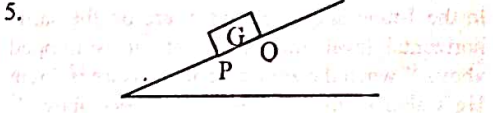
1. A car of mass 800 kg attains a speed of 25ms⁻¹ in 20 seconds. The power developed in the engine is A. 1.25 × 10⁴W B. 2.50 × 10⁴W C. 1.25 × 10⁶W D. 2.50 × 10⁶W

2. A lead bullet of mass 0.05 kg is fired with a velocity of 200 ms⁻¹ into a lead block of mass 0.95 kg. Given that the lead block can move freely, the final kinetic energy after impact is A. 50 J B. 100 J C. 150 J D. 200 J

3. A ball of mass 0.1 kg is thrown vertically upwards with a speed of 10ms⁻¹ from the top of a tower 10m high. Neglecting air resistance, its total energy just before hitting the ground is A. 5 J B. 10 J C. 15 J D. 20 J [g = 10 ms⁻²].

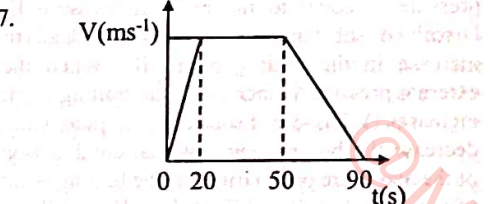


The figure above represents a frictionless pulley system in which a weight W is in equilibrium with a weight of 40 N. Find the value of W. A. 13.3 N B. 20.0 N C. 40.0 N D. 80.0 N.



The diagram above shows a solid figure with base, PQ and centre of gravity G on an inclined plane. Which of the following statements is correct? A. The solid will fall over if the vertical line through G lies outside the base B. The solid will fall over if the vertical line through G lies inside the base C. The solid will not fall over if the vertical line through G lies outside the base. D. The solid can never fall over.

6. Two bodies have masses in the ratio 3 : 1. They experience forces which impart to them accelerations in the ratio 2 : 9 respectively. Find the ratio of the forces the masses experience. A. 1:4 B. 2:1 C. 2:3 D. 2:5



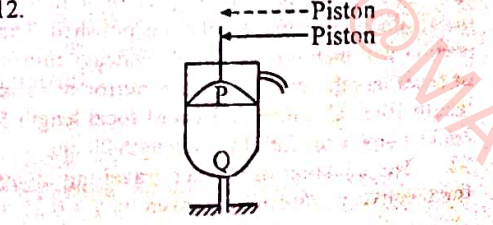
The diagram above shows the velocity-time graph of a vehicle. Its acceleration and retardation respectively are A. 8.0 ms⁻², 4.0 ms⁻² B. 4.0 ms⁻², 8.0 ms⁻² C. 4.0 ms⁻², 2.0 ms⁻² D. 2.0 ms⁻², 4.0 ms⁻².

8. A particle of mass 10-2 kg is fixed to the tip of a fan blade which rotates with angular velocity of 100 rads⁻¹. If the radius of the blade is 0.2m, the centripetal force is A. 2 N B. 20 N C. 200 N D. 400 N

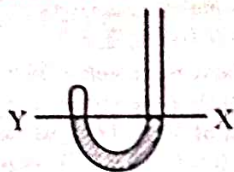
9. The inner diameter of a small test tube can be measured accurately using a A. micrometer screw guage B. pair of dividers C. metre rule D. pair of vernier calipers.

10. A gas at a volume V₀ in a container at pressure P is compressed to one fifth of its volume. What will be its pressure if it maintains its original temperature T? A. $\frac{P_0}{5}$ B. $\frac{4}{5} P_0$ C. P_0 D. $5P_0$

11. A piece of substance of specific heat capacity 450J kg⁻¹ K⁻¹ falls through a vertical distance of 20m from rest. Calculate the rise in temperature of the substance on hitting the ground when all its energies are converted into heat A. 2°C B. 4°C C. 9°C D. 2°C



The diagram above shows a lift pump with valves at P and Q. During a downward stroke of the piston, A. both valves are open B. P is open while Q is closed C. P is closed while Q is open D. both valves are closed.



In the J-tube above, Y and X are on the same horizontal level and 30cm^3 of air is trapped above Y when the atmospheric pressure is 75cm Hg . Calculate the volume of air trapped above Y when 15cm Hg is now poured into the limb above X. A. 15cm^3 B. 25cm^3 C. 35cm^3 D. 45cm^3 .

14. If the stress on a wire is 10^7Nm^2 and the wire is stretched from its original length of 10.00cm to 10.05cm . The Young's modulus of the wire is A. $5.0 \times 10^4\text{Nm}^2$ B. $5.0 \times 10^5\text{Nm}^2$ C. $2.0 \times 10^6\text{Nm}^2$ D. $2.0 \times 10^9\text{Nm}^2$

15. A solid weighs 10.0N in air, 6.0N when fully immersed in water and 7.0N when fully immersed in a certain liquid X. Calculate the relative density of the liquid. A. $\frac{5}{3}$ B. $\frac{4}{3}$ C. $\frac{3}{4}$ D. $\frac{7}{10}$

16. A liquid boils when its saturated vapour pressure is equal to the external pressure. Dissolved substances in pure water lead to increase in the boiling point. When the external pressure is increased, the boiling point increases. Dissolved substances in pure water decrease the boiling point. Which combination of the above are peculiarities of the boiling point of a liquid? A. I, II and III B. I, II, III and IV C. I, II and IV D. I, II and IV.

17. When the temperature of a liquid is increased, its surface tension A. decreases B. increases C. remains constant D. increases then decreases.

18. When the brakes in a car are applied, the frictional force on the tyres is A. a disadvantage because it is in the direction of motion of the car B. a disadvantage because it is in the opposite direction of motion of the car C. an advantage because it is in the direction of motion of the car D. an advantage because it is in the opposite direction of motion of the car.

19. The lowest note emitted by a stretched string has a frequency of 40Hz . How many overtones are there between 40Hz and 180Hz ? A. 4 B. 3 C. 2 D. 1

20. A man stands 4m in front of a plane mirror. If the mirror is moved 1m towards the man, the distance between him and his new image is A. 3m B. 5m C. 6m D. 10m

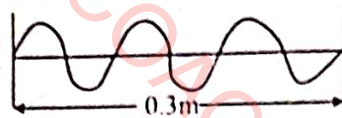
21. If a sound wave goes from a cold-air region to a hot-air region, its wavelength will A. increase B. decrease C. decrease then increase D. remain constant.

22. The inside portion of part of a hollow metal sphere of diameter 20cm is polished. The portion will therefore form a A. concave mirror of focal length 5cm B. concave mirror of focal length 10cm C. convex mirror of focal length 5cm D. convex mirror of focal length 20cm .

23. The equation of a wave travelling along the positive x-direction is given by $y = 0.25 \times 10^{-3} \sin(500t - 0.025x)$. Determine the angular frequency of the wave motion. A. $0.25 \times 10^{-3}\text{rads}^{-1}$ B. $0.25 \times 10^{-1}\text{rads}^{-1}$ C. $5.00 \times 10^2\text{rads}^{-1}$ D. $2.50 \times 10^1\text{rads}^{-1}$.

24. Calculate the mass of ice that would melt when 2kg of copper is quickly transferred from boiling water to a block of ice without heat loss. A. $\frac{8}{33}\text{kg}$ B. $\frac{33}{80}\text{kg}$ C. $\frac{80}{33}\text{kg}$ D. $\frac{33}{8}\text{kg}$ [Specific heat capacity of copper = $400\text{J kg}^{-1}\text{K}^{-1}$; Latent heat of fusion of ice = $3.3 \times 10^5\text{J kg}^{-1}$]

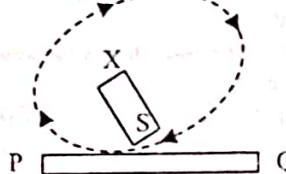
25. The diagram above represents a transverse electromagnetic wave travelling with speed $3.0 \times 10^8\text{ms}^{-1}$. What is the frequency of the wave? A. $3.0 \times 10^7\text{Hz}$ B. $9.0 \times 10^7\text{Hz}$ C. $1.0 \times 10^8\text{Hz}$ D. $3.0 \times 10^8\text{Hz}$



26. The temperature gradient across a copper rod of thickness 0.02m , maintained at two temperature junctions of 20°C and 80°C respectively is A. $3.0 \times 10^2\text{K m}^{-1}$ B. $3.0 \times 10^3\text{K m}^{-1}$ C. $5.0 \times 10^3\text{K m}^{-1}$ D. $3.0 \times 10^4\text{K m}^{-1}$.

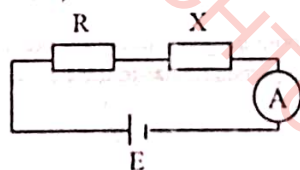
27. Which of the following electromagnetic waves is least energetic? A. Infra-red rays B. X-rays C. Ultraviolet rays D. Gamma rays.

28. The diagram above shows a magnet X with its South pole moved along a soft-iron bar PQ in the direction shown. After some time, the poles at P and Q respectively are A. North-North B. North-South C. South-North D. South-South



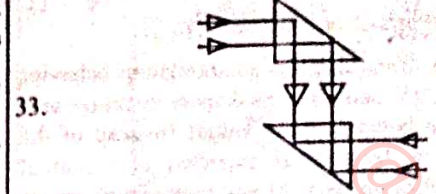
29. Four cells each of e.m.f. 1.5V and internal resistance of 4Ω are connected in parallel. What is the effective e.m.f. and internal resistance of the combination? A. 6.0V , 1Ω B. 6.0V , 1Ω C. 1.5V , 4Ω D. 1.5V , 1Ω

30. In the circuit above, the ammeter reads current of 5.0A when $R=8\Omega$ and reads 7.0A when $R=5\Omega$. The value of the unknown resistance X is A. 10.0Ω B. 7.5Ω C. 5.0Ω D. 2.5Ω



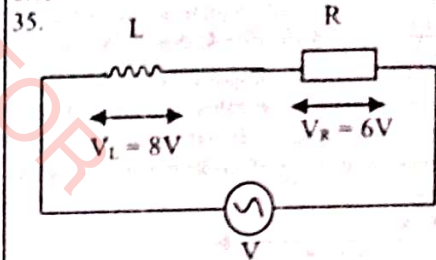
31. An astronomical telescope is said to be in normal adjustment when the A. eye is accommodated B. focal length of objective lens is longer than that of eye piece C. final image is at the near point of eye D. final image is at infinity.

32. Steel is more suitable for permanent magnet than iron because the former A. is easily demagnetized by shaking vigorously B. is an alloy of many metals C. is easily magnetized by alternating current through one cycle D. retains magnetism more than iron.



The diagram above shows the prism arrangement in a A. binocular B. spectrometer C. periscope D. projector.

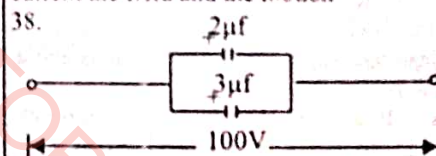
34. The velocities of light in air and glass are $3.0 \times 10^8\text{ms}^{-1}$ and $2.0 \times 10^8\text{ms}^{-1}$ respectively. If the angle of refraction is 30° , the sine of the angle of incidence is A. 0.33 B. 0.50 C. 0.67 D. 0.75



In the series circuit shown above, the p.d across the inductor is 8V_{rms} and that across the resistor is 6V_{rms} . The effective voltage is A. 2V B. 10V C. 14V D. 48V

36. The core of an efficient transformer should consist of laminated pieces of metal in order to A. increase the heat produced by increasing the eddy current B. increase the heat produced by reducing the eddy current C. reduce the heat produced by increasing the eddy current D. reduce the heat produced by reducing the eddy current.

37. In Fleming's right-hand rule the thumb the forefinger and the middle finger if held mutually at right angles represent respectively the A. motion, the field and the induced current B. induced current, the motion and the field C. field the induced current and the motion D. induced current the field and the motion

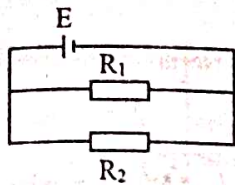


In the circuit above the potential across each capacitor is 100V . The total energy stored in the two capacitors is A. $3.0 \times 10^4\text{J}$ B. $3.0 \times 10^2\text{J}$ C. $2.5 \times 10^2\text{J}$ D. $6.0 \times 10^3\text{J}$

39. At what frequency would a 10H inductor have a reactance of 2000Ω ? A. $\frac{\pi}{200}\text{Hz}$ B. $\frac{100}{\pi}\text{Hz}$ C. $\frac{100}{\pi}\text{Hz}$ D. $100\pi\text{Hz}$

40. A 300W electric cooker is to be used on a 200V mains circuit. Which of the fuses below can be used safely with the cooker? A. 2A B. 5A C. 10A D. 20A

41. A galvanometer has a resistance of 5Ω . By using a shunt wire of resistance the galvanometer could be converted to an ammeter capable of reading 2A . What is the current through the galvanometer? A. 2mA B. 10mA C. 20mA D. 25mA



In the diagram above, if the internal resistance of the cell is zero, the ratio of the powers P_1 and P_2 dissipated by R_1 and R_2 respectively, is A. $\frac{R_2}{R_1}$ B.

$\frac{R_1}{R_2}$ C. $\frac{R_1 + R_2}{R_1}$ D. $\frac{R_1 + R_2}{R_2}$

43. If Δx is the uncertainty in the measurement of the position of a particle along the x-axis and ΔP_x is the uncertainty in the measurement of the linear momentum along the x-axis, then the uncertainty principle relation is given as A. $\Delta x \Delta P_x \geq h$ B. $\Delta x \Delta P_x = 0$ C. $\Delta x \Delta P_x < h$ D. $\Delta x \Delta P_x = \infty$

44. $\text{Na} + \text{Proton} \rightarrow \text{X} + \text{alpha particle}$. What are the values of p and q respectively in the equation above? A. 10 and 20 B. 12 and 24 C. 20 and 10 D. 24 and 12

45. A semi-conductor diode is used in rectifying alternating current into direct current mainly because it A. allows current to flow in either direction B. is non-linear C. offers a high input resistance D. allows current to flow only in one direction.

46. In semi-conductors, the carriers of current at room temperature are A. electrons only B. electrons and holes C. holes only D. electrons and ions.

47. What is the speed of a particle of mass 10^{-27} kg whose wavelength is 10^{-8} m? A. 6.63 ms^{-1} B. 66.30 ms^{-1} C. 663.00 ms^{-1} D. 6630.00 ms^{-1} [$h = 6.63 \times 10^{-34} \text{ Js}$]

48. In a series R-L-C circuit at resonance, the voltages across the resistor and the inductor are 30 V and 40 V respectively. What is the voltage across the capacitor? A. 30 V B. 40 V C. 50 V D. 70 V

49. Gamma rays are produced when A. high velocity electrons are abruptly stopped in metals B. energy changes occur within the nucleus of atoms C. energy changes occur 'within the electronic structure of atoms D. electrons are deflected in very strong magnetic fields.

50. In the Rutherford scattering experiment, a beam of alpha particles was fired at a thin gold film with some of the particles being considerably deflected. This shows that A. a gold nucleus contains protons, neutrons and electrons uniformly distributed in a tiny volume B. the gold nucleus is positively charged and is concentrated in a tiny volume C. the gold nucleus emitted alpha particles D. the gold nucleus is concentrated in a tiny volume and contains alpha particles.

1999 UME PHYSICS SOLUTION

1. B: Power = Force \times Velocity

$$a = \frac{\Delta v}{\Delta t} = \left(\frac{25}{20}\right) \text{ m/s}^2 = 1.25 \text{ m/s}^2$$

$$\text{Force} = \text{mass} \times \text{acceleration}$$

$$= (800 \times 1.25) \text{ N} = 1000 \text{ N}$$

$$\text{Power} = (1000 \times 25) \text{ W} = 25000 \text{ W} = 2.5 \times 10^4 \text{ W}$$

2. A: $m_1 u_1 = (m_1 + m_2) V$ (since the block was initially at rest)

$$0.05 \times 200 = (0.05 + 0.95) V$$

$$10 = V; V = 10 \text{ m/s}$$

$$\text{Total mass} = 0.95 \text{ kg} + 0.05 \text{ kg} = 1 \text{ kg}$$

$$\text{Final kinetic energy} = \frac{1}{2} m v^2 = \frac{1}{2} \times 1 \times 10^2 = 50 \text{ J}$$

3. C: KEY \Rightarrow We need to first calculate the height that the ball will finally attain. This should be added to the height of the tower to give the total distance from the ground. We may decide to use the distance so obtained to get the velocity of the ball when it reaches the ground. Alternatively, we may use the principle of conservation of mechanical energy: The potential energy (mgh) at the highest level equals the kinetic energy at the lowest level.

$$u = 10 \text{ m/s}, a = -10 \text{ m/s}^2, v = 0, s = ?$$

$$v^2 = u^2 + 2as; s = \frac{(v^2 - u^2)}{2a}$$

$$s = \frac{(v^2 - u^2)}{2a} = \frac{0^2 - 10^2}{2(-10)} = \left(\frac{-100}{-20}\right) \text{ m} = 5 \text{ m}$$

$$\text{Total distance} = 10 \text{ m} + 5 \text{ m} = 15 \text{ m}$$

$$P.E_{\text{max}} = K.E_{\text{max}} = mgh_{\text{max}} = (0.1 \times 10 \times 15) = 15 \text{ J}$$

4. D: Since the pulley is frictionless, its efficiency = 100%

$$\epsilon = \frac{M.A}{V.R} \times 100\%$$

$$\text{Since two pulleys are used, } V.R = 2$$

$$100\% = \frac{M.A}{V.R} \times 100\%; 100\% \times V.R = 100\% \times M.A$$

$$\text{Therefore, } M.A = V.R = 2$$

$$M.A = \frac{\text{Load}}{\text{Effort}}; 2 = \frac{\text{Load}}{40 \text{ N}}$$

$$\text{Load} = 2 \times 40 \text{ N} = 80 \text{ N}$$

5. A: The solid will fall over if the vertical line through G lies outside the base

6. C: Let the two bodies be X and Y. If the mass of X is taken as 3 units, that of Y will be 2 units. If the acceleration of X is 2 units, that of Y will be 9 units.

$$\text{Force} = \text{mass} \times \text{acceleration}$$

$$F_x = 3 \times 2 = 6 \text{ unit}; F_y = 1 \times 9 = 9 \text{ units}$$

$$\frac{F_x}{F_y} = \frac{6}{9} = \frac{2}{3}$$

$$7. \text{ C: } a = \frac{80-0}{20-0} = 4 \text{ ms}^{-2}$$

$$\text{Deceleration} = \frac{20-0}{90-50} = 2 \text{ ms}^{-2}$$

$$8. \text{ B: } V = rw = (0.2 \times 100) \text{ m/s} = 20 \text{ m/s}$$

$$m = 10^{-2} \text{ kg}$$

$$F = \frac{mv^2}{r} = \frac{10^{-2} \times 20^2}{0.2} = 20 \text{ N}$$

9. D: A vernier caliper is used to measure the internal and external diameter of a test tube. A micrometer screw gauge is suitable for measuring smaller distances such as the thickness of a piece of paper, the diameter of a thin rod etc.

$$10. \text{ D: } V_1 = \frac{V_0}{5}$$

$$P_1 V_0 = P_1 V_1 = P_1 \frac{V_0}{5}$$

$$P_1 V_0 = \frac{P_1 V_0}{5}; P_1 = \frac{5 \times P_0 \times V_0}{V_0} = 5 P_0$$

$$11. \text{ B: } mc\Delta\theta = mgh \text{ (} h = 20 \text{ m, } c = 450 \text{ J/kg}^\circ\text{K}^{-1}\text{)}$$

$$\Delta\theta = \frac{mgh}{mc} = \frac{gh}{c} = \frac{10 \times 20}{450} = \frac{200}{450} = \frac{4}{9}^\circ\text{C}$$

12. C: Valve P closes while Q opens.

$$13. \text{ B: } P_1 = 75 \text{ cmHg, } V_1 = 30 \text{ cm}^3$$

When 15 cm of mercury is poured into the limb above X, $P_2 = 75 \text{ cmHg} + 15 \text{ cmHg} = 90 \text{ cmHg}$

At constant temperature,

$$P_1 V_1 = P_2 V_2; V_2 = \frac{P_1 V_1}{P_2} = \left(\frac{75 \times 30}{90}\right) \text{ cm}^3 = 25 \text{ cm}^3$$

$$14. \text{ D: } Y = \frac{Fl}{Ae} = \frac{\text{Tensile Stress}}{\text{Tensile Strain}}$$

$$\text{Tensile stress} = 10^7 \text{ Nm}^{-2}$$

$$\text{Tensile strain} = \frac{e}{L} = \frac{10.05 \text{ cm} - 10 \text{ cm}}{10 \text{ cm}} = \frac{0.05 \text{ cm}}{10 \text{ cm}} = 0.005$$

$$Y = \frac{10^7}{0.005} = 2 \times 10^9 \text{ Nm}^{-2}$$

15. C: R.D. of a liquid =

$$\frac{\text{weight in air} - \text{weight in liquid}}{\text{weight in air} - \text{weight in water}}$$

$$= \frac{10 \text{ N} - 7 \text{ N}}{10 \text{ N} - 6 \text{ N}} = \frac{3}{4}$$

16. A: Boiling occurs when the saturated vapour pressure equals the external pressure.

Impurities decrease the melting point of a solid but increase the boiling point of a liquid. Increase in pressure causes an increase in boiling point but a decrease a melting point.

17. A: Increase in temperature causes a decrease in surface tension.

18. D: The frictional force acts in a direction opposite to that of motion. This is an advantage because it enables the brake to stop the motion of a moving car.

19. B: The harmonics recorded for a stretched string are $f_0, 2f_0, 3f_0, 4f_0$ (f_0 is the fundamental frequency). If $f_0 = 40 \text{ Hz}$, the second harmonic (or the first overtone) = $2 \times 40 \text{ Hz} = 80 \text{ Hz}$, the third harmonic (or the second overtone) = $3 \times 40 \text{ Hz} = 120 \text{ Hz}$, the fourth harmonic (or the third overtone) = $4 \times 40 \text{ Hz} = 160 \text{ Hz}$, the fifth harmonic (or the fourth overtone) = $5 \times 40 \text{ Hz} = 200 \text{ Hz}$. Note that there are only 4 harmonics (3 overtones) between 40 Hz and 180 Hz because the fifth harmonic (the fourth overtone) is 200 Hz, which is already more than 180 Hz.

20. C: If the mirror is moved 1 m towards the man, the distance between the man and the mirror = $4 \text{ m} - 1 \text{ m} = 3 \text{ m}$. In a plane mirror, the distance of the image (at the back) equals to that of the object at the front. The man is 3 m at the front of the mirror, the image must be at a point which is 3 m at the back of the mirror. Thus, the distance between the man and his image = $3 \text{ m} + 3 \text{ m} = 6 \text{ m}$

21. A: Since the velocity of a sound wave varies directly as the square root of the absolute temperature ($v \propto \sqrt{\theta}$); and the wavelength and velocity also vary directly as each other ($V = F\lambda$); it can be easily deduced that the wavelength will also increase as temperature increases.

$$22. \text{ A: } f = \frac{v}{\lambda} = \frac{D}{4} = \frac{20 \text{ cm}}{4} = 5 \text{ cm}$$

When the inside is polished, it means the outside is coated, such is the fate of a concave mirror!!!

$$23. \text{ C: } y = A \sin \left(2\pi ft - \frac{2\pi x}{\lambda} \right)$$

$$\text{Given: } 0.25 \times 10^{-3} \sin(500t - 0.025x)$$

When the two are compared, we have

$$2\pi f = 500t$$

$$2\pi f = 500$$

But the angular frequency, $\omega = 2\pi f$; thus, $\omega = 500 \text{ rads}^{-1} = 5 \times 10^2 \text{ rads}^{-1}$

$$24. \text{ A: } m_c c_c \Delta\theta_c = m_{ic} L_f$$

$$2 \times 400 \times (100 - 0) = m_{ice} \times 3.3 \times 10^5$$

$$m_{ice} = \left(\frac{2 \times 400 \times 100}{3.3 \times 10^5} \right) \text{kg} = 0.242 \text{kg} = \frac{8}{33} \text{kg}$$

25. D: Since three complete waves are involved, the distance 0.3m represent three wavelengths.

Thus,

$$\lambda = \frac{0.3 \text{m}}{3} = 0.1 \text{m}$$

$$V = 3 \times 10^8 \text{m/s}$$

$$f = \frac{V}{\lambda} = \left(\frac{3 \times 10^8}{0.1} \right) \text{Hz} = 3 \times 10^9 \text{Hz}$$

$$26. \text{ B: Temperature gradient} = \frac{\Delta\theta}{\Delta l} =$$

$$\left(\frac{80-20}{0.02} \right) \text{km}^{-1}$$

$$= 3000 \text{km}^{-1}$$

$$27. \text{ A: } \xrightarrow{\text{RIVUXG}}$$

Increasing frequency; increasing energy
Thus, of the given electromagnetic waves, infra-red rays will be the least energy.

28. B: The end P will become the north pole while the end Q will become the south pole.

29. D: When similar cells are connected in parallel, the equivalent emf is just that of one of them. Thus, the overall emf = 1.5V.

The internal resistance, r is given by:

$$\frac{1}{r} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \frac{1}{r_4} \dots$$

$$= \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} = \frac{1+1+1+1}{4} = \frac{4}{4} = 1$$

Thus, $r = 1\Omega$

$$30. \text{ D: } V = IR, I = \frac{V}{R}$$

$$5 = \frac{E}{8+x}; 7 = \frac{E}{5+x}$$

Thus, we have:

$$5(8+x) = 7(5+x); 40 = 5x + 35 + 7x$$

$$40 - 35 = 7x - 5x; 2x = 5; x = 2.5\Omega$$

31. D: The final image of an astronomical telescope is at infinity.

32. D: Iron is more easily magnetized than steel.

Steel, however, retains its magnetism more than iron.

This is why iron is used for making temporary magnets while steel is used for making permanent magnets.

33. C: This is the arrangement in a periscope. A periscope is a device used for seeing above obstacles.

$$34. \text{ D: } n_g = \frac{\text{Velocity of light in air}}{\text{Velocity of light in glass}} = \frac{\sin i^\circ}{\sin r^\circ}$$

Then,

$$\frac{3 \times 10^8}{2 \times 10^8} = \frac{\sin i^\circ}{\sin 30^\circ}$$

$$\sin i^\circ = \frac{3 \times 10^8 \times \sin 30^\circ}{2 \times 10^8} = 0.75$$

$$35. \text{ B: } V^2 = V_R^2 + V_L^2; V = \sqrt{6^2 + 8^2} = 10$$

$$V = \sqrt{100} = 10 \text{V}_{\text{r.m.s}}$$

36. D: This is to reduce the heat produced by reducing the eddy current.

37. A: The thumb points in the direction of motion, the forefinger points in the direction

of the field while the middle finger points in the direction of the induced current or emf.

$$38. \text{ C: } C_T = 2\mu\text{F} + 3\mu\text{F} = 5 \times 10^{-6}\text{F}$$

$$\text{Total energy} = \frac{1}{2} C_T V^2$$

$$= \frac{1}{2} \times 5 \times 10^{-6} \times 100^2$$

$$= 2.5 \times 10^{-2}\text{J}$$

$$39. \text{ C: } X_L = 2\pi fL$$

$$2000 = 2 \times \pi \times f \times 10$$

$$f = \frac{2000}{2 \times 10 \times \pi} = \frac{100}{\pi} \text{Hz}$$

$$40. \text{ D: } I = \frac{\text{Power}}{\text{Voltage}}$$

$$= \frac{3000}{200} = 15\text{A}$$

$$41. \text{ C: } R_s = \frac{I_g \times R_g}{I_T - I_g} = \frac{I_g \times 5}{2 - I_g}$$

$$R_s = 0.05\Omega$$

$$0.05 = \frac{5I_g}{2 - I_g}$$

$$0.05(2 - I_g) = 5I_g; 0.1 - 0.05I_g = 5I_g$$

$$5.05I_g = 0.1, I_g = \left(\frac{0.1}{5.05} \right) \text{A} = 0.0198\text{A}$$

$$= 0.02\text{A}$$

$$= 20\text{mA}$$

$$42. \text{ A: } P_1 = I_1^2 R_1; P_2 = I_2^2 R_2$$

But the current through the two are not the same, we need to find a way around this.

Recall that $V = IR$. Here, $V = E$.

$$\text{So, } E_1 = I_1 R_1, I_1 = \frac{E_1}{R_1}. \text{ Similarly } I_2 = \frac{E_2}{R_2}$$

Then,

$$P_1 = \left(\frac{E_1}{R_1} \right)^2 \quad R_1 = \frac{E_1^2}{P_1}$$

$$R_1 = \frac{E_1^2}{P_1}$$

Similarly, P_2 will give $\frac{E_2^2}{R_2}$

$$\frac{P_1}{P_2} = \frac{E_1^2}{R_1} \div \frac{E_2^2}{R_2} = \frac{E_1^2}{R_1} \times \frac{R_2}{E_2^2}$$

Note again that $E_1 = E_2 = E$. Then, we have:

$$\frac{E^2}{R_1} \times \frac{R_2}{E^2} = \frac{R_2}{R_1}$$

$$43. \text{ A: } \Delta p \cdot \Delta x \geq h \text{ OR } \Delta E \cdot \Delta t \geq h$$

(Heisenberg's uncertainty principle)

$$44. \text{ C: } {}_{11}^{23}\text{N} + {}_1^1\text{p} \rightarrow {}_{10}^{20}\text{X} + {}_2^4\text{He}$$

45. D: A diode is used in rectifying alternating current into direct current because it allows current to flow only in one direction.

46. B: The carriers of current in semiconductors are holes and electrons.

$$47. \text{ B: } \lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{10^{-27} \times v}$$

$$v = \frac{6.63 \times 10^{-34}}{10^{-27} \times \lambda} = \frac{6.63 \times 10^{-34}}{10^{-27} \times 10^{-8}} = 66.3 \text{m/s}$$

$$48. \text{ B: At resonance, } V_c = V_L \text{ and } X_c = X_L$$

Thus, if $V_L = 40\text{V}$, $V_c = 40\text{V}$

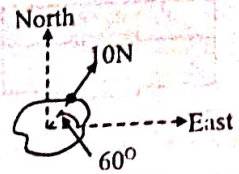
49. B: Gamma rays are produced when energy changes occur within the nucleus of atoms. For X-rays, the changes occur in the electronic structure of atoms.

50. B: It implies that the nucleus (of any atoms, not only gold) is positively charged and is concentrated in a tiny volume.

1998 UME PHYSICS QUESTIONS

1. The physical quantity that has the same dimensions as impulse is A. energy B. momentum C. surface tension D. pressure.

2. A ball is moving at 18ms^{-1} in a direction inclined at 60° to the horizontal. The horizontal component of its velocity is A. $9\sqrt{3}\text{ms}^{-1}$ B. $6\sqrt{3}\text{ms}^{-1}$ C. $6\sqrt{2}\text{ms}^{-1}$ D. 9ms^{-1}



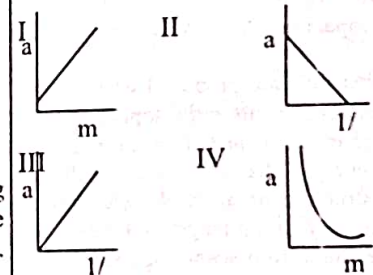
A body on the ground is acted on by a force of 10N at a point P as shown in the diagram above. What force is needed to stop the body from moving eastward? A. 5N in the direction of East B. 5N in the direction of West C. $5\sqrt{3}\text{N}$ in the direction of West D. 10N in the Southwest direction

4. In free fall, a body of mass 1kg drops from a height of 125m from rest in 5s. How long will it take another body of mass 2kg to fall from rest from the same height? A. 5s B. 10s C. 12s D. 15s [$g = 10\text{ms}^{-2}$]

5. A ball of mass 0.15kg is kicked against a rigid vertical wall with a horizontal velocity of 50ms^{-1} . If it rebounded with a horizontal velocity of 30ms^{-1} , calculate the impulse of the ball on the wall. A. 3.00s B. 4.5Ns C. 7.5Ns D. 12.0Ns

6. The force of attraction between two point masses is 10^{-4}N when the distance between them is 0.18m. If the distance is reduced to 0.06m, calculate the force. A. $1.1 \times 10^{-5}\text{N}$ B. $3.3 \times 10^{-5}\text{N}$ C. $3.0 \times 10^{-4}\text{N}$ D. $9.0 \times 10^{-4}\text{N}$

7. In an experiment, a constant force is applied to several masses (m) and the corresponding accelerations (a) are measured. Which of the following graphs correctly represents the experiment?



A. III and IV only B. II and IV only C. I and III only D. I and II only

8. A uniform metre rule weighing 0.5N is to be pivoted on a knife-edge at the 30cm-mark. Where will a force of 2N be placed from the pivot to balance the metre rule? A. 95cm B. 25cm C. 20cm D. 5cm

9. A bullet fired at a wooden block of thickness 0.15m manages to penetrate the block. If the mass of the bullet is 0.025kg and the average resisting force of the wood is $7.5 \times 10^3\text{N}$, calculate the speed of the bullet just before it hits the wooden block. A. 450ms^{-1} B. 400ms^{-1} C. 300ms^{-1} D. 250ms^{-1}

10. A man whose mass is 80kg climbs a staircase in 20s and expends a power of 120W. Find the height of the staircase. A. 1.8m B. 2.0m C. 2.5m D. 3.0m [$g = 10\text{ms}^{-2}$]

11. A parachute attains a terminal velocity when A. its density is equal to the density of air B. the viscous force of the air and the

upthrust completely counteract its weight C. it expands as a result of reduced external pressure D. the viscous force of the air is equal to the sum of the weight and upthrust.

12. In a wheel and axle mechanism, the diameters of the wheel and axle are 40cm and 8cm respectively. Given that the machine is 80% efficient, what effort is required to lift a load of 100N? A. 20N B. 25N C. 50N D. 80N

13. The tendon in a man's leg is 0.01 m long. If a force of 5N stretches the tendon by 2.0×10^{-5} m, calculate the strain on the muscle. A. 5×10^6 B. 5×10^2 C. 2×10^3 D. 2×10^{-7}

14. Which of these statements are correct for the pressures in liquids? I. Pressure in a liquid at a point acts equally in all directions II. Pressure increases with depth III. Pressure at a depth depends on the shape of the container. IV. Pressure at the same depth in different liquids are proportional to the densities of the liquids. A. I, II and III only B. I, II and IV only C. I, III and IV only D. II, III and IV only

15. The atmospheric pressure due to water is $1.3 \times 10^6 \text{ Nm}^{-2}$. What is the total pressure at the bottom of an ocean 10m deep? A. $1.3 \times 10^7 \text{ Nm}^{-2}$ B. $1.4 \times 10^6 \text{ Nm}^{-2}$ C. $1.4 \times 10^5 \text{ Nm}^{-2}$ D. $1.0 \times 10^5 \text{ Nm}^{-2}$ [Density of water = 1000 kgm^{-3} , $g = 10 \text{ ms}^{-2}$]

16. A solid of weight 0.600N is totally immersed in oil and water respectively. If the upthrust in oil is 0.210N and the relative density of oil is 0.875 find the upthrust in water. A. 0.600N B. 0.360N C. 0.240N D. 0.180N

17. A platinum resistance thermometer records 3.0Ω at 0°C and 8.0Ω at 100°C . If it records 6.0Ω in a certain environment, the temperature of the medium is A. 80°C B. 60°C C. 50°C D. 30°C

18. The linear expansivity of brass is $2 \times 10^{-5} \text{ }^\circ \text{C}^{-1}$. If the volume of a piece of brass is 15.00 cm^3 at 0°C , what is the volume at 100°C ? A. 16.03 cm^3 B. 16.00 cm^3 C. 15.09 cm^3 D. 15.03 cm^3

19. A gas has a volume of 100 cm^3 at 27°C . If it is heated to temperature T until a final volume of 120 cm^3 is attained, calculate T. A. 33°C B. 60°C C. 87°C D. 114°C

20. A 500W heater is used to heat 0.6kg of water from 25°C to 100°C in t_1 seconds. If another 1000W heater is used to heat 0.2kg of water from 10°C to 100°C in t_2 seconds, find $\frac{t_1}{t_2}$. A. 50 B. 5 C. $\frac{5}{4}$ D. $\frac{1}{5}$

21. How many grams of water at 17°C must be added to 42g of ice at 0°C to melt the ice completely? A. 200g B. 300g C. 320g D. 400g [Specific latent heat of fusion of ice = $3.4 \times 10^5 \text{ Jkg}^{-1}$, Specific heat capacity of water = $4200 \text{ Jkg}^{-1} \text{ K}^{-1}$].

22. A vapour is said to be saturated when A. more molecules return to the liquid than the amount that left it B. a dynamic equilibrium exists between the molecules of the liquid and the vapour molecules at a given temperature C. the vapour pressure is equal to the

atmospheric pressure D. all molecules are moving with the same speed in all directions at a given temperature

23. One valid assumption of the kinetic theory of gases is that A. the molecules of a gas and constantly in state of motion and the number of collisions remain constant B. the number of molecules of gas increases with increasing pressure C. as the temperature increases, the number of collisions made by the gas molecules remain constant D. the molecules of gas are all identical and are very small in size.

24. The physical properties of sound waves can best be described by A. reflection and diffraction B. polarization and reflection C. polarization and diffraction D. polarization and refraction

25. The velocity of a sound wave at 27°C is 360 ms^{-1} . Its velocity at 127°C is A. $120\sqrt{3} \text{ ms}^{-1}$ B. 240 ms^{-1} C. $240\sqrt{3} \text{ ms}^{-1}$ D. $720\sqrt{3} \text{ ms}^{-1}$

26. In a closed organ pipe producing a musical note, an antinode will always be produced at A. the closed end B. the open end C. the middle D. all the parts of the pipe.

27. A steel wire of length 0.50m is stretched between two fixed points and its fundamental frequency is 200Hz. The speed of the wave in the wire is A. 100 ms^{-1} B. 120 ms^{-1} C. 200 ms^{-1} D. 250 ms^{-1}

28. In a resonance tube experiment, if the fundamental frequency of the vibrating air column is 280Hz, the frequency of the third overtone is A. 70Hz B. 840Hz C. 1120Hz D. 1960Hz.

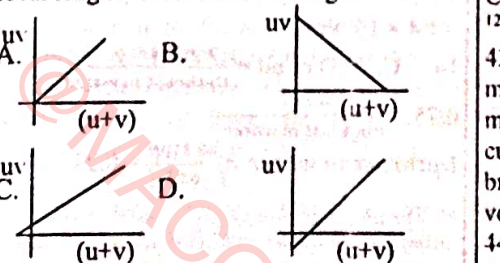
29. An object O lies at a distance m in front of concave mirror of focal length f. If $m < f$, then the final image obtained will be A. virtual and diminished B. magnified and erect C. real and inverted D. diminished and erect.

30. An object is placed in front of two plane mirrors inclined at an angle of 90° . If the total number of images formed is 7, find the value of θ . A. 30° B. 45° C. 51° D. 90°

31. The most suitable type of mirror used for the construction of a searchlight is the A. concave mirror B. convex mirror C. spherical mirror D. parabolic mirror

32. The displacement d produced in a glass block of thickness t and refractive index n when an object is viewed through it is A. $t - n$ B. $t(1 + \frac{1}{n})$ C. $t(1 - \frac{1}{n})$ D. $t(\frac{1}{n} - 1)$

33. The correct shape of the graph of uv against $(u + v)$ for an object distance u and image distance v in an experiment to find the focal length of a convex lens is given as



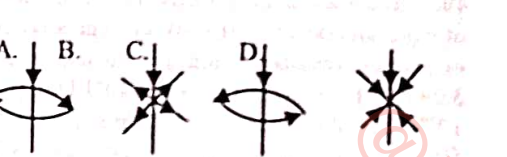
34. A man wears convex lens glasses of focal length 30cm in order to correct his eye defect. Instead of the optimum 25cm, his least distance of distinct vision is A. 14cm B. 28cm C. 75cm D. 150cm.

35. Which of the following are true about infra-red radiation? I. It is invisible II. It is called heat ray III. Its frequency is higher than that of blue light IV. It travels as a transverse wave. A. I, II, III and IV B. I, II and IV only C. I, III and IV only D. II, III and IV only.

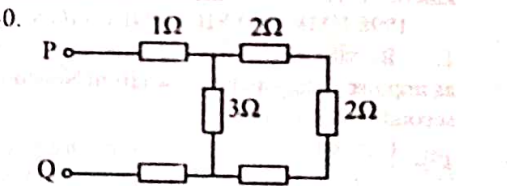
36. The force of repulsion between two point positive charges $5 \mu\text{C}$ and $8 \mu\text{C}$ separated at a distance of 0.02m apart is A. $1.8 \times 10^{-10} \text{ N}$ B. $9.0 \times 10^{-8} \text{ N}$ C. $9.0 \times 10^2 \text{ N}$ D. $4.5 \times 10^3 \text{ N}$ [$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 \text{ C}^{-2}$]

37. An ebonite rod rubbed with fur attracts a glass rod rubbed with silk because A. ebonite has a negative charge while glass has a positive charge B. ebonite has a positive charge while glass has a negative charge C. both have negative charges D. both have positive charges.

38. Which of the following diagrams shows the correct direction of the magnetic lines of force of a vertical wire XY carrying a current I?



39. Which of the following can be used to reduce local action in a Leclanche cell? A. A carbon rod as the positive pole B. Pure zinc as the negative pole C. Potassium permanganate solution in contact with the positive pole D. Common salt solution.



The total resistance measured at PQ in the diagram above is A. 18.0Ω B. 11.0Ω C. 4.0Ω D. 2.0Ω

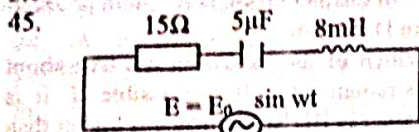
41. Find the work done in moving a 2 C charge between two points X and Y in an electric field if the potential difference is 100 volts. A. 50J B. 100J C. 200J D. 400J

42. A parallel plate capacitor has a common plate area of $5 \times 10^{-6} \text{ m}^2$ and plate separation of $2 \times 10^{-3} \text{ m}$. Assuming free space, what is the capacitance? A. $2.25 \times 10^{-17} \text{ F}$ B. $4.50 \times 10^{-17} \text{ F}$ C. $2.25 \times 10^{-16} \text{ F}$ D. $4.50 \times 10^{-16} \text{ F}$ [$\epsilon_0 = 9.0 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$]

43. The iron core of an induction coil is made from bundles of wires so as to A. minimize eddy-currents B. generate eddy-current C. prevent sparking at the contact breaker D. get the greatest possible secondary voltage.

44. Electricity is supplied to a school along a cable of total resistance 0.5Ω with the

maximum current drawn from the mains as 100A. The maximum energy dissipated as heat for 1 hr is A. 3.6×10^3 J B. 5.0×10^3 J C. 3.0×10^3 J D. 1.8×10^3 J



In the a.c. circuit diagram above, the resonance frequency is A. 5000π Hz B. 2500π Hz C. $\frac{5000}{\pi}$ Hz D. $\frac{2500}{\pi}$ Hz

46. A transformer which can produce 8V from a 240V a.c. supply, has an efficiency of 80%. If the current in the secondary coil is 15A, calculate the current in the primary coil. A. 0.625A B. 1.600A C. 2.500A D. 6.250A

47. The electrochemical equivalent of a metal is 1.3×10^{-7} kg C⁻¹. The mass of the metal which 2.0×10^4 C of electricity will deposit from a suitable electrolyte is A. 6.5×10^{-2} kg B. 2.6×10^{-2} kg C. 6.5×10^{-3} kg D. 2.6×10^{-3} kg

48. A radioactive substance has a half-life of 80 days. If the initial number of atoms in the sample is 6.00×10^{10} , how many atoms would remain at the end of 320 days? A. 3.75×10^9 B. 7.50×10^9 C. 3.00×10^{10} D. 5.63×10^{10}

49. In a nuclear fusion experiment, the loss of mass amounts to 1.0×10^{-6} kg. The amount of energy obtained from the fusion is A. 3.0×10^4 J B. 3.0×10^{-1} J C. 9.0×10^4 J D. 9.0×10^{10} J [Speed of light = 3.0×10^8 m s⁻¹]

50. In photoelectric effect, electrons will leave the metal surface when illuminated by light of appropriate frequency if the photon energy is A. greater than the work function B. less than the work function C. equal to the work function D. equal to the maximum kinetic energy of the electrons.

1998 UME PHYSICS SOLUTION

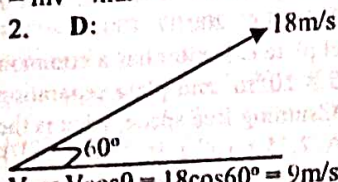
1. B: Momentum has the same dimension as impulse. This can be shown from Newton's second law of motion

$$F = \frac{(v - u)}{t}$$

$$Ft = m(v - u)$$

Impulse, which is the product of force and time = Ft while momentum which is the product of mass and velocity will be mu or mv. Change in momentum = mv - mu.

2. D:



$$V_x = V \cos \theta = 18 \cos 60^\circ = 9 \text{ m/s}$$

3. B: Horizontal (eastward) force = $10 \text{ cm} \cdot 60^\circ = 5 \text{ N}$

To stop the body from moving eastward, a force of 5N must therefore be applied in the westward (opposite) direction.

4. A: Neglecting air resistance, two objects released from the same point at the same time will get to the ground at the same time.

5. D: Impulse = Ft = m(v - u)

If $u = +50$ m/s, $v = -30$ m/s (v is negative) because an object that rebounds will move in a direction opposite to the original direction.

Then,

Impulse = $0.15(-30 - 50) = 0.15 \times -80 = -12 \text{ Ns}$ (the negative sign only shows the direction)

6. D: $F = \frac{Gm_1m_2}{r^2}$ Then, $F \propto \frac{1}{r^2}$

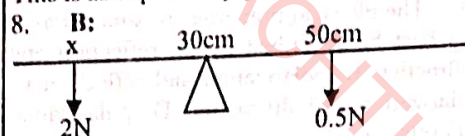
$$F_1 r_1^2 = F_2 r_2^2$$

$$F_2 = \frac{F_1 r_1^2}{r_2^2} = \frac{10^{-4} \times 0.10^2}{0.06^2} = 9 \times 10^{-4} \text{ N}$$

7. A: $F = ma$

$$a = \frac{F}{m} \text{ i.e. } a \propto \frac{1}{m}$$

This is as depicted by graphs III and IV



$$0.5(80 - 30) = 2(30 - x); 60 - 2x = 10$$

$$-2x = 10 - 60 = -50; x = \frac{-50}{-2} = 25 \text{ cm}$$

9. C: $F = -7.5 \times 10^3 \text{ N}$

$$F = ma = \frac{7.5 \times 10^3}{0.025} = -3 \times 10^5 \text{ m/s}^2$$

$$V = 0, u = ? a = -3 \times 10^5 \text{ m/s}^2, s = 0.15 \text{ m}$$

$$V^2 = u^2 + 2as$$

$$0^2 = u^2 + 2(-3 \times 10^5) \times 0.15$$

$$0 = u^2 - 90000$$

$$u^2 = 90000; u = \sqrt{90000} = 300 \text{ m/s}$$

10. D: Power = $\frac{mgh}{t}$; $120 = \frac{80 \times 10 \times h}{20}$

$$h = \frac{120 \times 20}{80 \times 10} \Rightarrow 3 \text{ m}$$

11. B: The terminal velocity is attained when the retarding force (upthrust and viscous force) equals the weight

$$V + U = mg \text{ (} V = \text{viscous force, } U = \text{upthrust)}$$

12. B: V.R of wheel and axle =

Radius of wheel

Radius of axle

Diameter of wheel

Diameter of axle

$$= \frac{8 \text{ cm}}{40 \text{ cm}} = 5$$

$$E = \frac{M.A}{V.R} \times 100\%; M.A = \frac{80\% \times 5}{100\%} = 4$$

M.A = $\frac{\text{Load}}{\text{Effort}}$

$$4 = \frac{100}{\text{Effort}}; \text{Effort} = \frac{100 \text{ N}}{4} = 25 \text{ N}$$

13. C: Tensile strain = $\frac{e}{L} = \frac{2 \times 10^{-5} \text{ m}}{0.01 \text{ m}} = 2 \times 10^{-3}$

14. B: Pressure in a liquid at a point acts equally in all directions.

Pressure increases with depth ($p = h\rho g$).

It does not depend on the shape of the container.

Pressure increases as density increases.

15. B: $P_{\text{total}} = P_{\text{water}} + P_{\text{atmosphere}}$

$$= h\rho g + 1.3 \times 10^6$$

$$= [(10 \times 1000 \times 10) + 1.3 \times 10^6] \text{ Nm}^{-2}$$

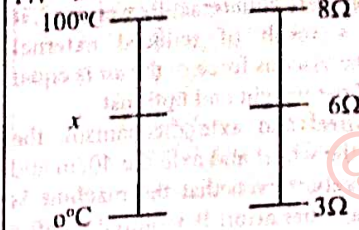
$$= 1.4 \times 10^6 \text{ Nm}^{-2}$$

16. C: R D of oil = $\frac{\text{upthrust in oil}}{\text{upthrust in water}}$

$$0.75 = \frac{0.21 \text{ N}}{\text{upthrust in water}}$$

$$\text{upthrust in water} = \frac{0.210 \text{ N}}{0.75} = 0.24$$

17. B:



$$\frac{100 - 0}{x - 0} = \frac{8 - 3}{6 - 3}; \frac{100}{x} = \frac{5}{3}; x = \left(\frac{3 \times 100}{5}\right)^\circ \text{C} = 60^\circ \text{C}$$

18. C: $V_2 = V_1(3\alpha\Delta\theta + 1)$

$$= 15(3 \times 2 \times 10^{-5} \times 100 + 1)$$

$$= 15(1.006) = 15.09 \text{ cm}^3$$

19. C: $V_1 = 100 \text{ cm}^3, T_1 = 27^\circ \text{C} = (27 + 273) \text{ K} = 300 \text{ K}$

$$V_2 = 120 \text{ cm}^3, T_2 = ?$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}; T_2 = \frac{V_2 T_1}{V_1} = \left(\frac{120 \times 300}{100}\right) \text{ K} = 360 \text{ K}$$

$$T(^\circ \text{C}) = (360 - 273)^\circ \text{C} = 87^\circ \text{C}$$

20. B: $P \times t = mc\Delta\theta$

$$500 \times t_1 = 0.6 \times c \times (100 - 25)$$

$$500 t_1 = 45c$$

$$t_1 = \frac{45c}{500}$$

Also, for the second heater

$$P \times t = mc\Delta\theta$$

$$1000 \times t_2 = 0.2 \times c \times (100 - 10)$$

$$1000 t_2 = 18c$$

$$t_2 = \frac{18c}{1000}$$

$$\frac{t_1}{t_2} = \frac{45c}{500} \div \frac{18c}{1000}$$

$$= \frac{45c}{500} \times \frac{1000}{18c}$$

$$= \frac{45 \times 1000}{500 \times 18} = 5$$

21. A: KEY \Rightarrow The ice will melt by gaining heat from the warm water. The heat gained by the ice must be equal to the heat lost by water

$$m_{\text{ice}} L_f = m_{\text{water}} c_{\text{water}} \Delta\theta_{\text{water}}$$

$$0.042 \times 3.4 \times 10^5 = m_{\text{water}} \times 4200 \times 17$$

$$m_w = \left(\frac{0.042 \times 3.4 \times 10^5}{4200 \times 17}\right) \text{ kg} = 0.2 \text{ kg}$$

$$= (0.2 \times 1000) \text{ g} = 200 \text{ g}$$

22. B: The vapour is said to be saturated when a dynamic equilibrium exists between the molecules of the liquid and the vapour molecules. In other words, the vapour is saturated, when the amount of water evaporated equals to that condensing at a given temperature.

23. D: Note that the actual volume occupied by the molecules of a gas is negligible when compared with the volume of the container.

24. A: Sound wave does not undergo polarization because it is a longitudinal wave. Polarization is an exclusive property of transverse waves.

25. C: $V_1 = 360 \text{ m/s}, T_1 = 27^\circ \text{C} = 300 \text{ K}$

$$V_2 = ? T_2 = 127^\circ \text{C} = 400 \text{ K}$$

$$V \propto \sqrt{T}, V = K\sqrt{T}$$

$$K = \frac{v}{\sqrt{T}} \text{ i.e. } \frac{v_1}{\sqrt{T_1}} = \frac{v_2}{\sqrt{T_2}}$$

$$V_2 = \frac{v_1 \sqrt{T_2}}{\sqrt{T_1}} = \frac{360 \times \sqrt{400}}{\sqrt{300}} = \frac{360 \times \sqrt{4}}{\sqrt{3}}$$

$$= \frac{360 \times 2}{\sqrt{3}} = \frac{720}{\sqrt{3}}$$

$$= \frac{720}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}}$$

$$= \frac{720 \sqrt{3}}{\sqrt{3}}$$

$$= \frac{720\sqrt{3}}{3} = 240\sqrt{3}$$

26. **B:** An antinode will be produced at the open end while a node will be produced at the closed end.

27. **C:** $F = \frac{v}{2l}$

$$v = F \times 2l = 200 \times 2 \times 0.5 = 200 \text{ m/s}$$

28. **D:** For a resonance tube

F_0 = fundamental frequency (first harmonic)

$3f_0$ = second harmonic or first overtone

$5f_0$ = third harmonic or second overtone

$7f_0$ = fourth harmonic or third overtone

Thus,

$$\text{Third overtone} = 7 \times 280 \text{ Hz} = 1960 \text{ Hz}$$

29. **B:** Whenever the object distance is less than the focal length of a concave mirror, a magnified, virtual and upright (erect) image will be formed.

30. **B:** $N = \frac{360}{\theta} - 1$ ($N = 7$)

$$7 = \frac{360}{\theta} - 1; \quad \frac{360}{\theta} = 7 + 1 = 8$$

$$8\theta = 360$$

$$\theta = \frac{360}{8} = 45^\circ$$

31. **D:** A parabolic mirror is the choice for constructing search light. Concave mirror is used as having mirror while convex mirror is used as a driving mirror.

32. **C:** Refractive index = $\frac{\text{Real depth}}{\text{Apparent depth}}$

Displacement = real depth - apparent depth ... (i)

Here, the real depth is the thickness t .

$$n = \frac{t}{\text{apparent depth}}$$

From equation (i)

Apparent depth = real depth (t) - displacement (d)

$$n = \frac{t}{t-d}; \quad n(t-d) = t; \quad t-d = \frac{t}{n}$$

Then,

$$d = t - \frac{t}{n} = t \left(1 - \frac{1}{n}\right)$$

33. **A:** $\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{v+u}{uv}$

$$f(v+u) = uv \text{ or } uv = f(v+u)$$

If this equation is compared with the general equation of a straight line, $y = mx + c$, $y = uv$, gradient $m = f$, $x = v + u$. where is c ? There is no c ! We mean the intercept is zero and the fact that m is positive indicates that the graph is a direct proportionality graph which passes through the origin.

34. **D:** $f = 30 \text{ cm}$, $u = 25 \text{ cm}$, $v = ?$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}; \quad \frac{1}{30} = \frac{1}{25} + \frac{1}{v} = \frac{1}{30} - \frac{1}{25}$$

$$\frac{1}{v} = \frac{5-6}{150} = \frac{-1}{150}$$

$$-v = 150; \quad v = -150 \text{ cm}$$

The negative sign only indicates that the object and the image are on the same side of the lens.

35. **B:** The only incorrect statement is contained in "III"

R I V U X G

Increasing frequency \rightarrow

Thus, infra-red has lower frequency than visible light and not the other way round.

36. **C:** $F = \frac{Kq_1q_2}{r^2} = \frac{q_1q_2}{4\pi\epsilon_0 r^2} = \frac{q_1q_2}{r^2} \times \frac{1}{4\pi\epsilon_0}$

$$= \frac{5 \times 10^{-6} \times 8 \times 10^{-6}}{0.02^2} \times 9 \times 10^9$$
$$= 900 \text{ N} = 9 \times 10^2 \text{ N}$$

37. **A:** The ebonite rod has acquired a negative charge while glass has acquired a positive charge.

38. **A:** According to the right hand grip rule (or corkscrew rule), the direction of magnetic lines of force will be as shown in A.

39. **B:** Local action is caused by impurities in the zinc anode. It can be reduced by using amalgamated zinc metal or by simply using pure zinc.

40. **C:** The three 2Ω resistors are connected in series. This arrangement is connected in parallel with the 3Ω resistor. The whole combination is now connected in series with the two 1Ω resistors.

$$R = \left(\frac{3 \times 6}{3+6}\right) + 1 + 1 = 4\Omega$$

41. **C:** $W = qV = (2 \times 100) \text{ J} = 200 \text{ J}$

42. **C:** $C = \frac{A\epsilon_0}{d} = \frac{5 \times 10^{-8} \times 9 \times 10^{-12}}{2 \times 10^{-3}} = 2.25 \times 10^{-16} \text{ F}$

43. **A:** this is to minimize eddy currents

44. **D:** $H = I^2 R t = 100^2 \times 0.5 \times 1 \times 3600 = 1.8 \times 10^7 \text{ J}$

45. **D:** $f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2 \times \pi \sqrt{8 \times 10^{-3} \times 5 \times 10^{-6}}} = \frac{1}{4 \times 10^{-4} \pi}$

$$= \frac{1}{4 \times 10^{-4} \pi} \times \frac{1}{\pi} = \left(\frac{2500}{\pi}\right) \text{ Hz}$$

46. **A:** Efficiency = $\frac{I_p \times V_s}{I_p \times V_p} \times 100\%$

$$80\% = \frac{15 \times 8}{I_p \times 240} \times 100\%$$

$$I_p = \frac{15 \times 8 \times 100\%}{80\% \times 240} = 0.625 \text{ A}$$

47. **D:** $m = ZQ$ (Faraday's First law of electrolysis)

$$M = 1.3 \times 10^{-7} \text{ kg} \cdot \text{c}^{-1} \times 2 \times 10^4 \text{ c} = 2.6 \times 10^{-3} \text{ kg}$$

48. **A:** $N_t = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_1}} = 6 \times 10^{10} \left(\frac{1}{2}\right)^{\frac{320}{80}}$

$$= 6 \times 10^{10} \left(\frac{1}{2}\right)^4$$

$$= 6 \times 10^{10} \left(\frac{1}{16}\right)$$

$$= 6 \times 10^{10} \times \frac{1}{16} = \frac{6 \times 10^{10}}{16} = 3.75 \times 10^9$$

49. **D:** $E = mc^2$ (Einstein's equation)

$$= 10^{-6} \times (3 \times 10^8)^2$$

$$= 9 \times 10^{10} \text{ J}$$

50. **A:** The photon energy must be greater than the work function of the metal because part of the photon's energy will be used to break the surface barrier of the metal while the rest will account for the K.E of the electrons.

1997 UME PHYSICS QUESTIONS

1. At what respective values of x , y and z would the unit of force, the Newton, be dimensionally equivalent to $M^x L^y T^z$? A. -1, 1, 2 B. 1, 1, -2 C. 1, -1, 2 D. -1, 1, -2

2. The distance x m travelled by a particle in time t seconds is described by the equation $x = 10 + 12t^2$. Find the average speed of the

particle between the time interval $t = 2$ s and $t = 5$ s. A. 60 ms^{-1} B. 72 ms^{-1} C. 84 ms^{-1} D. 108 ms^{-1}

3. A 5kg block is released from rest on a smooth plane inclined at an angle of 30° to the horizontal. What is the acceleration down the plane? A. 5.0 ms^{-2} B. 5.8 ms^{-2} C. 8.7 ms^{-2} D. 25.0 ms^{-2} [$g = 10 \text{ ms}^{-2}$]

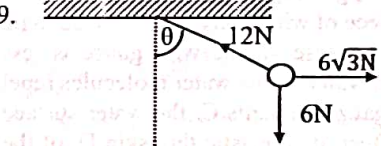
4. An arrow of mass 0.1kg moving with a horizontal velocity of 15 ms^{-1} is shot into a wooden block of mass 0.4kg lying at rest on a smooth horizontal surface. Their common velocity after impact is A. 15.0 ms^{-1} B. 7.5 ms^{-1} C. 3.8 ms^{-1} D. 3.0 ms^{-1}

5. Two bodies X and Y are projected on the same horizontal plane, with the same initial speed but at angles 30° and 60° respectively to the horizontal. Neglecting air resistance, the ratio of the range of X to that of Y is A. 1 : 1 B. 1 : 2 C. $\sqrt{3}$: 1 D. 1 : $\sqrt{3}$

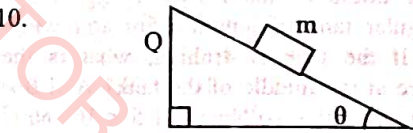
6. Which of the following with respect to a body performing simple harmonic motion are in phase? A. Displacement and velocity of the body B. Displacement and force on the body C. Velocity and acceleration of the body D. Force acting on the body and the acceleration

7. A body of mass 2kg moving vertically upwards has its velocity increased uniformly from 10 ms^{-1} to 40 ms^{-1} in 4s. Neglecting air resistance, calculate the upward vertical force acting on the body. A. 15 N B. 20 N C. 35 N D. 45 N [$g = 10 \text{ ms}^{-2}$]

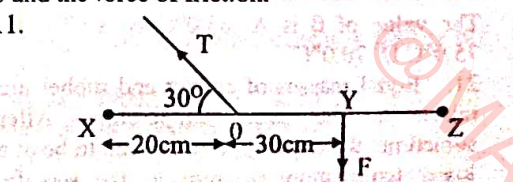
8. A planet has mass m_1 and is at a distance r , from the sun. A second planet has mass $m_2 = 10m_1$ and is at a distance of $r_2 = 2r_1$ from the sun. Determine the ratio of the gravitational forces experienced by the planets. A. 1:5 B. 2:5 C. 3:5 D. 4:5



9. For what value of θ are the forces in the diagram above in equilibrium? A. 15° B. 30° C. 45° D. 60°



10. The figure above shows a block of mass m sliding down a rough inclined plane QP at angle θ . The forces acting on the block along the plane QP are A. $mg \sin \theta$ and the normal reaction B. $mg \sin \theta$ and the force of friction C. $mg \cos \theta$ and the normal reaction D. $mg \cos \theta$ and the force of friction.



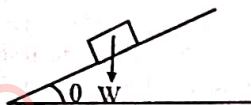
11. A uniform light beam XZ is hinged at X and kept in equilibrium by the forces T and F as

shown in the diagram above. If $XO = 20\text{cm}$ and $OY = 30\text{cm}$, express T in terms of F .
 $T = \frac{2\sqrt{3}}{3} F$ B. $T = 2F$ C. $T = \frac{5\sqrt{3}}{3} F$ D. $T = 5F$

12. An object of mass 100g projected vertically upwards from the ground level has a velocity of 20ms^{-1} at a height of 10m . Calculate its initial kinetic energy at the ground level. A. 10J B. 20J C. 30J D. 50J . [$g = 10\text{ms}^{-2}$, neglect air resistance].

13. An electric water pump rated 1.5kW , lifts 200kg of water through a vertical height of 6metres in 10seconds . What is the efficiency of the pump? A. 90.0% B. 85.0% C. 80.0% D. 65.0% [$g = 10\text{ms}^{-2}$, neglect air resistance]

14.



For a rough inclined plane on which lies a body of weight W , the angle θ in the diagram above becomes the angle of friction if A. $\tan \theta =$ coefficient of static friction B. $\cos \theta =$ coefficient of dynamic friction C. $\sin \theta =$ coefficient of sliding friction D. $\sec \theta =$ limiting frictional force

15. A load of 20N on a wire of cross-sectional area $8 \times 10^{-7}\text{m}^2$, produces an extension of 10m . Calculate Young's modulus for the material of the wire if its length is 3m . A. $7.0 \times 10^{11}\text{Nm}^{-2}$ B. $7.5 \times 10^{11}\text{Nm}^{-2}$ C. $8.5 \times 10^{11}\text{Nm}^{-2}$ D. $9.0 \times 10^{11}\text{Nm}^{-2}$

16. A cube of sides 0.1m hangs freely from a string. What is the upthrust on the cube when totally immersed in water? A. 1000N B. 700N C. 110N D. 10N [Density of water is 1000kgm^{-3} , $g = 10\text{ms}^{-2}$]

17. A piece of wire gauze can be made to lie on water because A. the wire gauze is less dense than water B. the water molecules repel the wire gauze upwards C. the water surface has the effect of an elastic thin skin D. of the cohesive forces between the water and the wire gauze molecules.

18. A liquid of mass $1.0 \times 10^3\text{kg}$ fills a rectangular tank of length 2.5m and width 2.0m . If the tank is 4m high, what is the pressure at the middle of the tank? A. $1.0 \times 10^4\text{Nm}^{-2}$ B. $2.0 \times 10^3\text{Nm}^{-2}$ C. $1.5 \times 10^3\text{Nm}^{-2}$ D. $1.0 \times 10^3\text{Nm}^{-2}$ [$g = 10\text{ms}^{-2}$]

19. An empty 60litre petrol tank has a mass of 10kg . Its mass when full of fuel of relative density 0.72 is A. 7.2kg B. 33.2kg C. 43.2kg D. 53.2kg

20. The length of mercury thread when it is at 0°C , 100°C and at an unknown temperature θ is 25mm , 225mm and 175mm respectively. The value of θ is A. 85.0°C B. 80.0°C C. 75.0°C D. 70.0°C

21. Equal masses of copper and rubber are raised to the same temperature. After sometime, the copper was observed to be at a lower temperature because A. the specific heat capacity of copper is lower than that of

rubber B. copper expands more than rubber C. the specific heat capacity of rubber is lower than that of copper D. rubber expands more than copper.

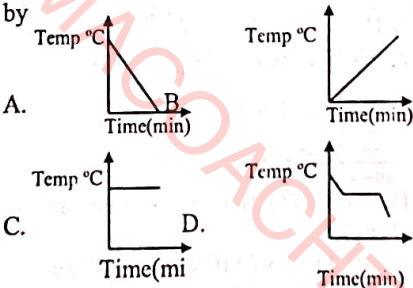
22. Before starting a journey, the tyre pressure of a car was $3 \times 10^5\text{Nm}^{-2}$ at 27°C . At the end of the journey, the pressure rose to $4 \times 10^5\text{Nm}^{-2}$. Calculate the temperature of the tyre after the journey assuming the volume is constant. A. 400°C B. 300°C C. 273°C D. 127°C

23. A mass of a liquid at 30°C is mixed with a mass of the same liquid at 70°C and the temperature of the mixture is 45°C . Find the ratio of the mass of the cold liquid to the mass of the other liquid. A. $3 : 5$ B. $5 : 3$ C. $3 : 7$ D. $7 : 3$

24. A heating coil rated at 1000W is used to boil off 0.5kg of boiling water. The time taken to boil off the water is A. $1.15 \times 10^9\text{s}$ B. $1.15 \times 10^7\text{s}$ C. $1.15 \times 10^5\text{s}$ D. $1.15 \times 10^3\text{s}$ [Specific latent heat of vaporization of water = $2.3 \times 10^6\text{Jkg}^{-1}$]

25. What happens when a certain quantity of pure ice is completely changed to water at 0°C ? A. Latent heat is absorbed, the mass remains constant and the volume decreases. B. Latent heat is given out, the mass remains constant and the volume decreases C. Latent heat is given out, the mass increases and the volume remains constant D. Latent heat is absorbed, the mass decreases and the volume increases.

26. The correct cooling curve for a molten substance such as naphthalene is represented by



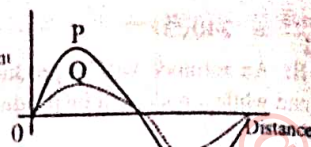
27. What happens when a gas expands at constant temperature? A. Its pressure decreases B. The total momentum of its molecules remains constant C. Its pressure decreases and the total momentum of its molecules remains constant D. Its pressure decreases and the total kinetic energy of its molecules decreases.

28. Ripples on water and light waves are similar because both A. have the same frequency B. can be refracted and diffracted C. are longitudinal waves D. have the same velocity

29. Under constant tension and constant mass per unit length, the note produced by a plucked string is 500Hz when the length of the string is 0.90m . At what length is the frequency 150Hz ? A. 3m B. 4m C. 5m D. 6m

30. The colours seen in thin films of oil on the road and in soap bubbles are due to A. reflection B. interference C. diffraction D. polarization

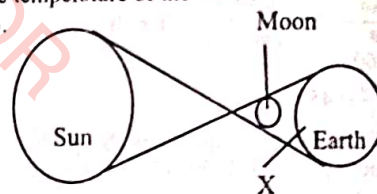
31. Particle Displacement



The diagram above shows two wave forms P and Q at a particular instant of time. The two waves will interfere. A. destructively to produce a wave of a larger amplitude B. destructively to produce a wave of a smaller amplitude C. constructively to produce a wave of a larger amplitude D. constructively to produce a wave of a smaller amplitude.

32. If the load at the end of a sonometer wire is immersed in a bucket of water, the original fundamental frequency of the wire could be restored by A. decreasing the length of the wire B. increasing the length of the wire C. increasing the mass per unit length of the wire D. changing the temperature of the water.

33.



When the sun, the moon and the earth are as shown in the diagram above, an observer standing at X is in A. penumbra and sees a partial eclipse B. penumbra and sees a total eclipse C. umbra and sees a partial eclipse D. umbra and sees a total eclipse.

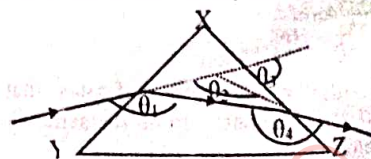
34. A boy on looking into a mirror observed that his face appeared to have grown bigger. The boy must have been looking at a A. convex mirror with his face at the focus B. concave mirror with his face between the focus and the mirror C. concave mirror with his face at the focus D. convex mirror with his face between the focus and the mirror.

35. Light of velocity $3.0 \times 10^8\text{ms}^{-1}$ is incident on a material of refractive index n . If the velocity of light is reduced to $2.4 \times 10^8\text{ms}^{-1}$ in the material, what is n ? A. 2.33 B. 2.25 C. 1.33 D. 1.25

36. A patient with a sight defect has a least distance of distinct vision of 150cm . For him to be able to read a material placed at a distance of 25cm , what is the focal length of the glasses he should wear? A. 15.0cm B. 17.6cm C. 21.4cm D. 30.0cm

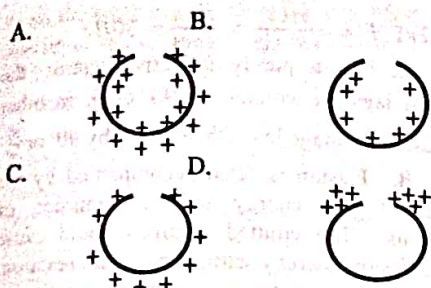
37. The electromagnetic waves that are sensitive to temperature changes are A. x-rays B. gamma-rays C. ultra-violet rays D. infra-red rays

38.



In the diagram above, which of the angles θ_1 , θ_2 , θ_3 , and θ_4 is the angle of deviation of a ray of light passing through the glass prism. XYZ? A. θ_3 B. θ_2 C. θ_1 D. θ_4 .

39. Which of the figures below shows the correct distribution of charges on an isolated positively charged hollow metal?



40. Three electric cells each of e.m.f. 1.5V and internal resistance 1.0Ω are connected in parallel across an external resistance of $\frac{2}{3}\Omega$. Calculate the value of the current in the resistor. A. 0.5A B. 0.9A C. 1.5A D. 4.5A

41. A galvanometer of internal resistance 50Ω has a full scale deflection for a current of 5mA . What is the resistance required to convert it to a voltmeter with full scale deflection of 10V? A. 1750Ω B. 1950Ω C. 2000Ω D. 2500Ω

42. If $8 \times 10^{-2}\text{J}$ of work is required to move $100\mu\text{C}$ of charge from a point X to a point Y in an electrical circuit, the potential difference between X and Y is A. $4.0 \times 10^2\text{V}$ B. $4.0 \times 10^4\text{V}$ C. $8.0 \times 10^2\text{V}$ D. $8.0 \times 10^4\text{V}$

43. In a metre bridge experiment, two resistors 2Ω and 3Ω occupy the left and right gaps respectively. Find the balance point from the left side of the bridge. A. 20cm B. 40cm C. 60cm D. 80cm

44. Two $50\mu\text{F}$ parallel plate capacitors are connected in series. The combined capacitor is then connected across a 100-v battery. The charge on each plate of the capacitor is A. $5.00 \times 10^{-5}\text{C}$ B. $2.50 \times 10^{-3}\text{C}$ C. $1.25 \times 10^{-3}\text{C}$ D. $1.00 \times 10^{-2}\text{C}$

45. What is the total electrical energy consumed by using an electric cooker rated 1000 W for 5 hrs? A. $5.3 \times 10^3\text{J}$ B. $6.5 \times 10^3\text{J}$ C. $1.8 \times 10^7\text{J}$ D. $2.3 \times 10^7\text{J}$

46. The power dissipated in an a.c. circuit with an r.m.s. current of 5A, r.m.s. voltage of 10 V and a phase angle of 60° is A. 25W B. 50W C. 120W D. 125W

47. The voltage of the domestic electric supply is represented by the equation $V = 311 \sin 314.2t$. Determine the frequency of the a.c. supply. A. 50.0 Hz B. 100.0 Hz C. 311.0 Hz D. 314.2 Hz [$\pi = 3.142$]

48. In a purely inductive circuit, the current A. lags behind the voltage in phase by 90° B. leads the voltage in phase by 90° C. is the same phase with the voltage D. leads the voltage by 180°

49. One of the features of the fission process is that A. its products are not radioactive B. it leads to chain reaction C. neutrons are not released D. the sum of the masses of the reactants equals the sum of the masses of the products.

50. The graphite rods surrounding the uranium fuel rods in a nuclear reactor, are used to A. absorb the neutrons and hence halt the nuclear process B. create the neutrons and hence slow up the nuclear process C. slow down the neutrons and hence slow the nuclear process D. speed up the neutrons and hence speed up the nuclear process.

1997 UME PHYSICS SOLUTION

1. B: Force = mass \times acceleration

The dimension of mass = M
The dimension of acceleration = LT^{-2}
Then, force = MLT^{-2}
If this dimension is compared to $\text{M}^x\text{L}^y\text{T}^z$
 $x = 1, y = 1$ and $z = -2$

2. C: $x = 10 + 12t^2$

When $t = 2\text{s}$

$$x = 10 + 12(2)^2 = 58\text{m}$$

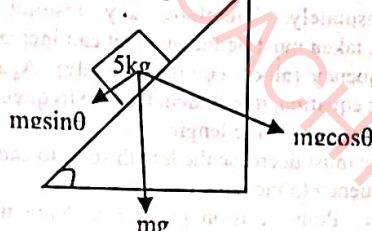
When $t = 5\text{s}$

$$x = 10 + 12(5)^2 = 310\text{m}$$

average speed between $t = 2$ and $t = 5$ is given by

$$\frac{310\text{m} - 58\text{m}}{5\text{s} - 2\text{s}} = \frac{252\text{m}}{3\text{s}} = 84\text{m/s}$$

3. A: Method 1



Since the plane is smooth, no friction acts between the block and the plane. Thus, force down the plane = $mgsin\theta \Rightarrow 5 \times 10 \sin 30^\circ = 25\text{N}$

But $F = ma$

$$a = \frac{F}{m} = \frac{25\text{N}}{5\text{kg}} = 5\text{m/s}^2$$

METHOD 2

$$a = g \sin \theta = 10 \sin 30^\circ = 5\text{m/s}^2$$

4. D: $m_1u_1 = (m_1 + m_2)v$

Since the block was originally at rest

$$0.1 \times 15 = (0.1 + 0.4)v$$

$$1.5 = 0.5v; v = \frac{1.5}{0.5} = 3\text{m/s}$$

$$5. \text{ A: } R = \frac{u^2 \sin 2\theta}{g}$$

For body X

$$R_x = \frac{u^2 \sin(2 \times 30^\circ)}{g} = \frac{u^2 \sin 60^\circ}{g} = \frac{0.8660u^2}{g}$$

$$R_y = \frac{u^2 \sin(2 \times 60^\circ)}{g} = \frac{u^2 \sin 120^\circ}{g} = \frac{0.8660u^2}{g}$$

Thus,

$$R_x : R_y = \frac{0.8660u^2}{g} : \frac{0.8660u^2}{g} = 1 : 1$$

6. D: The force and the acceleration are in phase.

$$7. \text{ C: } a = \frac{v-u}{t} = \left(\frac{40-10}{4}\right)\text{m/s}^2 = 7.5\text{m/s}^2$$

$F - mg = ma$

$$F = ma + mg = (m(a + g)) = 2(7.5 + 10) = 35\text{N}$$

$$8. \text{ B: } F = \frac{Gm_1m_2}{r^2} = \frac{Gm_s m_p}{r^2}$$

(m_s = mass of sun, m_p = mass of planet)

Since G and m_s are constant, we have:

$$F \propto \frac{m_p}{r^2}; F = \frac{km_p}{r^2}; K = \frac{Fr^2}{m_p}$$

Then,

$$\frac{F_1 r_1^2}{m_1} = \frac{F_2 r_2^2}{m_2}; m_2 = 10m_1 \text{ and } r_2 = 2r_1$$

$$\frac{F_1 r_1^2}{m_1} = \frac{F_2 \times (2r_1)^2}{10m_1} = \frac{F_2 \times (4r_1)^2}{10m_1}$$

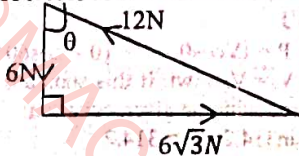
$$F_2 = \frac{F_1 r_1 \times 10m_1}{m_1 \times 4r_1^2} = \frac{10F_1}{4} = \frac{5}{2}F_1$$

Then,

$$2F_2 = 5F_1$$

$$F_1 : F_2 = 2 : 5$$

9. D: We arrange the forces to form a triangle of forces as shown below:



We can now use any approach to get the value of θ

$$\sin \theta = \frac{6\sqrt{3}}{12} = 0.8660$$

$$\theta = \sin^{-1} 0.8660 = 60^\circ$$

Or

$$\cos \theta = \frac{6}{12} = 0.5, \theta = \cos^{-1} 0.5 = 60^\circ$$

Or

$$\tan \theta = \frac{6\sqrt{3}}{6} = 1.732, \theta = \tan^{-1} 1.732 = 60^\circ$$

10. B: The force of friction acts up the plane while $mgsin\theta$ acts down the plane. NB: $mg \cos \theta$ acts perpendicular to the plane.

11. D: $T \sin 30^\circ \times 20 = F \times 50$

$$T = \frac{F \times 50}{20 \sin 30^\circ} = \frac{50F}{10} = 5F$$

12. C: We need to get the take-off velocity first.

$$U = ? v = 20\text{m/s}, s = 10\text{m}, a = -10\text{m/s}^2$$

$$V^2 = u^2 + 2as$$

$$U^2 = v^2 - 2as = 20^2 - 2(-10)10$$

$$= 400 + 200 = 600$$

$$\text{K.E} = \frac{1}{2}mu^2 = (\frac{1}{2} \times 0.1 \times 600)\text{J}$$

$$= 30\text{J}$$

13. C: Power input = $1.5\text{kW} = 1.5 \times 10^3\text{W} = 1500\text{W}$

$$\text{Power output} = \frac{mgh}{t} = \frac{200 \times 10 \times 6}{10} = 1200\text{W}$$

$$\text{Efficiency} = \frac{\text{Power output}}{\text{Power input}} \times 100\%$$

$$= \frac{1200}{1500} \times 100\% = 80\%$$

14. A: $\mu = \tan \theta$

μ = coefficient of static friction

θ = angle of friction

$$15. \text{ B: } Y = \frac{FL}{Ae}$$

(Y = Young's modulus, L = Length, A = Area, e = extension)

$$Y = \left(\frac{20 \times 3}{8 \times 10^{-7} \times 10^{-4}}\right)\text{Nm}^{-2}$$

$$= 7.5 \times 10^{11}\text{Nm}^{-2}$$

16. D: Volume of cube = $L^3 = (0.1\text{m})^3 = 0.001\text{m}^3$

$$U = \rho Vg = 100\text{kgm}^{-3} \times 0.001\text{m}^3 \times 10\text{ms}^{-2} = 10\text{N}$$

17. C: This is an effect of surface tension.

18. D: Density (ρ) of the liquid = $\frac{\text{Mass}}{\text{Volume}}$

$$\text{Mass} = 1.0 \times 10^3\text{kg}$$

$$V = LBH = (2.5 \times 2.0 \times 4)\text{m}^3 = 20\text{m}^3$$

$$\rho = \frac{1.0 \times 10^3\text{kg}}{20\text{m}^3} = 50\text{kgm}^{-3}$$

Since the pressure at the middle of the 4m high tank is sought, we take 'h' as 2m (which is half of the given height)

$$P = h\rho g = (2 \times 50 \times 10)\text{N} = 1000\text{N} = 1.0 \times 10^3\text{N}$$

19. D: Since the tank is full of fuel, volume of fuel = volume of tank = 60 litres. Mass of tank = 10kg

Note that 1 litre = 1dm^3

Thus,

$$\text{Volume of fuel} = 60 \times 1\text{dm}^3 = 60\text{dm}^3 = 60(10^{-1})^3\text{m}^3 = 0.06\text{m}^3$$

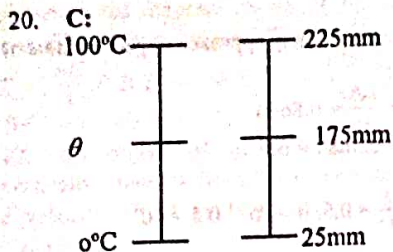
Density of fuel = relative density \times density of water

$$= (0.72 \times 1000)\text{kgm}^{-3} = 720\text{kgm}^{-3}$$

$$\text{Mass of fuel} = \text{density} \times \text{volume}$$

$$= (720 \times 0.06)\text{kg} = 43.2\text{kg}$$

$$\text{Total mass of the tank} = 10\text{kg} + 43.2\text{kg} = 53.2\text{kg}$$



$$\frac{100-\theta}{\theta} = \frac{225-175}{175-25}$$

$$\frac{100-\theta}{\theta} = \frac{50}{150}$$

$$50\theta = 15000 - 15\theta$$

$$\theta = \frac{15000}{200} = 75^\circ\text{C}$$

21. A: The specific heat capacity of copper is lower than that of rubber.

22. D: $P_1 = 3 \times 10^5 \text{ Nm}^{-2}$, $T_1 = 27^\circ\text{C} = (27 + 273) = 300\text{K}$, $P_2 = 4 \times 10^5 \text{ Nm}^{-2}$, $T_2 = ?$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow T_2 = \frac{P_2 T_1}{P_1} = \frac{4 \times 10^5 \times 300}{3 \times 10^5} = 400\text{K}$$

$T(^\circ\text{C}) = T(\text{K}) - 273 = (400 - 273)^\circ\text{C} = 127^\circ\text{C}$

23. B: KEY \Rightarrow The hot liquid will lose heat while the cold liquid will gain heat. The amount of heat lost by the hot liquid must be equal to the amount of heat gained by cold liquid (if no heat is exchanged with the surrounding). Also, note that the specific heat capacity, C of a substance is constant, regardless of whether it is hot or cold (unless it has undergone a change of state).

$$M_c C \Delta\theta_c = M_h C \Delta\theta_h$$

$$M_c \times C \times (45 - 30) = M_h \times C \times (70 - 45)$$

$$M_c \times C \times 15 = M_h \times C \times 25$$

$$\frac{m_c}{m_h} = \frac{C \times 25}{C \times 15} = \frac{25}{15} = \frac{5}{3}$$

Therefore, $M_c : M_h = 5 : 3$

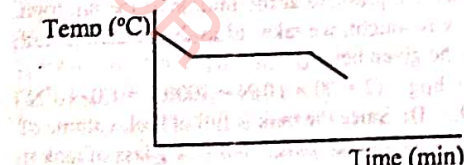
24. D: Power \times time = mass \times specific latent heat

$$1000 \times t = 0.5 \times 2.3 \times 10^6$$

$$t = \left(\frac{0.5 \times 2.3 \times 10^6}{1000}\right) \text{ s} = 1.15 \times 10^3 \text{ s}$$

25. A: The Latent heat of fusion of ice will be absorbed. As the ice melts, the volume decreases (this is because ice contracts on melting). Note that the mass will be constant, unless there is a spillage.

26. D: As the molten substance cools, its temperature drops. When it gets to the solidification point, the temperature is constant until all the molten substance has solidified, after which the temperature continues dropping



27. C: When a gas expands at constant temperature, its pressure decreases. The total momentum and kinetic energy remain unaffected.

28. B: All waves can undergo reflection, refraction, diffraction and interference. It must be noted that only transverse waves can undergo polarization, longitudinal waves (such as sound waves) cannot.

29. A: $L_2 = \frac{(500 \times 0.9)}{150} = 3\text{m}$

30. A: Rays of light are refracted and ultimately get totally internally reflected by liquid droplets and are dispersed in the process.

31. C: Since the waves are in phase, they will interfere constructively to produce a wave of a larger amplitude.

32. A: $F = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$
(F = Frequency, l = length, T = Tension, μ = mass per unit length)

If the load is immersed in a bucket of water, upthrust acts on it and causes its weight (which is taken as tension here) to reduce.

As can be seen, there is a direct relation between frequency and the tension, so since the tension has decreased the frequency will decrease commensurately. Therefore, any restorative measure taken must be the one that can increase the frequency (albeit commensurately). Again from the equation, it is evident that the frequency varies inversely as the length.

Thus, we must decrease the length so as to cause the frequency to increase.

33. A: Point X is in penumbra. Note that umbra means total darkness while penumbra means partial darkness.

34. B: The boy must have been looking at a concave mirror with his face between the focus and the mirror. Note that a convex mirror never produces an enlarged image.

35. D: Refractive index of a medium, $n = \frac{\text{Velocity of light in air}}{\text{velocity of light in medium}} = \frac{3 \times 10^8 \text{ ms}^{-1}}{2.4 \times 10^8 \text{ ms}^{-1}} = 1.25$

36. D: $U = 25\text{cm}$
 $V = -150\text{cm}$ (both image and object are on the same side of the lens)

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{25} + \frac{1}{-150} = \frac{-6+1}{-150} = \frac{-5}{-150}$$

$$f = \frac{-150}{-5} = 30\text{cm}$$

37. D: Infra-red rays are the electromagnetic waves that are sensitive to temperature changes.

38. A: θ_3 is the angle of deviation of the ray of light. Note that the angle of deviation is the angle between the incident ray and the emergent ray.

39. C: The charge on a hollow conductor collects only on its outer surface.

40. C: Total emf = 1.5V (since the cells are connected in parallel)

$$\frac{1}{r} = \frac{1}{1} + \frac{1}{1}; r = \frac{1}{2} \Omega = 0.5 \Omega$$

$$I = \frac{E}{\mu + r} = \frac{1.5}{\frac{2}{3} + 0.5} = \frac{1.5}{\frac{2+1}{3}} = \frac{1.5 \times 3}{3} = 1.5\text{A}$$

41. B: $R_m = \frac{V_T}{I_g} - r_g = \frac{10}{5(10^{-3})} - 50 = 1950 \Omega$

42. C: $W = qV$. $V = \frac{W}{q} = \frac{8 \times 10^{-2}}{1 \times 10^{-4}} = 800\text{V}$

43. B: Let the balance point from the left side be x.

$$\frac{2}{x} = \frac{3}{100-x}; 3x = 200 - 2x, x = \left(\frac{200}{5}\right) \text{ cm} = 40\text{cm}$$

44. B: $\frac{1}{C} = \frac{1}{50} + \frac{1}{50}; C = 25 \mu\text{F} = 2.5 \times 10^{-5}\text{F}$

$Q = VC = (100 \times 2.5 \times 10^{-5})\text{C} = 2.5 \times 10^{-2}\text{C}$

45. C: $t = 5\text{hrs} = (5 \times 3600)\text{s} = 18000\text{s}$
Energy = Power \times time = $(1000 \times 18000)\text{J} = 1.8 \times 10^7\text{J}$

46. A: $P = IV \cos\theta = 5 \times 10 \times \cos 60^\circ = 25\text{W}$

47. A: $V = V_0 \sin\omega t$. If this standard equation is compared with the given equation: $V = 211 \sin 314.2t$. $\omega = 314.2$

$$w = 2\pi F, F = \frac{314.2}{2 \times 3.142} = \frac{314.2}{6.284} = 50\text{Hz}$$

48. A: In a purely inductive circuit, the current lags the voltage by 90° or $\frac{\pi}{2}$. In other words, the voltage leads the current by 90° or $\frac{\pi}{2}$.

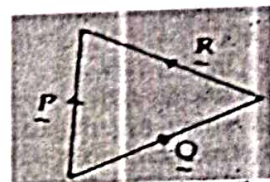
49. B: Fission is often accompanied by the release of heat energy and the emission of neutrons. The emitted neutrons could cause more fission, thereby setting up a chain reaction, resulting in the release of a large quantity of energy.

50. C: The graphite is a moderator - it slows down the neutrons and hence slow the nuclear process.

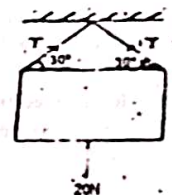
1995 UME PHYSICS QUESTIONS

1. Which of the following is the dimension of pressure? A. $\text{ML}^{-1}\text{T}^{-2}$ B. MLT^2 C. ML^2T^{-3} D. ML^{-3}

2. The length of a displaced pendulum bob which passes its lowest point twice every second is A. 2.5m B. 0.45m C. 0.58m D. 1.00m [$g = 10 \text{ ms}^{-2}$]



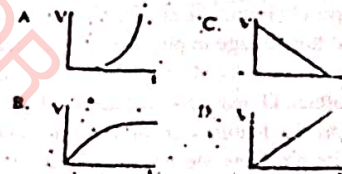
3. In the diagram above \vec{P} , \vec{Q} and \vec{R} are vectors. Which of the following options gives the correct relationship between the vectors? A. $\vec{P} = \vec{Q} + \vec{R}$ B. $\vec{P} = \vec{Q} - \vec{R}$ C. $\vec{P} = \vec{R} - \vec{Q}$ D. $\vec{P} + \vec{Q} + \vec{R} = 0$



The value of T in the figure above is A. 10.0 N. B. 11.8N C. 20.0N D. 40.0N

5. When a ball rolls on a smooth level ground, the motion of its centre is A. translational B. oscillatory C. random D. rotational.

6. The velocity-time graph of a body moving in a straight line and decelerating uniformly to rest is represented by



The acceleration of the system shown above is A. 2 ms^{-2} B. 4 ms^{-2} C. 6 ms^{-2} D. 8 ms^{-2}

8. What is the acceleration due to gravity 'g' on the moon, if g is 10 ms^{-2} on the earth? A. 0.10 ms^{-2} B. 0.74 ms^{-2} C. 1.67 ms^{-2} D. 10.00 ms^{-2}

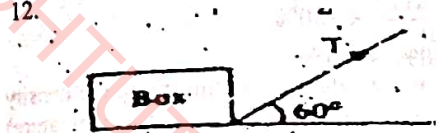
9. A body is projected from the earth's surface with the intention of letting: it escape

from the earth's gravitational field. What is the minimum escape velocity of the body? A. 14 km s^{-1} B. 13 km s^{-1} C. 12 km s^{-1} D. 11 km s^{-1} . [Earth's radius = $6.4 \times 10^3 \text{ km}$, $g = 10 \text{ ms}^{-2}$]

10. A uniform rod PQ of length 1m and mass 2kg is pivoted at the end P. If a load of 14 N is placed at the centre of the rod, find the force that should be applied vertically upwards at Q to maintain the rod in equilibrium horizontally. A. 68N B. 28N C. 17N D. 7N [$g = 10 \text{ ms}^{-2}$]

11. A vehicle of mass m is driven by an engine of power P from rest. Find the minimum time it will take to acquire a speed A. $\frac{mv^2}{P}$ B. $\frac{mv^2}{2P}$ C.

$\frac{mv}{P}$ D. $\frac{mv}{2P}$

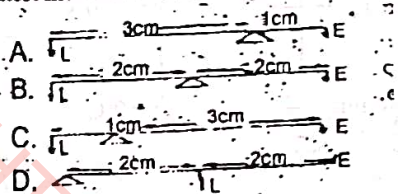


A box of mass 40kg is being dragged along the floor by a rope inclined at 60° to the horizontal. The frictional force between the box and the floor is 100N and the tension on the rope is 300N. How much work is done in dragging the box through a distance of 4m? A. 680 J B. 400 J C. 200 J D. 100 J

13. Which of the following statements are TRUE about frictional force? I. It is always a disadvantage II. It. Sometimes a disadvantage III. It always exists where there is a relative motion of two bodies that are in contact IV. It is sometimes very useful. A. I and III only B. I and IV only C. II and III only D. II and IV only

14. The energy contained in a wire when it is extended by 0.02m by a force of 500 N is A. 5 J B. 10J C. 10^3 J D. 10^4 J

15. Which of the following levers has the greatest mechanical advantage?



16. A hydraulic press has a large circular piston of radius 0.8m and a circular plunger of radius 0.2m. A force of 500 N is exerted by the plunger. Find the force exerted on the piston. A. 8000 N B. 4000 N C. 2000 N D. 31 N

17. The volume of an air bubble increases from the bottom to the top of a lake at constant temperature because A. atmospheric pressure acts on the surface of the lake B. pressure increases with depth C. density remains constant with pressure D. the bubble experiences an upthrust.

18. Temperature is a measure of the A. quantity of heat transferred into the molecules of an object B. mean kinetic energy of the molecules of the object C. kinetic energy of any individual molecule of the substance D. amount of work done by the molecules of the object.

19. A rectangular metal block of volume 10^{-6} m^3 at 273K is heated to 573K. If its coefficient of linear expansion is $1.2 \times 10^{-5} \text{ K}^{-1}$, the percentage change of its volume is A. 1.5% B. 1.1% C. 0.4% D. 0.1%

20. A piece of wood floats inside water at room temperature with a fraction of it above the liquid surface. As the temperature of the water is raised, the part of the wood above the liquid will A. decrease because the density of water decreases with temperature B. increase, because the density of water decreases with temperature C. decrease because the density of water increases with temperature D. increase because the density of water increases with temperature.

21. The equation $P^x V^y T^z = \text{constant}$ is Charles' law when A. $x=1, y=-1, z=1$ B. $x=0, y=1, z=-1$ C. $x=1, y=0, z=-1$ D. $x=0, y=1, z=1$.

22. An electric kettle with negligible heat capacity is rated at 2000W. If 2.0Kg of water is put in it, how long will take the temperature of water, to rise from 20°C to 100°C ? A. 420s B. 336s C. 168s D. 84s [Specific heat capacity of water = $4200 \text{ J kg}^{-1} \text{ K}^{-1}$]

23. A temperature scale has a lower fixed point of 40mm and an upper fixed point of 200mm. What is the reading on this scale when a thermometer reads 60°C ? A. 33.3mm B. 36.0mm C. 96.0mm D. 136.0mm.

24. A quantity of ice at -10°C is heated, until the temperature of the heating vessel is 90°C . Which of the following constants is NOT required to determine the quantity of heat supplied to the vessel? A. Specific heat capacity of ice B. Specific heat capacity of water C. Specific latent heat of fusion D. Specific latent heat of vaporization.

25. Which of the following statements give the TRUE differences between evaporation and boiling? I. Evaporation occurs at all temperatures while boiling occurs at a fixed temperature for a given pressure II. Evaporation is a surface phenomenon while boiling is an interior phenomenon III. Evaporation is affected by surface area while boiling is not A. I and II only B. I and III only. C. II and III only D. I, II and III

26. A well-lagged bar of length 100cm has its ends maintained at 100°C and 40°C respectively. What is the temperature at a point 60cm from the hotter end? A. 58°C B. 62°C C. 64°C D. 76°C

27. Which of the following is the exclusive property of a transverse wave? A. Diffraction B. Refraction. C. Compression D. Polarization

28. The wavelength of signals from a radio transmitter is 1500m and the frequency is 200kHz. What is, the wavelength for a transmitter operating at 1000kHz? A. 7500m B. 300m C. 75m D. 15m

29. The difference between sound waves and light waves is that sound waves A. are transverse while light waves are longitudinal B. require a medium to travel while light waves do not C. can be diffracted but light waves cannot D. cannot be reflected but light waves can.

30. Which of the diagrams below represents the second overtone of a vibrating string fixed at both ends?

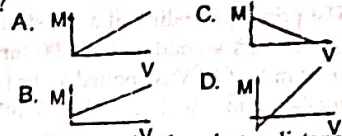


31. The pitch of an acoustic device can be increased by A. increasing the frequency B. increasing the amplitude C. decreasing the loudness D. decreasing the intensity

32. Total eclipse of the sun occurs when the A. earth is between the moon and the sun B. sun is between the moon and the earth C. moon is between the sun and the earth D. ozone layer is threatened.

33. What is the approximate critical angle for total internal reflection for diamond if the refractive index of diamond is 2.42? A. 21° B. 22° C. 23° D. 24°

34. Which of the graphs represents the relationship between m and v for a covering mirror?



35. A real object is placed at a distance u cm in front of a curved mirror of focal length f cm. If the image is upright and magnified, then the mirror is A convex and $u = 2f$ B. concave and $u = 2f$ C. convex and $u = \frac{f}{2}$ D. concave and $u = \frac{f}{2}$

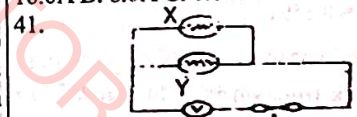
36. Which of the following pairs of colours gives the widest separation in the spectrum of white light? A. Red and violet B. Green and yellow C. Red and indigo D. Yellow and violet.

37. Two parallel plates at a distance of $8.0 \times 10^{-3} \text{ m}$ apart are maintained at a p.d. of 600 volts with the negative plate earthed. What is the electric field strength? A. 4.8 Vm^{-1} B. 75.0 Vm^{-1} C. 4800.0 Vm^{-1} D. 75000.0 Vm^{-1}

38. At different locations on the earth's surface, the earth's magnetic field is A. the same in magnitude and direction B. the same in magnitude but different in direction C. different in both magnitude and direction D. different in magnitude but not in direction

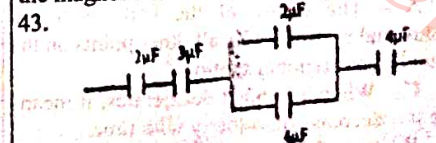
39. If a resistance is halved in value and the potential difference across it is tripled, then the ratio of the new current to the old is A. 1:6 B. 1:3 C. 2:1 D. 6:1

40. A 12-V battery has an internal resistance of 0.5W. If a cable of 1.0W resistance is connected across the two terminals of the battery, the current drawn from the battery is A. 16.0A B. 8.0A C. 0.8A D. 0.4A



The diagram above shows two similar bulbs X and Y connected to a suitable power supply with F as an appropriate fuse rating. If the filament of X breaks, then the A. brightness of Y will reduce B. brightness of Y will remain constant C. brightness of Y will increase D. fuse F will blow.

42. The purpose of a dielectric material in a parallel plate capacitor is to A. increase its capacitance B. decrease its capacitance C. insulate the plates from each other D. increase the magnetic field between the plates.



43.

The resultant capacitance in the figure above is
 A. 15.0 μ F B. 9.8 μ F C. 1.3 μ F D. 0.8 μ F
 44. An electric current of 2 amperes flows in a heating coil of resistance 50 ohms for 3 minutes 20 seconds. Determine the heat produced A. 0.5 kJ B. 8.0 kJ C. 20.0 kJ D. 40.0 kJ

45. If the maximum voltage across a 100-ohm resistor is 20V, then the maximum power it can dissipate is A. 5.00 W B. 4.00 W C. 2.00 W D. 0.25 W

46. Which of the following is required to convert a milliammeter to an ammeter? A. A high resistance in parallel B. A high resistance in series C. A low resistance in parallel D. A low resistance in series.

47. The primary winding of a transformer has 400 turns and its secondary has 100 turns. If a source of e.m.f. of 12 V is applied to the primary, the secondary e.m.f. will be A. 3 V B. 6 V C. 24 V D. 48 V.

48. An alternating source is connected in series to a capacitor of capacity reactance of $10^3\sqrt{3}$ and a resistor of resistance $10^3\Omega$. The impedance of the circuit is A. $2000\sqrt{3}\Omega$ B. 2000Ω C. $1000\sqrt{3}\Omega$ D. 1000Ω .

49. The half-life of a radioactive element is 9 days. What fraction of atoms has decayed in 36 days? A. $\frac{1}{16}$ B. $\frac{1}{4}$ C. $\frac{1}{2}$ D. $\frac{15}{16}$

50. A light of energy 5eV falls on a metal and the electrons with a maximum kinetic energy of 2eV are ejected. The work function of the metal is A. 0.4eV B. 2.5eV C. 3.0eV D. 7.0eV

1995 UME PHYSICS SOLUTION

1. A - Pressure = $\frac{\text{Force}}{\text{Area}} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

2. A - KEY \Rightarrow A complete oscillation entails a to and fro motion. Thus, if it passes the lowest point (or any other point) twice in a second, it simply means it takes 1s to complete one oscillation i.e. $T = 1s$

$$T = 2\pi \sqrt{\frac{l}{g}}$$

$$l = 2 \times 3.142 \sqrt{\frac{l}{10}}$$

$$l = 6.284 \sqrt{\frac{l}{10}}$$

$$\sqrt{\frac{l}{10}} = \frac{1}{6.284} = 0.1591$$

$$\frac{l}{10} = 0.1591^2 = 0.02532$$

$$l = (0.02532 \times 10)m = 0.25m$$

3. A - $\vec{P} = \vec{Q} + \vec{R}$

Note the directions of the arrows

4. C - KEY \Rightarrow The vertical components of the tensions in the strings will balance the weight.

Thus,

$$T \sin 30 - T \sin 30 = 20$$

$$0.5T + 0.5T = 20; T = 20N$$

Note that the horizontal components of the tensions in the strings are in opposite directions, so they cancel out.

5. A - The centre of the ball undergoes translational motion while all other points on the ball undergo rotational motion.

6. C - When an object decelerates, it means there is a decrease of velocity with time.

7. B - $m_1 = 20kg$, $m_2 = 30kg$

$$T - m_1 g \sin \theta = ma \dots\dots\dots (i)$$

$$M_2 g - T = m_2 a \dots\dots\dots (ii)$$

From equation (i)

$$T - 20(10) \times \sin 30^\circ = 20a; T - 100 = 20a \dots\dots$$

(iii)

From equation (ii)

$$30(10) - T = 30a; 300 - T = 30a \dots\dots\dots$$

(iv)

Add equations (iii) and (iv)

$$200 = 5a; a = \frac{200}{5} = 4m/s^2$$

$$8. C - g_{\text{moon}} = \frac{1}{6} g_{\text{earth}}$$

$$= \frac{1}{6} \times 10m/s^2$$

$$= 1.67m/s^2$$

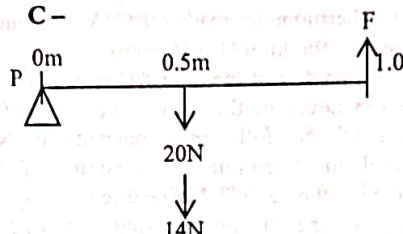
$$9. D - V = \sqrt{2gR}$$

(V = escape velocity, g = acceleration due to gravity, R = radius of the earth = $6.4 \times 10^3 km = 6.4 \times 10^6 m$)

$$V = \sqrt{2 \times 10 \times 6.4 \times 10^6}$$

$$= \sqrt{1.28 \times 10^8} = 11313.7m/s = 11.3km/s$$

10. C -



At the 0.5m, the two weights are the weight of the rod and the 14N

Total weight at the centre = (20N + 14N) = 34N

$$(34 \times 0.5) = F \times 1$$

$$F = 17N$$

11. D - Power \times time = $\frac{1}{2}mv^2$

$$t = \frac{\frac{1}{2}mv^2}{P} = \frac{mv^2}{2P}$$

12. C - Horizontal component of the force = $300 \cos 60^\circ$

Resultant force = (150 - 100)N = 50N

Distance = 4m

$$\text{Work} = \text{force} \times \text{distance} = (50 \times 4)J = 200J$$

13. D - Friction has some advantages, likewise some disadvantages.

Advantages

- It allows walking without slipping.
- It permits driving without skidding.
- It is useful for holding belts on machinery.
- It allows nails to be driven into walls.

Disadvantages

- It causes wear and tear.
- It causes overheating.
- It reduces the efficiency of machines.

$$14. A - E = \frac{1}{2} Fe = \frac{1}{2} \times 500 \times 0.02 \Rightarrow 5J$$

$$15. C - V.R = \frac{\text{Effort distance}}{\text{Load distance}}$$

V.R is greatest in option C

$$V.R :: \frac{3cm}{1cm} = 3$$

$$M.A = \frac{e \times V.R}{100}$$

Thus, the one that has the greatest V.R will have the greatest M.A (the two are directly proportional to each other).

16. A - From Pascal's principle of transmissibility of pressure,

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_1 = 500N, A_1 = \pi r^2 = 3.142 \times 0.2^2 = 0.12568m^2,$$

$$A_2 = \pi r^2 = 3.142 \times 0.8^2 = 2.01088m^2$$

$$\frac{500}{0.12568} = \frac{F_2}{2.01088}; F_2 = \left(\frac{500 \times 2.01088}{0.12568}\right) N = 8000N$$

17. B - Pressure increases as we go down the lake

($P = h\rho g$).

Thus, as the bubble rises to the top, the pressure decreases.

18. B - It is a measure of the mean kinetic energy of the molecules of the object.

$$19. B - Y = \frac{\Delta V}{V \Delta \theta}$$

$$\Delta V = YV \Delta \theta = 3 \times 1.2 \times 10^{-5} \times 10^{-6} \times 1.08 \times 10^8 m^3$$

$$\text{Percentage increase} = \frac{\Delta V}{V} \times 100\%$$

$$= \frac{1.08 \times 10^{-8}}{10^{-6}} \times 100\%$$

$$= 1.08\% \approx 1.1\%$$

20. A - As the temperature rises, the density of water (originally at room temperature) decreases. Since volume varies inversely as density, more of the liquid (greater volume) will have to be displaced for the object to remain afloat.

21. B - $V \propto T$ (Pressure is constant)

$$V = KT; K = \frac{V}{T}$$

This can be written in a linear fashion as $VT^{-1} = P^0 V^1 T^{-1} = K$

Thus, if $P^x V^y T^z = K$ presents Charles' law:

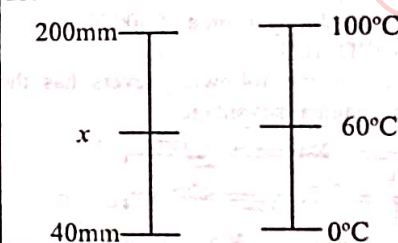
$$x = 0, y = 1, z = -1$$

22. B - $P \times t = mc \Delta \theta$

$$2000 \times t = 2 \times 4200 \times (100 - 20)$$

$$2000t = 672000; t = \frac{672000}{2000} = 336s$$

23. D -



$$\frac{200-40}{x-40} = \frac{100-0}{60-0}$$

$$\frac{160}{x-40} = \frac{100}{60}$$

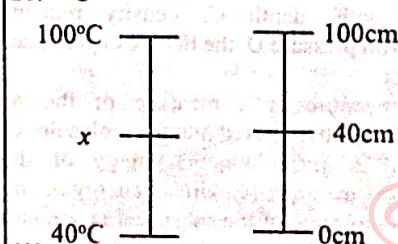
$$x-40 = \frac{160 \times 60}{100} = 96$$

$$x = (96 + 40)mm = 136mm$$

24. D - Since water does not boil at 90°C, the specific latent heat of vapourization will not be needed in our estimation.

25. D - The three statements correctly depict the differences between boiling and evaporation

26. C -



$$\frac{100-40}{x-40} = \frac{100-0}{40-0}; \frac{60}{x-40} = \frac{100}{40}$$

$$x-40 = \frac{60 \times 40}{100} = 24$$

$$x = (24 + 40)^\circ C = 64^\circ C$$

Please note that 60cm from the hotter (upper) end actually means 40cm from the cooler (lower) end, since the total length is 100cm.

27. D - Polarization is an exclusive property of a transverse wave; longitudinal waves do not undergo polarization.

28. $B \rightarrow \lambda = \frac{v}{f}$ i.e. $\lambda \propto \frac{1}{f}$

Then, $\lambda_1 f_1 = \lambda_2 f_2$
 $\lambda_2 = \frac{\lambda_1 f_1}{f_2} = \frac{1500 \times 200 \times 10^3}{1000 \times 10^3} = 300\text{m}$

29. B - Sound wave is a mechanical wave (it requires a medium for propagation) while light wave is an electromagnetic wave (it does not require a medium for propagation).

30. C - Option A \Rightarrow Fundamental or first harmonic

Option B \Rightarrow First overtone or second harmonic

Option C \Rightarrow Second overtone or third harmonic

Option D \Rightarrow Third overtone or fourth harmonic

31. A - Since pitch depends on frequency, one can increase the pitch by increasing the frequency. Note that:

- (i) Quality depends on overtone and
- (ii) Loudness depends on amplitude

32. C - Eclipse of the sun (or solar eclipse) occurs when the moon comes between the sun and the earth.

Eclipse of the moon (or lunar eclipse) occurs when the earth comes between the sun and the moon.

33. $D \rightarrow n = \frac{1}{\sin c}$; $\sin c = \frac{1}{n} = \frac{1}{2.42} = 0.4132$
 $C = \sin^{-1} 0.4132 = 24.4^\circ$

34. $D \rightarrow m = \frac{v}{f} - 1$

If this is compared with the equation of straight line, $y = mx + c$

Gradient, $m = \frac{1}{f}$ and intercept $c = -1$

This is as shown in graph 'D'

35. D - First of all note that a convex mirror can never form a magnified image. Also, for a concave mirror to form an erect (upright) image, the object must be positioned such that the object distance u , is less than the focal length, f .

36. A -
 Red, Orange, Yellow, Green, Blue, Indigo, Violet

Increasing separation/deviation \rightarrow

37. $D \rightarrow E = \frac{V}{d} = \left(\frac{600}{8 \times 10^{-3}}\right) \text{Vm}^{-1} = 75000 \text{Vm}^{-1}$

38. C - At different location on the earth's surface, the earth's magnetic field is different both in magnitude and direction.

39. $D \rightarrow V = IR$; $I = \frac{V}{R}$

$I_1 = \frac{V_1}{R_1}$
 $R_2 = \frac{1}{2} R_1$, $V_2 = 3V_1$

Then,
 $I_2 = \frac{V_2}{R_2} = \frac{3V_1}{\frac{1}{2}R_1} = \frac{6V_1}{R_1}$

Thus,
 $I_2 : I_1 = \frac{6V_1}{R_1} \div \frac{V_1}{R_1} = \frac{6V_1}{R_1} \times \frac{R_1}{V_1} = \frac{6}{1} = 6 : 1$

40. $B \rightarrow I = \frac{E}{R+r} = \frac{12}{1+0.5} = \frac{2}{1.5} = 8\text{A}$

41. B - If the filament X breaks, the brightness of Y will not be affected since the two of them are independently connected to a given potential difference V (parallel connection). For a series connection, the termination of one filament will cause the brightness of the other to increase

42. $A \rightarrow C = \frac{AK\epsilon_0}{d}$

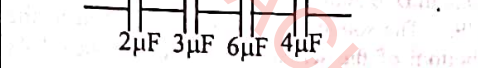
(A = Area of overlap, K = dielectric constant, ϵ_0 = permittivity of free space, d = separation between the two plates).

As can be seen, C and K vary directly as each other.

43. D -



For the parallel connection of 2μ and 4μ , $C = 2\mu\text{F} + 4\mu\text{F} = 6\mu\text{F}$. Then, we have:



As can be seen, this gives a resultant series connection. Thus, the effective capacitance, C_{eff} is given by

$\frac{1}{C_{eff}} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} + \frac{1}{4} = \frac{6+4+2+3}{12} = \frac{15}{12}$

$C_{eff} = \left(\frac{12}{15}\right)\mu\text{F} = 0.8\mu\text{F}$

44. $D \rightarrow H = I^2 R t = 2^2 \times 50 \times (3 \times 60 + 20) = 4 \times 50 \times 200 \Rightarrow 40000\text{J} = 40\text{KJ}$

45. $B \rightarrow P = \frac{V^2}{R} = \frac{20^2}{100} = 4\text{W}$

46. C - To convert a millimeter to ammeter, a low resistance known as the shunt should be connected in parallel with it.

47. $A \rightarrow \frac{N_s}{N_p} = \frac{V_s}{V_p}$; $\frac{100}{400} = \frac{V_s}{12}$; $V_s = \left(\frac{100 \times 12}{400}\right) V = 3V$

48. $B \rightarrow Z = \sqrt{R^2 + X_c^2} = \sqrt{(10^3)^2 + (10^3 \sqrt{3})^2}$

$= \sqrt{10^6 + 10^6 \times 3} = \sqrt{4 \times 10^6} = 2000\Omega$

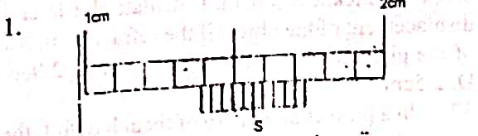
49. $D \rightarrow$ Fraction that remains $= \left(\frac{1}{2}\right)^{\frac{36}{9}} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$

Fraction that has decayed $= 1 - \frac{1}{16} = \frac{15}{16}$

50. C - Photon energy = work function + kinetic energy of electrons

$5\text{eV} = W_0 + 2\text{eV}$
 $W_0 = 5\text{eV} - 2\text{eV} = 3\text{eV}$

1994 UME PHYSICS SOLUTION QUESTIONS



1. What is the reading of the vernier calipers shown above? A. 1.73cm B. 1.73cm C. 1.39cm D. 1.34cm

2. If it takes 5.0 hours to drain a container of 540.0cm³ of water, what is the flow rate of water from the container in kg s⁻¹? A. 32.5 B. 31.5 C. 30.8 D. 30.0 (Density of water 1000 kgm⁻³)

3. A boat travels due east at a speed of 40ms⁻¹ across a river flowing due south at 30ms⁻¹. What is the resultant speed of the boat? A. 1.3ms⁻¹ B. 10.0ms⁻¹ C. 50.0ms⁻¹ D. 70.0ms⁻¹

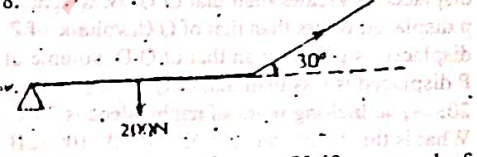
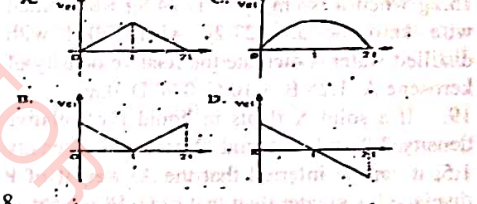
4. An object is projected with a velocity of 80ms⁻¹ at an angle of 30° to the horizontal. The

maximum height reached is A. 20m B. 80m C. 160m D. 320m

5. A motor vehicle is brought to rest from a speed of 15ms⁻¹ in 20 seconds. Calculate the retardation. A. 0.75ms⁻² B. 1.33ms⁻² C. 5.00ms⁻² D. 7.50ms⁻²

6. Which of the following is TRUE of a particle moving in a horizontal circle with constant angular velocity A. The energy is constant but the linear momentum varies B. The linear momentum is constant but the energy varies C. Both energy and linear momentum are constant D. The speed and the linear velocity are both constant

7. A stone thrown vertically upwards returns to the ground. Which of the following figures represents the velocity-time graph?



The diagram above shows a Uniform wood of weight 200 N and length 50m. It is pivoted at one end and suspended by a cord at the other end, at an angle of 30° to the wood. Calculate the tension in the cord if the wood is horizontal. A. 10 N B. 20 N C. 100 ND. 200N

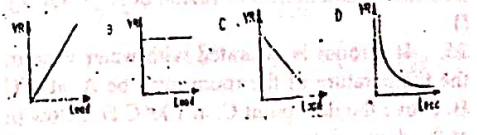
9. An object of mass 50kg is released from a height of 2m. Find the kinetic energy just before it strikes the ground. A. 250 J B. 1000 J C. 10 000 JD. 100000J

10. A cone in an unstable equilibrium has its potential energy A. decreased B. increased C. unchanged D. oscillating

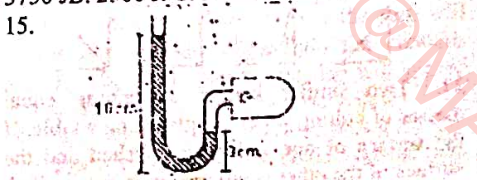
11. Calculate the magnitude of the force required to just move a 20kg object along a horizontal surface if the coefficient of friction is 0.2 A. 400.0 NB. 400 N C. 4.0 N D. 0.4 N (g = 10ms⁻²)

12. Calculate the velocity ratio of a screw jack of pitch 0.3cm if the length of the tommy bar is 21cm A. $\frac{1}{140}\pi$ B. 14π C. 70π D. 140π

13. Which of the following graphs correctly represents the relationship between the load and the velocity ratio of a machine?



14. A spring of length 25cm is extended to 30cm by a load of 150 N attached to one of its ends. What is the energy stored in the spring? A. 3750 JB. 2500 J C. 3.75 J D. 2.50 J



15.

In the diagram above, if the atmospheric pressure is 760mm the pressure in the chamber G is A. 660mm B. 690mm C. 830mm D. 860mm

16. A force of 15 N stretches a spring to a total length of 30cm. An additional force of 10 N stretches the spring 5cm, further. Find the natural length of the spring A. 25.0cm B. 22.5cm C. 20.0cm D. 15.0cm

17. Which of these statements are TRUE of pressure in liquids? I. Pressure acts equally in all directions II. Pressure decreases with depth III. Pressure at the same level of a liquid is the same IV. Pressure is dependent on the cross-sectional area of the barometer tube. A. I and III only B. I, II and III only C. I, III and IV only D. I, II, III and IV.

18. The mass of a specific gravity bottle is 15.2g when it is empty. It is 24.8g when filled with kerosene and 27.2g when filled with distilled water. Calculate the relative density of kerosene A. 1.25 B. 1.10 C. 0.90 D. 0.80

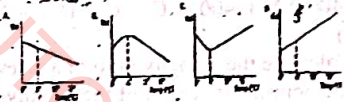
19. If a solid X floats in liquid P of relative density 2.0 and in liquid Q of relative density 1.5, it can be inferred that the A. weight of P displaced is greater than that of Q B. weight of P displaced is less than that of Q C. volume of P displaced is greater than that of Q D. volume of P displaced is less than that of Q.

20. The melting point of naphthalene is 78°C. What is this temperature in Kelvin? A. 100 K B. 351 K C. 378 K D. 444 K

21. A motor tyre is inflated to pressure of $2.0 \times 10^5 \text{ Nm}^{-2}$ when the temperature of air is 27°C. What will be the pressure in it at 87°C assuming that the volume of the tyre does not change? A. $2.6 \times 10^5 \text{ Nm}^{-2}$ B. $2.4 \times 10^5 \text{ Nm}^{-2}$ C. $2.2 \times 10^5 \text{ Nm}^{-2}$ D. $1.3 \times 10^5 \text{ Nm}^{-2}$

22. When 100g of liquid L_1 at 7.8°C was mixed with Xg of liquid L_2 at 50°C, the final temperature was 60°C. Given that the specific heat capacity of L_2 is half that of L_1 , find X. A. 50g B. 100g C. 150g D. 200g

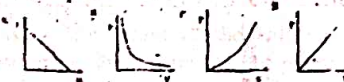
23. A volume of water is heated from 0°C to 15°C. Which of the following diagrams correctly represents the variation of the volume with temperature?



24. Heat is supplied to a test tube containing 100g of ice at its melting point. The ice melts completely in 1min. What is the power rating of the source of heat? A. 336 W B. 450 W C. 560 W D. 600 W (Latent heat of fusion of ice = 336 Jg^{-1})

25. If a room is saturated with water vapour, the temperature of the room must be A. at 0°C B. above the dew point C. at 100°C D. below or at the dew point.

26. Which of the following graphs represents the variation of pressure P against volume V at constant temperature?



27. Two similar kettles, containing equal masses of boiling water are placed on a table. If the surface of one is highly polished and the surface of the other is covered with soot which

of the following observations is correct? A. The two kettles will cool down at the same rate B. The polished kettle cools down more quickly by conduction C. The kettle covered with soot cools down more quickly because it is a good radiator of heat D. The kettle covered with soot cools down more quickly by the process of heat convection.

28. The equation of transverse wave travelling along a string is given by $y = 0.3 \sin(05x - 50t)$ where y and x are in cm and t is in seconds. Find the maximum displacement of the particles from the equilibrium position. A. 50.0cm B. 2.5cm C. 0.5cm D. 0.3cm

29. The sound from a source travelled to the bottom of the sea and the echo was heard 4s later. If the speed of sound in sea water is 1500 ms^{-1} , the depth of the sea is. A. 6000m. B. 3000m C. 1500m D. 375m

30. The fundamental frequency of vibration of a sonometer wire may be halved by. A. doubling the length of the wire B. doubling the mass of the wire C. reducing the tension by half D. reducing the absolute temperature by half.

31. A pipe of length 45cm is closed at one end. Calculate the fundamental frequency of the sound wave generated in the pipe if the velocity of sound in air is 360 ms^{-1} (Neglect end corrections). A. 5.5 Hz B. 148.5Hz C. 200.0 Hz D. 550.0 Hz

32. The note produced by a stretched string has a fundamental frequency of 400 Hz. If the length of the string is doubled while the tension in the string is increased by a factor of 4, the frequency is A. 200 Hz B. 400 Hz C. 800 Hz D. 1600 Hz

33. To produce a parallel beam of light from a concave mirror, the distance at which the lamp should be placed from the mirror is equal to A. the focal length B. two times the focal length C. the distance of the image D. two times the radius of curvature

34. Light of frequency $6.0 \times 10^{14} \text{ Hz}$ travelling in air is transmitted through glass of refractive index 1.5. Calculate the frequency of the light in the glass. A. $4.0 \times 10^{14} \text{ Hz}$ B. $6.0 \times 10^{14} \text{ Hz}$ C. $7.5 \times 10^{14} \text{ Hz}$ D. $9.0 \times 10^{14} \text{ Hz}$

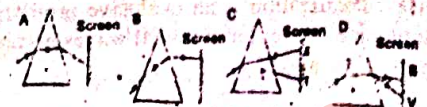
35. An object is placed in front of a converging lens of focal length 20cm. The image is virtual and has a magnification of 2. What is the distance of the object from the lens? A. 5cm B. 10cm C. 30cm D. 40cm

36. An object is placed directly below a glass block of thickness 3.0cm. Calculate the lateral displacement of the object if the refractive index of the glass is 1.5. A. 1.0cm B. 1.5cm C. 2.0cm D. 2.5cm

37. In a projection lantern of focal length f, the object distance u, is such that A. $u > 2f > f$ B. $u < f < 2f$ C. $u = f < 2f$ D. $f < u < 2f$

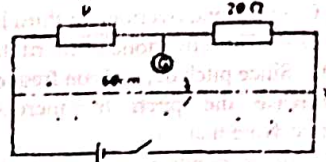
38. If the Nigerian flag (green, white, green) is viewed in pure yellow light, which of the following set of colours would be observed on the flag? A. Green, yellow, green B. Red, yellow, red C. Black, yellow, black D. Green, white, green

39. Which of the figures below illustrates the dispersion of white light through a triangular glass prism?



40. Which of the following has the lowest internal resistance when new? A. Leclanche cell B. Daniel cell C. Accumulator D. Torch battery

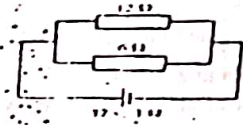
41. When a biro pen rubbed on a dry silk cloth is moved very close to a piece of paper on a dry table, the pen is found to pick up the paper. This is because A. both the pen and the cloth are magnetized B. the pen is magnetized but the cloth is not C. the pen is charged while the cloth is magnetized D. both the pen and the cloth are charged.



In the figure above, XY is of length 1 m. The value of R at balance point Z is A. 3.0Ω B. 13.3Ω C. 15.0Ω D. 30.0Ω

43. A capacitor $8\mu\text{F}$, is charged to a potential difference of 100V. The energy stored by the capacitor is A. $1.0 \times 10^4 \text{ J}$ B. $8.0 \times 10^4 \text{ J}$ C. $1.25 \times 10^4 \text{ J}$ D. $4.0 \times 10^2 \text{ J}$

44. Two resistors, $R_1 = 4\Omega$ and $R_2 = 5\Omega$, are connected in parallel across a potential difference. If P_1 and P_2 represent the power dissipated in R_1 and R_2 respectively, then the ratio $P_1 : P_2$ is A. 4 : 5 B. 5 : 4 C. 16 : 25 D. 25 : 16



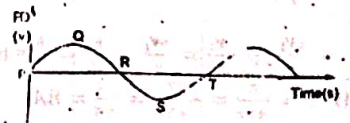
In the circuit diagram above, calculate the current in the 12Ω resistor if the cell has an e.m.f. of 12V and an internal resistance of 1Ω . A. 0.8A B. 1.0A C. 1.6A D. 2.4A

46. Which of the following are found in the receiver but not in the microphone of a telephone handset? I. Diaphragm II. Soft iron pole pieces III. Permanent magnet IV. Carbon blocks A. I and II B. I and IV C. II and III D. III and IV.

47. If two parallel conductors carry currents flowing in the same direction, the conductors will A. attract each other B. repel each other C. both move in the same direction D. have no effect on each other

48. A certain radioisotope of ${}^{235}_{92}\text{U}$ emits four alpha particles and three beta particles. The mass number and the atomic number of the resulting element respectively are A. 219 and 87 B. 84 and 223 C. 223 and 87 D. 219 and 81.

49. In the curve above, PQRST represents an alternating voltage of frequency 50 Hz. The time interval between points P and R on the graph is A. 25s B. $\frac{1}{50}\text{s}$ C. $\frac{1}{100}\text{s}$ D. $\frac{1}{200}\text{s}$



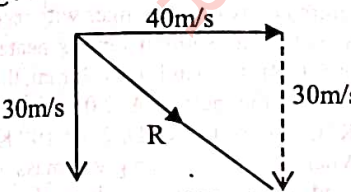
50. If light with photon energy 2eV is incident suitably on the surface of a metal with work function 3eV, then A. no electron will be emitted B. the few electrons emitted will have a

maximum kinetic energy of 1eV C. the few electrons emitted will be have a maximum kinetic energy of 3eV D. many, electrons will be emitted.

1994 UME PHYSICS SOLUTION

1. C - Main reading = 1.3cm
Position of the vernier line that comes most directly in line with the main scale = 9
Reading accuracy of vernier caliper = 0.01cm
Then,
Vernier reading = $(9 \times 0.01)\text{cm} = 0.09\text{cm}$
Total reading = main reading + Vernier Reading
= 1.3cm + 0.09cm
= 1.39cm

2. D - Mass of water = density of water \times volume of water
= $1000\text{kgm}^{-3} \times 540\text{cm}^3$
= $5.4 \times 10^5\text{kg}$
Time = 5 hours
= $(5 \times 3600)\text{s} = 18000\text{s}$
Rate of flow $\frac{\text{mass}}{\text{time}} = \frac{5.4 \times 10^5\text{kg}}{18000\text{s}} = 30\text{kg s}^{-1}$

3. C -

 $R^2 = 40^2 + 30^2 = 1600 + 900 = 2500$
 $R = \sqrt{2500} = 50\text{m/s}$

4. B - $H_{\text{max}} = \frac{u^2 \sin^2 \theta}{2g} = \frac{80^2 (\sin 30^\circ)^2}{20} = 80\text{cm}$
5. A - $u = 15\text{m/s}$, $t = 20\text{s}$, $v = 0$, $a = ?$
 $v = u + at$
 $0 = 15 + 20a$
 $20a = -15$
 $a = -\frac{15}{20} = -0.75\text{m/s}^2$
The retardation/deceleration is 0.75m/s^2

6. A - A body undergoing a circular motion at a constant speed is still accelerating! This is because the direction is constantly changing. In other words, although the speed is constant, the velocity (which is a vector quantity and as such depends on direction) is changing. Since the velocity is changing, the linear momentum is also changing. Since the magnitude of the velocity (which is the speed) is constant, the energy is also constant.

7. B - When an object is thrown vertical upwards, its velocity decreases. The velocity reduces to zero when it gets to the maximum height, after which it starts increasing as the object starts coming down.

8. D - KEY \Rightarrow The weight of the wood creates clockwise moment while the vertical component of the tension in the string creates anticlockwise moment.

Weight = 200N
Vertical component of tension, $T = T \sin 30^\circ$
Clockwise moment = anticlockwise moment
 $200 \times 25 = T \sin 30^\circ \times 50 = 25T$
 $T = \frac{(200 \times 25)}{25} = 200\text{N}$

9. B - KEY \Rightarrow The kinetic energy before hitting the ground equals the potential energy at the highest level.
 $P.E = mgh = (50 \times 10 \times 2)\text{J} = 1000\text{J}$

10. B - Since the centre of gravity is raised when an object is an unstable equilibrium, the potential energy is raised.

11. B - KEY \Rightarrow The force that will be required to just move the object is simply the force required to overcome the friction
 $F_r = \mu R = \mu mg = (0.2 \times 20 \times 10)\text{N} = 40\text{N}$

12. D - Pitch, $P = 0.3\text{cm}$
Length of tommy bar, $L = 21\text{cm}$
 $V.R = \frac{2\pi L}{P} = \frac{2 \times \pi \times 21}{0.3} = \left(\frac{2 \times 21}{0.3}\right)\pi = 140\pi$

13. B - The velocity ratio is a ratio of distances. Thus, the variation of load does not affect it; as load increases (or decreases), the velocity ratio is constant.

14. C - $e = 30\text{cm} - 25\text{cm} = 5\text{cm} = 0.05\text{m}$
Energy = $\frac{1}{2}Fe = (\frac{1}{2} \times 150 \times 0.05)\text{J} = 3.75\text{J}$

15. C - $P_{\text{atm}} + 10\text{cmHg} = P_{\text{gas}} + 3\text{cmHg}$
Since the atmospheric pressure is quoted in mmHg and the options are also supplied in same, we bring all the units to mmHg.

$10\text{cmHg} = 100\text{mmHg}$; $3\text{cmHg} = 30\text{mmHg}$
 $760\text{mmHg} + 100\text{mmHg} = P_{\text{gas}} + 30\text{mmHg}$
 $P_{\text{gas}} = (760 + 100 - 30)\text{mmHg} = 830\text{mmHg}$

16. B - $e_1 = 30 - l_0$; $e_2 = 35 - l_0$. From Hooke's law:
 $\frac{F_1}{e_1} = \frac{F_2}{e_2}$; $\frac{15}{30 - l_0} = \frac{25}{35 - l_0}$; $l_0 = 22.5\text{cm}$

17. A - Pressure does not decrease with depth, it increases instead.
Pressure does not depend on the cross-sectional area of the container

18. D - Mass of kerosene = $24.8\text{g} - 15.2\text{g} = 9.6\text{g}$
Mass of water = $27.2\text{g} - 15.2\text{g} = 12\text{g}$

$R.D \text{ of kerosene} = \frac{\text{mass of kerosene}}{\text{mass of equal volume of water}} = \frac{9.6\text{g}}{12\text{g}} = 0.8$

19. D - The weight of the fluids displaced must be equal to the weight of the floating object. Since the density of P is greater than that of Q, less volume of P will be required to give the same mass, which is the mass of the floating object.

20. B - $T(k) = T(^{\circ}\text{C}) + 273$
 $= (78 + 273)\text{K} = 351\text{K}$

21. B - $P_1 = 2 \times 10^5\text{Nm}^{-2}$, $T_1 = 27^{\circ}\text{C} = (27 + 273)\text{K} = 300\text{K}$
 $T_2 = 87^{\circ}\text{C} = (87 + 273)\text{K} = 360\text{K}$
 $\frac{P_1}{T_1} = \frac{P_2}{T_2}$; $P_2 = \frac{P_1 T_2}{T_1} = \left(\frac{2 \times 10^5 \times 360}{300}\right)\text{Nm}^{-2} = 2.4 \times 10^5\text{Nm}^{-2}$

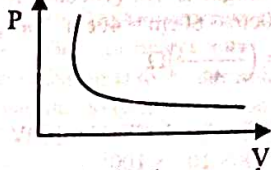
22. C - KEY \Rightarrow Heat lost by the host liquid equal the heat gain by the other liquid
 $M_1 C_1 \Delta \theta_1 = M_2 C_2 \Delta \theta_2$
 $C_2 = \frac{1}{2} C_1 = 0.5 C_1$. Then,
 $100 \times C_1 \times (78 - 66) = M_2 \times 0.5 C_1 \times (66 - 50)$
 $100 \times C_1 \times (78 - 66) = \frac{100 \times C_1 \times 12}{0.5 C_1 \times (66 - 50)}$
 $M_2 = \frac{100 \times C_1 \times (78 - 66)}{0.5 C_1 \times (66 - 50)} = \frac{100 \times C_1 \times 12}{0.5 C_1 \times 16} = 150\text{g}$

23. C - The behavior of water between 0°C and 4°C is anomalous - as the temperature rises, the volume of water decreases (as opposed to an increase that is expected for a normal liquid). From 4°C upwards, the volume now increases.

24. C - Power \times time = MLT
 $P \times 60\text{s} = 100\mu \times 336\text{Jg}^{-1} = 33600\text{J}$
 $P = \frac{33600\text{J}}{60\text{s}} = 560\text{Js}^{-1} = 560\text{W}$

25. D - The dew point is the temperature at which the water vapour present in the air is just sufficient to saturate it.

26. B - At constant temperature, the volume of a given mass of a gas is inversely proportional to the pressure



27. C - The kettle covered with soot cools down more quickly because it is a good radiator

28. D - $y = A \sin\left(\frac{2\pi x}{\lambda} - 2\pi f t\right)$
 $A = \text{Amplitude} = 0.3\text{cm}$ in the given equation. The amplitude is defined as the maximum displacement from the equilibrium position.

29. B - $V = \frac{2x}{t_{\text{echo}}}$; $x = \frac{V \cdot t_{\text{echo}}}{2}$
 $= \left(\frac{1500 \times 4}{2}\right)\text{m} = 3000\text{m}$

30. A - The fundamental frequency of vibration of a sonometer wire may be halved by doubling the length of the wire. This is evident from the equation:

$$F = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$

31. C - For a closed pipe, the fundamental frequency,

$$F = \frac{v}{4L}$$

$$V = 360\text{m/s}$$
, $L = 45\text{cm} = 0.45\text{m}$
 $F = \frac{360}{4 \times 0.45} = 200\text{Hz}$

32. B - $F \propto \frac{\sqrt{T}}{L}$; $F = \frac{K\sqrt{T}}{L}$; $K = \frac{FL}{\sqrt{T}}$

Then,
 $\frac{F_1 L_1}{\sqrt{T_1}} = \frac{F_2 L_2}{\sqrt{T_2}}$; $L_2 = 2L_1$ and $T_2 = 4T_1$

Then,
 $\frac{F_1 L_1}{\sqrt{T_1}} = \frac{F_2 \times 2L_1}{\sqrt{4T_1}}$; $F_2 = \frac{F_1 L_1 \times \sqrt{4T_1}}{2L_1 \times \sqrt{T_1}}$
 $= \frac{F_1 \times \sqrt{4}}{2} = \frac{F_1 \times 2}{2} = F_1$

Therefore, the new frequency will also be 400Hz.

33. A - It must be equal to the focal length
34. B - When light travels from one medium to the other, the frequency does not change. It is only the velocity and wavelength that change.

35. B - $m = 2 = \frac{v}{u}$; $V = 2U$
Since the image is virtual, we set V as $-2U$
 $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$; $\frac{1}{20} = \frac{1}{u} + \frac{1}{-2u} = \frac{1}{u} - \frac{1}{2u}$
 $\frac{1}{20} = \frac{1}{u} - \frac{1}{2u} = \frac{2-1}{2u} = \frac{1}{2u}$
 $2u \times 1 = 20 \times 1$, $u = \frac{20}{2} = 10\text{cm}$

36. A - $D = t \left(1 - \frac{1}{n}\right) = 3 \left(1 - \frac{1}{1.5}\right) = 3(0.3333) = 1\text{cm}$

37. B - In a projection lantern of focal length f , the object distance must be greater than f but less than $2f$.

38. A - Yellow = red + green; white = yellow + blue. Thus, the green part of the flag will appear green (since yellow light also contains green). The white part of the flag will appear yellow (since white light contains yellow).

39. C - The diagram will be as shown in "C". Note that the separation will begin from the first side of the prism.

40. C - A secondary cell (accumulator) has a low internal resistance while a primary cell has a high internal resistance.

41. D - Both the pen and the cloth are charged.

42. $D \frac{R_1}{L_1} = \frac{R_2}{L_2}$

Since the total length is 1m (100cm), if L_1 is known, $L_2 = 100\text{cm} - 60\text{cm} = 40\text{cm}$. Then,

$\frac{R}{60} = \frac{20}{40}$; $R = \left(\frac{60 \times 20}{40}\right)\Omega = 30\Omega$

43. $D - C = 8\mu\text{F} = 8 \times 10^{-6}\text{F}$; $V = 100\text{V}$

$E = \frac{1}{2}CV^2 = \frac{1}{2} \times 8 \times 10^{-6} \times 100^2$

$= 4 \times 10^{-2}\text{J}$

44. $B - P_1 = \frac{V^2}{R_1}$; $P_2 = \frac{V^2}{R_2}$

Note that the voltage is constant since the resistors are connected in parallel.

Then, we can write:

$P_1R_1 = P_2R_2$

Therefore,

$\frac{P_1}{P_2} = \frac{R_2}{R_1} = \frac{5}{4} = 5:4$

45. A - $I_1 = \frac{V}{R_1} = \frac{V}{R_1}$; $R_{\text{effective}} =$

$\left(\frac{12 \times 6}{12+6}\right)\Omega = 4\Omega$

The only problem here is that the voltage will not be up to 12V because of the internal resistance. We need to subtract the lost voltage, $v = Ir$ (where $r =$ internal resistance)

$I_{\text{total}} = \frac{E}{R+r} = \frac{12}{4+1} = 2.4\text{A}$

Lost voltage $= (2.4 \times 1) = 2.4\text{V}$

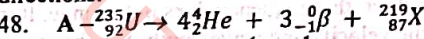
Terminal voltage, $V = 12\text{V} - 2.4\text{V} = 9.6\text{V}$

Then,

$I_1 = \frac{V}{R_1} = \left(\frac{9.6}{12}\right)\text{A} = 0.8\text{A}$

46. C - The component parts of a telephone earpiece consists of (i) the speech coils wound in opposite directions round the soft iron pole pieces placed at the ends of a permanent strong magnet (ii) a soft iron diaphragm made of magnetic alloy and located in front of the iron cores. Note that the microphone, unlike the earpiece, does not have permanent magnet.

47. A - They will attract each other since current is flowing in the same direction. They will repel if the current in them are in opposite directions.



49. $C - F = 50\text{Hz}$, $T = \frac{1}{F} = \frac{1}{50} = 0.02\text{s}$

PR represents half of a cycle, thus, the time taken to move from P to R must be half of the period $= \frac{0.02}{2} = 0.01\text{s} = \frac{1}{100}\text{s}$

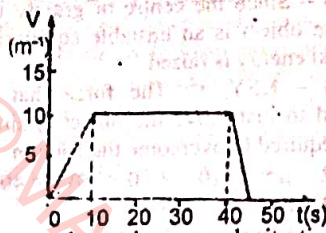
50. A - No electron will be emitted since the photon energy is less than the work function of the metal.

1993 UME PHYSICS QUESTIONS

1. Which of the following quantities has the same unit as the watt? A. Force x time B. Force x distance C. Force x acceleration D. Force x velocity

2. The external and internal diameters of a tube are measured as $(32 \pm 2)\text{mm}$ and $(21 \pm 1)\text{mm}$ respectively. Determine the percentage error in the thickness of the tube. A. 27% B. 14% C. 9% D. 3%

3.



The diagram above shows a velocity-time graph representing the motion of a car. Find the total distance covered during the acceleration and retardation periods of the motion. A. 75m B. 150m C. 300m D. 375m

4. Two forces of magnitudes 7N and 3N act at right angles to each other. The angle θ between the resultant and the 7N force is given by A. $\cos \theta = \frac{3}{7}$ B. $\sin \theta = \frac{3}{7}$ C. $\tan \theta = \frac{3}{7}$ D. $\cot \theta = \frac{3}{7}$

5. An aeroplane lands on a runway at a speed of 180 kmh⁻¹ and is brought to a stop uniformly in 30 seconds. What distance does it cover on the runway before coming to rest? A. 360m B. 540m C. 750m D. 957m

6. A rocket burns fuel at the rate of 10kgs⁻¹ and ejects it with a velocity of $5 \times 10^3\text{ms}^{-1}$. The thrust exerted by the gas on the rocket is A. $2.5 \times 10^7\text{N}$ B. $5.0 \times 10^4\text{N}$ C. $5.0 \times 10^2\text{N}$ D. $2.0 \times 10^{-3}\text{N}$.

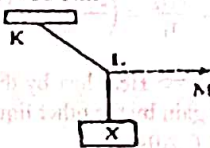
7. The force experienced by an object of mass 60.0kg in the moon's gravitational field is $1.002 \times 10^2\text{N}$. What is the intensity of the gravitational field? A. 0.60N kg^{-1} B. 1.67N kg^{-1} C. $6.12 \times 10^2\text{N kg}^{-1}$ D. 9.81ms^{-2}

8. Which of the following correctly describes the energy changes in the generation of light by a hydroelectric power station? A. Electrical \rightarrow mechanical \rightarrow potential \rightarrow light B. Potential \rightarrow mechanical \rightarrow electrical \rightarrow light C. Mechanical \rightarrow sound \rightarrow electrical \rightarrow light D. Kinetic \rightarrow mechanical \rightarrow electrical \rightarrow light

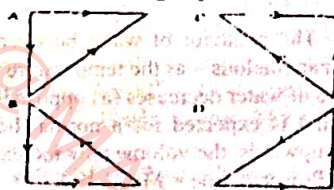
9. A plane inclined at angle θ has a velocity ratio of 10: 1. The inclination of the plane to the horizontal is given by A. $\tan \theta = \frac{1}{10}$ B. $\cot \theta = \frac{1}{10}$ C. $\cos \theta = \frac{1}{10}$ D. $\sin \theta = \frac{1}{10}$

10. A weightless vessel of dimensions 4m x 3m x 2m is filled with a liquid of density 1000 kgm⁻³ and sealed. What is the maximum pressure this container can exert on a flat surface? [$g = 10\text{ms}^{-2}$] A. $9 \times 10^4\text{Nm}^{-2}$ B. $4 \times 10^4\text{Nm}^{-2}$ C. $3 \times 10^4\text{Nm}^{-2}$ D. $2 \times 10^4\text{Nm}^{-2}$

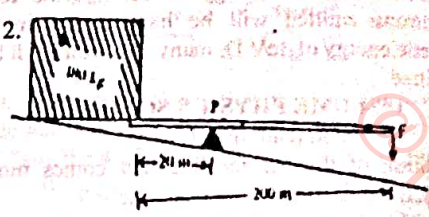
11.



In the figure above the weight X is held in position by pulling the rope KLM in the direction LM. Which of the following diagrams shows the force acting at point L?



12.



In the diagram above, a lever of length 200m is used to lift a load of mass 180kg. The pivot at P is 20m from the load. What minimum force, F, must be applied at the end of the lever? [$g = 10\text{ms}^{-2}$] A. 9N B. 18N C. 20N D. 200N

13. An object of mass 400g and density 600 kgm⁻³ is suspended with a string so that half of it is immersed in paraffin of density 900 kgm⁻³. The tension in the string is A. 1.0N B. 3.0N C. 4.0N D. 5.0N

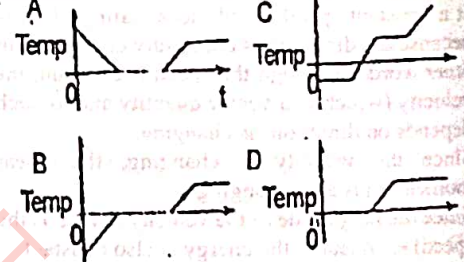
14. The thermometric property of the thermocouple is that its A. e.m.f. changes with temperature B. resistance changes with temperature C. volume changes with temperature D. pressure changes with resistance.

15. A metal rod 800mm long is heated from 10°C to 95°C. If it expands by 1.36mm, the linear expansivity of the metal is A. $2.0 \times 10^{-2}\text{K}^{-1}$ B. $2.0 \times 10^{-2}\text{K}^{-1}\text{C}$. $5.0 \times 10^{-3}\text{K}^{-1}$ D. $2.0 \times 10^{-5}\text{K}^{-1}$

16. When the volume of a given mass of gas is halved and its temperature doubled, the pressure A. remains constant B. increases by a factor of 4 C. increases by a factor of 3 D. decreases by a factor of 4.

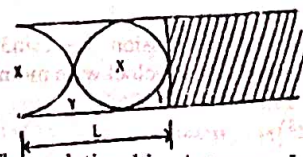
17. 200g of water at 90°C is mixed with 100g of water at 30°C. What is the final temperature? A. 50°C B. 60°C C. 70°C D. 80°C

18. A block of ice at 0°C is put in an open vessel and heated uniformly until half the water boils off. Which of the following graphs best illustrates the change in temperature during the process?



19. The melting point of a solid is given as 80°C. If 1.05J of heat energy is required at this temperature to melt 10g of the solid, the specific latent heat of fusion of the solid is A. $1.00 \times 10^3\text{J kg}^{-1}$ B. $1.25 \times 10^5\text{J kg}^{-1}$ C. $1.00 \times 10^7\text{J kg}^{-1}$ D. $8.00 \times 10^8\text{J kg}^{-1}$.

Use the figure below which shows a stationary wave in a closed tube to answer questions 20 and 21.



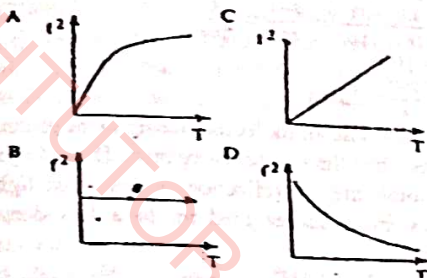
20. The relationship between L and the wavelength λ of the stationary wave is A. $2L = \lambda$ B. $L = \lambda$ C. $L = \frac{\lambda}{3}$ D. $4L = 3\lambda$.

21. Determine the distance between the consecutive antinodes XX' if the wavelength is 66cm. A. 15cm B. 30cm C. 60cm D. 120cm

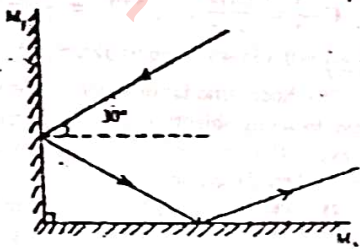
22. Which of the following waves can propagate through a vacuum? A. High velocity sound waves B. Ultrasonic waves C. Acoustic waves D. Infrared waves.

23. Radio waves emitted from an antenna are picked up by a radar after reflection from an aircraft in 4×10^{-4} s. How far is the aircraft from the antenna? [$c = 3 \times 10^8 \text{ ms}^{-1}$] A. $6.0 \times 10^7 \text{ ms}^{-1}$ B. $1.2 \times 10^3 \text{ km}$ C. $3.0 \times 10^3 \text{ km}$ D. $6.0 \times 10^3 \text{ km}$.

24. The fundamental frequency of vibration (f) of a wire is measured as a function of the tension (T) in the wire. Which of the following curves adequately represents the data?



25.



Two mirrors, M_1 , M_2 are inclined at right angles as shown above. Calculate the angle of reflection of the ray of light at mirror M_2 . A. 30° B. 45° C. 60° D. 90°

26. Which of the following expressions gives the linear magnification produced by a concave mirror of radius of curvature r, if u and v are the object and image distances respectively? A. $\frac{v}{r}$ - 1 B. $\frac{2v}{r}$ - 1 C. $\frac{u}{r}$ - 1 D. $\frac{2u}{r}$ - 1

27. If the focal length of a camera lens is 20cm, the distance from the film at which the lens must be set to produce a sharp image of an object 100cm away is A. 17cm B. 20cm C. 25cm D. 100cm

28. Which of the following may be used to explain a mirage? I. Layers of air near the road surface have varying refractive indices in hot weather II. Road surfaces sometimes become good reflectors in hot weather. III. Light from the sky can be reflected upwards after coming close to the road surface. A. II only B. II and III only C. I and III only D. I, II and III

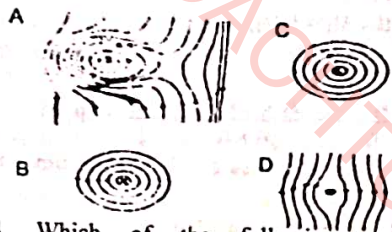
29. A beam of light is incident from air to water at an angle of 30° . Find the angle of refraction if the refractive index of water is $\frac{4}{3}$. A. 15° B. 18° C. 22° D. 24°

30. The property of the eye known as its power of accommodation is controlled by the A. pupil B. vitreous humour C. iris D. ciliary muscles.

31. Which of the following correctly explain(s) why a green leaf appears green in bright daylight? I. It absorbs only the green component of sunlight. II. It absorbs all colours in sunlight except green III. It reflects only the green component of sunlight. A. I only B. II only C. I and III only D. II and III only

32. The field that results from the contact of a positively charged ball with the inner wall of an uncharged hollow conducting sphere is A. inside the sphere B. on the surface of the ball C. inside and outside the sphere D. outside the sphere.

33. A horizontal component of the earth's magnetic field and the magnetic field of a straight wire X carries current into the plane of a paper. Which of the following figures correctly illustrates the resultant magnetic field pattern in the horizontal plane?



34. Which of the following correctly explain(s) why soft iron is preferred to steel in electromagnets? I. Soft iron is more readily

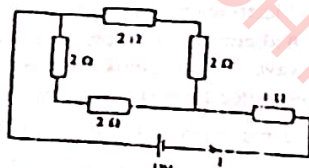
magnetized than steel II. Soft iron is more readily demagnetized than steel III. Soft iron retains magnetism more than steel. A. I only B. II and III only C. I and II only D. I, II and III.

35. A current-carrying conductor experiences a force when placed in a magnetic field because the A. conductor is magnetized B. magnetic field of the current interacts with external magnetic field C. force is due to the motor principle D. electric field of the current interacts with the external magnetic field.

36. A simple cell with mercury-amalgamated zinc electrode prevents A. local action B. polarization C. buckling D. degradation.

37. The terminal voltage of a battery is 4.0 V when supplying a current of 2.0A, and 2.0V when supplying a current of 3.0A. The internal resistance of the battery is A. 0.5Ω B. 1.0Ω C. 2.0Ω D. 4.0Ω

38.

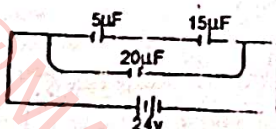


The current I in the figure above is A. 4.00A B. 1.30A C. 0.80A D. 0.75A

39. A current of 100mA passes through a conductor for 2 minutes. The quantity of electricity transported is A. 200C B. 50C C. 12C D. 0.02C

40. A parallel plate capacitor of area 10 cm^2 in vacuum has a capacitance of $10^{-2} \mu\text{F}$. What is the distance between the plates? ($\epsilon_0 = 9 \times 10^{-12} \text{ Fm}$) A. $9 \times 10^{-13} \text{ m}$ B. $9 \times 10^{-7} \text{ m}$ C. $9 \times 10^{-3} \text{ m}$ D. $9 \times 10^7 \text{ m}$.

41.



In the network shown above, determine the potential difference across the $5\mu\text{F}$ capacitor. A. 3V B. 6V C. 12V D. 18V

42. A 40-W instrument has a resistance of 90Ω . On what voltage should it be operated normally? A. 60V B. 150V C. 225V D. 3600V

43. Which of the following devices may be used to step up the voltage in a d.c. circuit? A. A step-up transformer B. A d.c. generator C. A wattmeter D. An induction coil.

44. The primary aim in high tension transmission is to A. minimize electrical energy losses due to heat production B. increase the rate of energy transfer by using high voltage C. increase the current in the wires D. generate electricity at high current and low voltage.

45. Determine the inductive reactance when a 30.0 mH inductor with a negligible resistance is connected to a $1.30 \times 10^3 \text{ Hz}$ oscillator. A. 39.0Ω B. 122.5Ω C. 245.0Ω D. 39000.0Ω

46. Which of the following statements correctly describe(s) cathode rays? I. They consist of tiny particles carrying negative electric charges II. They are deflected in a magnetic field but not in an electric field. III. They consist of fast moving neutrons and deflected in an electric field. A. I only B. III only C. I and II only D. II and III only.

47. Natural radioactivity is the random spontaneous disintegration of the nuclei of heavy isotopes of certain elements with the emission of A. α , β and X-rays B. α , β and γ -rays C. X, α and γ -rays D. β , γ and X-rays.

48. Which of the following are produced after a nuclear fusion process? I. One heavy nucleus II. Neutrons III. Protons IV. Energy A. I and II B. I and IV C. II and III D. II and IV.

49. An element X of atomic number 88 and mass number 226 decays to form an element Z by emitting two beta particles and an alpha particle. Z is represented by A. Z B. Z C. Z D. Z

50. The kinetic energy of a photoelectron liberated from a metallic surface depends on the A. intensity of the incident radiation B. time duration of the incident radiation C. temperature of the incident radiation D. frequency of the incident radiation.

1993 UME PHYSICS SOLUTION

1. D - The watt is the unit of power. Power can be expressed as a product of force and velocity. This is how:

$$\text{Power} = \frac{\text{Energy}}{\text{time}} = \frac{\text{workdone}}{\text{time}} = \frac{\text{Force} \times \text{distance}}{\text{time}}$$

$$\text{But } \frac{\text{displacement}}{\text{time}} = \text{velocity}$$

Thus,

$$\text{Power} = \text{Force} \times \text{velocity}$$

2. C - Thickness = External diameter - Internal diameter

$$(32 \pm 2) \text{ mm} - (21 \pm 1) \text{ mm} = 11 \pm 1 \text{ mm}$$

$$\text{Percentage error of the thickness} = \frac{1}{11} \times 100\% = 9.09\%$$

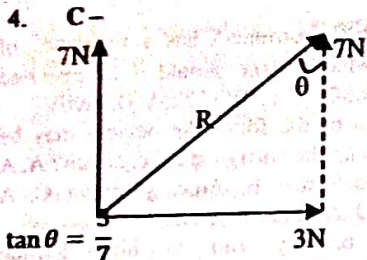
3. D - Total distance covered = Area of the figure

$$= \text{Area of a trapezium}$$

$$= \frac{1}{2} (a + b)h$$

$$= \frac{1}{2} (30 + 45)10$$

$$= 375$$



4. $\tan \theta = \frac{7}{3}$

5. $C - u = 180 \text{ kmh}^{-1} = \left(\frac{180 \times 1000}{3600}\right) \text{ m/s} = 50 \text{ m/s}$
 $V = 0, t = 30 \text{ s}, s = ?$
 $S = \left(\frac{v+u}{2}\right)t = \left(\frac{50+0}{2}\right)30 = 750 \text{ m}$

6. $B - \text{Force} = \text{Mass per second} \times \text{velocity}$
 $10 \text{ kg s}^{-1} \times 5 \times 10^3 \text{ ms}^{-1} = 5 \times 10^4 \text{ N}$

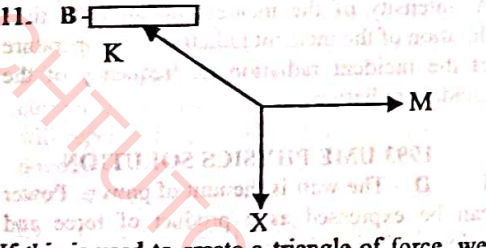
7. $B - \text{Gravitational field intensity} = \frac{\text{Force}}{\text{Mass}}$
 $= \frac{1.002 \times 10^2 \text{ N}}{60 \text{ kg}} = 1.67 \text{ N kg}^{-1}$

8. $B -$ In a hydroelectric power station, electrical energy is generated from mechanical energy. The energy can be converted to light energy or any other form of energy.

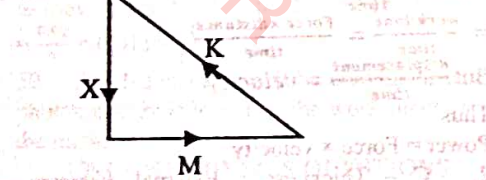
9. $D - V.R = \frac{1}{\sin \theta}$
 $\frac{10}{1} = \frac{1}{\sin \theta}$
 $10 \sin \theta = 1; \sin \mu = \frac{1}{10}$

10. $B - \text{Volume of the vessel} = 4 \text{ m} \times 3 \text{ m} \times 2 \text{ m} = 24 \text{ m}^3$
 Density of liquid = 1000 kg m^{-3}
 Mass = $(1000 \times 24) \text{ kg} = 24000 \text{ kg}$
 Weight of the liquid = $(24000 \times 10) \text{ N} = 2.4 \times 10^5 \text{ N}$

To record a maximum pressure, the area has to be minimum
 Smallest are = $3 \text{ m} \times 2 \text{ m} = 6 \text{ m}^2$
 $P = \frac{\text{Force}}{\text{Area}} = \frac{2.4 \times 10^5 \text{ N}}{6 \text{ m}^2} = 4 \times 10^4 \text{ Nm}^{-2}$



If this is used to create a triangle of force, we have:



12. $D - \text{Mass} = 180 \text{ kg}$
 Weight = $(180 \times 10) \text{ N} = 1800 \text{ N}$
 The weight of the load constitutes anticlockwise moment while the force, F constitutes the clockwise moment
 $1800 \times 20 = F \times (200 - 20) = 180F$
 $F = \frac{1800 \times 20}{180} = 200 \text{ N}$

13. $A - \text{Mass of object} = 400 \text{ g} = 0.4 \text{ kg}$
 Density = 600 kg m^{-3}
 Volume = $\frac{\text{mass}}{\text{density}} = \frac{0.4 \text{ kg}}{600 \text{ kg m}^{-3}} = 6.67 \times 10^{-4} \text{ m}^3$

$= 3.33310^{-4} \text{ m}^3$
 Upthrust = $\rho v g = (900 \times 3.333 \times 10^{-4} \times 10) \text{ N} = 3 \text{ N}$
 Weight of the object = $(0.4 \times 10) \text{ N} + 4 \text{ N}$
 Tension in the string = $4 \text{ N} - 3 \text{ N} = 1 \text{ N}$

14. $A -$ The thermometric property of the thermocouple is that its e.m.f changes with temperature.

15. $D - \alpha = \frac{\Delta L}{L \Delta \theta} = \frac{1.36 \times 10^{-3}}{800 \times 10^{-3} \times (95 - 10)} = \frac{1.36 \times 10^{-3}}{68} = 2 \times 10^{-5} \text{ K}^{-1}$

16. $B - V_1 = \frac{1}{2} V_2, T_2 = 2T_1$
 $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
 $P_2 = \frac{P_1 V_1 T_2}{V_2 T_1} = \frac{P_1 \times V_1 \times 2T_1}{\frac{1}{2} V_1 \times T_1} = \frac{2P_1}{\frac{1}{2}} = 4P_1$

Thus, the new pressure will be four times the original pressure.

17. $C - m_1 c \Delta \theta_1 = m_2 c \Delta \theta_2$
 $200 \times c \times (90 - f) = 100 \times c \times (f - 30)$
 (Where f is the final temperature)
 $200(90 - f) = 100(f - 30)$
 $2(90 - f) = f - 30$
 $180 - 2f = f - 30$
 $180 + 30 = f + 2f$
 $3f = 210$
 $f = \frac{210}{3} = 70^\circ \text{C}$

18. $D -$ During melting (or even any other change of state), the temperature is constant. If more heat is supplied after melting, the temperature starts rising until the liquid starts boiling (during which a temperature is again constant).

19. $C - Q = mL_f; L_f = \frac{Q}{m} = \frac{10^5 \text{ J}}{\left(\frac{10}{1000}\right) \text{ kg}} = 10^7 \text{ J kg}^{-1}$

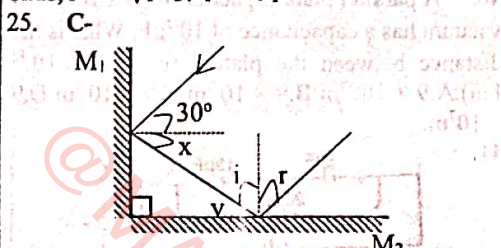
20. $D - L = \frac{1}{2} \lambda + \frac{1}{4} \lambda = \frac{3}{4} \lambda$
 Then, $4L = 3\lambda$

21. $B -$ Distance between consecutive antinodes (or nodes) = $\frac{1}{2} \times \text{wavelength} = \frac{1}{2} \times 60 \text{ cm} = 30 \text{ cm}$

22. $D -$ Electromagnetic waves do not require material medium for their propagation. Since infra-red waves are electromagnetic waves, they can be propagated through a vacuum.

23. $A - \text{Time to reach the aircraft} = \frac{4 \times 10^{-3} \text{ s}}{2} = 2 \times 10^{-3} \text{ s}$
 Distance = speed \times time
 $= (3 \times 10^8 \times 2 \times 10^{-3}) \text{ m} = 6 \times 10^5 \text{ m} = 6 \times 10^2 \text{ km}$

24. $C - F = \frac{1}{2l} \sqrt{T \mu}$
 Thus, $F \propto \sqrt{T}$ or $F^2 \propto T$



$x = 30^\circ$ (law of reflection)
 $x = y$ (alternate angles are equal)
 Thus, $y = 30^\circ$
 $y + i = 90^\circ$ (right angle)

Then, angle of incidence, i on mirror $m_2 = 90^\circ - y = 90^\circ - 30^\circ = 60^\circ$

Angle of reflection, $r = i = 60^\circ$ (law of reflection)

26. $B - \frac{1}{f} = \frac{1}{u} + \frac{1}{v}; u = \frac{v}{m}$
 Then, $\frac{1}{f} = \frac{m}{v} + \frac{1}{v} = \frac{m+1}{v}$
 $\frac{1}{f} = \frac{m+1}{v}; \frac{2}{r} = \frac{m+1}{v}$
 $2v = (m+1)r$
 $m+1 = \frac{2v}{r}; m = \frac{2v}{r} - 1$

27. $C - u = 100 \text{ cm}, f = 20 \text{ cm}, v = ?$
 $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}; \frac{1}{20} = \frac{1}{100} + \frac{1}{v}$
 $\frac{1}{v} = \frac{1}{20} - \frac{1}{100} = \frac{5-1}{100} = \frac{4}{100}$
 $4v = 100$
 $v = \frac{100}{4} = 25 \text{ cm}$

28. $C -$ The air molecules closer to the ground are less than those above them. Don't forget that total internal reflection occurs when light passes from denser medium to a less dense medium.

29. $C - \frac{4}{3} = \frac{\sin 30^\circ}{\sin r}; 1.3333 = \frac{0.5}{\sin r}; \sin r = \left(\frac{0.5}{1.3333}\right) = 0.375 = r = \sin^{-1} 0.375 = 22^\circ$

30. $D -$ Accommodation refers to the ability of the eye to focus objects at various distance from the eye. The power of accommodation is controlled by the ciliary muscles.

31. $D -$ The green leaf appears green because it absorbs other components of light and reflect only green.

32. $D -$ The charge acquired by a hollow conductor is outside it.

33. $A -$ The pattern of the resultant magnetic field in the horizontal plane is as shown in option "A".

34. $C -$ Soft iron is more easily magnetized than steel but loses its magnetism more readily. This is why soft iron is used for making temporary magnets while steel is for making permanent magnets.

35. $B -$ It is because the magnetic field of the current interacts with external magnetic field.

36. $A -$ Local action is caused by impurities in the zinc anode. This can be prevented by using amalgamated zinc or by simply using pure zinc.

37. $C - E = 4 + 2r; E = 2 + 3r$. Then, $4 + 2r = 2 + 3r; 3r - 2r = 4 - 2, r = 2\Omega$

38. $A - R = \frac{(2+2) \times (2+2)}{(2+2) + (2+2)} + 1 = 3\Omega$
 $I = \frac{V}{R} = \left(\frac{12}{3}\right) \text{ A} = 4 \text{ A}$

39. $C - Q = It = 100(10^{-3}) \times 2 \times 60 = 12 \text{ C}$

40. $B - C = \frac{A \epsilon_0}{c} = \frac{10(10^{-4}) \times 9 \times 10^{-12}}{10^{-2} \times 10^{-6}} = 9 \times 10^7 \text{ m}$

41. $D -$ For the series connection, $C = \left(\frac{5 \times 15}{5+15}\right) \mu\text{F} = 3.75 \mu\text{F} = 3.75 \times 10^{-6} \text{ F}$

The charge passing through series connection = $V_{\text{voltage}} \times C_{\text{charge}} = (24 \times 3.75 \times 10^{-6}) = 9 \times 10^{-5} \text{ C}$
 Then,

$V_s = \frac{Q}{C_s} = \frac{9 \times 10^{-5}}{5 \times 10^{-6}} = 18 \text{ V}$

42. $A - P = \frac{V^2}{R}; V = \sqrt{PR} = \sqrt{40 \times 90} = \sqrt{3600} = 60 \text{ V}$

43. $D -$ An induction coil can be used to step up the voltage in a d.c circuit.

44. A - High tension transmission involves high voltage and low current. The aim is to minimize electrical energy losses due to heat production (since $heat = I^2Rt$, and the smaller the value of the current, I , the smaller the heat loss)

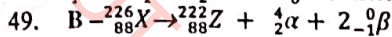
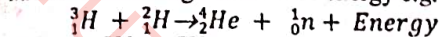
45. $C - X_L = 2\pi FL = 2 \times 3.142 \times 1.3 \times 10^3 \times 30 \times 10^{-1}$
 $= 245\Omega$

46. A - Cathode rays are a stream of fast moving electrons.

Cathode rays are deflected towards the positive plate in an electric field and towards the north pole of a magnetic field.

47. B - Natural radioactivity leads to the emission of radiations such as alpha particles (α), beta particles (β) and gamma rays (γ).

48. B - Nuclear fusion gives a heavy nucleus and releases a large amount of energy e.g.



49. B - The number of photoelectrons released depends on the intensity of light while the kinetic energy of the electrons depends on the frequency of light.

1992 UME PHYSICS QUESTIONS

1. What is the least possible error in using a rule graduated in centimeters? A. 0.1cm B. 0.5cm C. 1.0cm D. 2.0cm

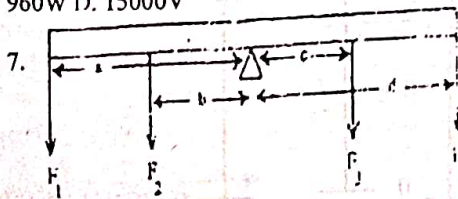
2. Which of The following affects the period of a simple pendulum? I. Mass of the pendulum bob II. Length of the pendulum III. Acceleration due to gravity A. I, II and III B. II and III only C. I and III only D. I and II only

3. A boy sits in a train moving with uniform speed on a straight track. If from his outstretched palm he gently tosses a coin vertically upwards, the coin will fall A. in front of his palm B. behind his palm C. beside his palm D. into his palm

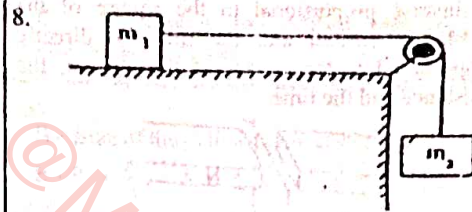
4. A body starts from rest and moves with uniform acceleration of 6ms^{-2} . What distance does it cover in the third second? A. 1.5m B. 1.8m C. 2.7m D. 3.0m

5. A stone, Q is thrown with velocity u at an angle of 75° to the horizontal. Another stone R is thrown with the same velocity u but at an angle of 15° to the horizontal. The ranges covered by the stones will be A. greater for Q B. greater for R C. the same for Q and R D. greater for the heavier of the two stones

6. A man weighing 800N climbs up a flight of stairs to a height of 1.5m in 1.25s. What is the man's average power A. 667W B. 810W C. 960W D. 15000W



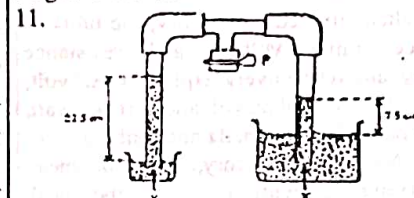
7. A uniform light rod is kept in horizontal equilibrium under the influence of four forces as shown above. Which of the following equations correctly represents the condition of equilibrium for the rod? A. $F_1 + F_2 = F_3 + F_4$ B. $F_1 + F_2 = F_3 + F_4$
 $= 0$ C. $(F_1 + F_2)ab = (F_3 + F_4)cd$ D. $F_1a + F_2b = F_3c + F_4d = 0$



8. In the diagram above, the hanging mass m_2 is adjusted until m_1 is on the verge of sliding. The coefficient of static friction between the mass m_1 and the table is $A. \frac{m_1}{m_2} B. \frac{m_1 g}{m_2} C. \frac{m_2}{m_1} D. \frac{m_2 g}{m_1}$

9. A machine requires 1000 J of work to raise a load of 500N through a vertical distance of 1.5m. Calculate the efficiency of the machine. A. 80% B. 75% C. 50% D. 33%

10. In an experiment to determine Young's Modulus for a wire, several loads are attached to the wire and the corresponding extensions measured. The tensile stress in each case depends on the A. load and the extension B. load and the radius of the wire C. radius of the wire and the extension D. extension and the original length of the wire



11. The figure above shows the heights of two liquids X and Y when some air is sucked out of the apparatus through the pump P. The diameter of the tube in X is twice that of the tube in Y. What is the relative density of liquid X with respect to liquid Y? A. $\frac{1}{3}$ B. $\frac{2}{3}$ C. 3 D. 6

12. If a plastic sphere floats in water (density = 1000kgm^{-3}) with 0.5 of its volume submerged and floats on oil with 0.4 of its volume submerged, the density of the oil is A. 800kg m^{-3} B. 1200kg m^{-3} C. 1250kg m^{-3} D. 2000kg m^{-3}

13. A platinum resistance thermometer wire has a resistance of 5 ohms at 0°C and 5.5 ohms at 100°C . Calculate the temperature of the wire when the resistance is 5.2 ohms. A. 80°C B. 60°C C. 40°C D. 10°C

14. A bridge made of steel is 600m long. What is the daily variation in its length if the nighttime and daytime temperatures are 10°C and 35°C respectively. The linear expansivity of steel is 0.000012 C^{-1} . A. 0.18cm B. 1.80cm C. 18.00cm D. 1800cm

15. One of the most important applications of bi-metallic strip is found in the construction of A. a thermostat B. an altimeter C. a thermocouple D. a hygrometer

16. At constant pressure, the density of a fixed mass of gas is A. constant with temperature B. proportional to its volume C. inversely proportional to its temperature D. independent of its volume.

17. How much heat is absorbed when a block of copper of mass 0.05kg and specific heat capacity $390\text{Jkg}^{-1}\text{K}^{-1}$ is heated from 20°C to 70°C ? A. $3.98 \times 10^1\text{J}$ B. $9.75 \times 10^2\text{J}$ C. $3.98 \times 10^3\text{J}$ D. $9.75 \times 10^3\text{J}$

18. A block of ice floats on water inside a container. If the block of ice gets completely melted, the level of water in the container will A.

increase B. remain the same C. decrease D. first decrease and then increase

19. The space between the double glass walls of a thermos flask is evacuated and the two surfaces facing the evacuated space are silvered. The residual source of heat loss takes place by A. convection B. radiation from the surfaces C. conduction through the stopper and the glass D. conduction across the walls.

20. The equation of a wave is $y = 0.005 \sin [x(0.5x - 200t)]$ where x and y are in metres and t is in seconds. What is the velocity of the wave? A. 4000ms^{-1} B. 400ms^{-1} C. 250ms^{-1} D. 40ms^{-1}

21. Which of the following characteristics of a wave is used in the measurement of the depth of the sea? A. Diffraction B. Interference C. Refraction D. Reflection

22. A note is the octave of another note if it has A. a frequency twice that of the first note B. frequency half that of the first note C. the same fundamental frequency as the first one D. a frequency eight times that of the first note.

23. What is the frequency of the sound made by a siren having a disc with 32 holes and making 25 revolutions per second? A. 80 Hz B. 600 Hz C. 800 Hz D. 1600 Hz

24. Which of the following properties make the convex mirror useful as a driving mirror? I. The image is real II. The image is erect III. It has a wide field of view IV. The image is magnified. A. I, II and IV B. I, II and III C. II and III D. I and III.

25. When an object is placed very close to the pole of a concave mirror, the virtual image obtained is A. diminished and upright B. diminished and inverted C. enlarged and inverted D. enlarged and upright

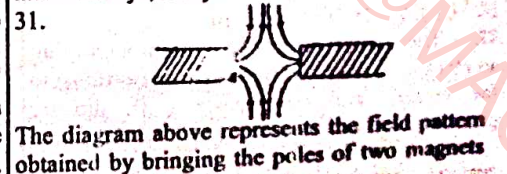
26. A concave mirror has a radius of curvature of 36cm. At what distance from the mirror should an object be placed to give a real image three times the size of the object? A. 12cm B. 24cm C. 48cm D. 108cm

27. Which of the following statements is CORRECT about a long-sighted boy who does not put on glasses? A. He cannot see distant objects clearly B. Rays of light from a close object are focused in front of his retina C. His eyeball is too long D. Parallel rays of light are focused behind his retina.

28. The speed of light in air is $3 \times 10^8\text{ms}^{-1}$. What is the speed in glass with a refractive index of 1.50? A. $1.5 \times 10^8\text{ms}^{-1}$ B. $3.0 \times 10^8\text{ms}^{-1}$ C. $2.0 \times 10^8\text{ms}^{-1}$ D. $6.0 \times 10^8\text{ms}^{-1}$.

29. If the refractive index of a medium in air is 2.0, what is the critical angle for this medium? A. 30° B. 42° C. 45° D. 50°

30. Which of the following arrangements of the components of electromagnetic spectrum is in ascending order of wavelengths? A. Gamma rays, ultraviolet rays, x-rays, infra-red rays B. Gamma rays, x-rays, ultraviolet rays, infra-red rays C. infra-red rays, ultraviolet rays, x-rays, gamma rays D. Gamma rays, ultraviolet rays, infra-red rays, x-rays.



31. The diagram above represents the field pattern obtained by bringing the poles of two magnets

near each other. The poles must be A. N-N poles B. S-S poles C. S-N poles D. N-S poles

32. The angle between the direction of the earth's magnetic field and the horizontal is called the A. angle of deviation B. magnetic declination C. magnetic meridian D. angle of dip.

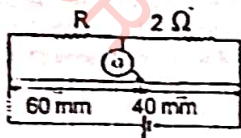
33. Calculate the force acting on an electron of charge 1.6×10^{-19} C placed in an electric field of intensity 10^6 V m^{-1} . A. 1.6×10^{-11} N B. 1.6×10^{-14} N C. 1.6×10^{-16} N D. 1.0×10^{-16} N

34. When an ebonite rod is rubbed with fur, it has A. no charge at all B. a negative charge C. a positive charge D. negative and positive charges.

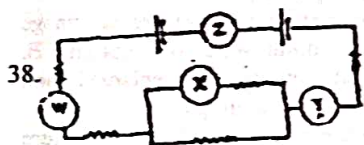
35. Which of the following factors has no effect on the e.m.f. of a primary cell? A. temperature B. size of the cell C. Nature of the plates D. Nature of the electrolyte.

36. A wire of length 15m made of a material of resistivity $1.8 \times 10^{-6} \Omega\text{-m}$ has a resistance of 0.27Ω . Determine the area of the wire. A. $1.5 \times 10^{-4} \text{ m}^2$ B. $1.0 \times 10^{-4} \text{ m}^2$ C. $2.7 \times 10^{-5} \text{ m}^2$ D. $7.3 \times 10^{-6} \text{ m}^2$.

37.



The diagram above shows a meter bridge in which two of the arms contain resistances R and 2Ω . A balance point is obtained at 60cm from the left end. Calculate the value of R. A. 1.2Ω B. 1.3Ω C. 3.0Ω D. 6.0Ω

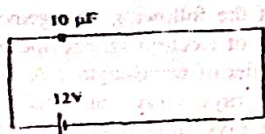


38. The circuit diagram above contains four ammeters W, X, Y and Z. Which of the following statements about the ammeter reading is correct? A. The reading of W is equal to that of Y and twice that of X. B. The reading of Y is greater than that of Z. C. The readings of W and Y are equal and each is greater than that, of X. D. The reading of Z is equal to the sum of the readings of W and Y.

39. A 5-V battery is connected across the plates of a $2.0 \mu\text{F}$ uncharged parallel plate capacitor. The charge on the capacitor after a long time is A. $2.5 \mu\text{C}$ B. $10.0 \mu\text{C}$ C. $20.0 \mu\text{C}$ D. $50.0 \mu\text{C}$

40. Which of the following apparatus will require the smallest fuse rating for its protection? A. 60W, 240V B. 60W, 40V C. 40W, 12V D. 40W, 5V

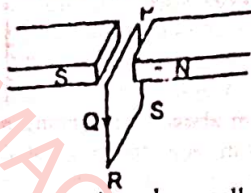
41.



A capacitor of $10 \mu\text{F}$ is connected across a cell of 12 volts as shown above. Calculate the energy stored in the capacitor. A. $7.2 \times 10^{-4} \text{ J}$ B. $1.4 \times 10^{-3} \text{ C}$ C. $1.4 \times 10^{-4} \text{ J}$ D. 1.2×10^{-2}

42. The heat produced in a conductor carrying an electric current is A. inversely proportional to the current and the resistance B. directly proportional to the current, resistance and the time

C. inverse proportional to the square of the resistance, current and the time D. directly proportional to the square of the current, the resistance and the time.



43. PQRS is a rectangular coil with PQ perpendicular to the magnetic field as shown in the diagram. If a current flows in the direction PQRS, in what direction will the coil move? A. Upwards B. Downwards C. Towards the north pole D. Towards the south pole

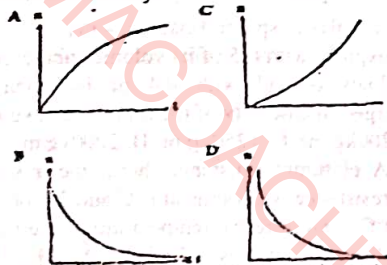
44. The maximum permissible current through a galvanometer G of internal resistance 10Ω is 0.05 A . A resistance R is used to convert G into a voltmeter with a maximum reading of 100V. Find the value of R and how it is connected to G. A. 20,000 ohms in parallel B. 19,990 ohms in series C. 1990 ohms in series D. 100 ohms in series.

45. In alternating current theory, the units of impedance, r.m.s. voltage and resonance frequency are respectively equal to A. volt, ampere and hertz B. ohm, volt and hertz C. watt, ohm and radian D. ohm, hertz and joule

46. In A.C. circuit theory, the root mean square (r.m.s. current, I_{rms} and the peak (maximum) current I_0 are related by A. $I_0 = \frac{I_{\text{rms}}}{\sqrt{2}}$

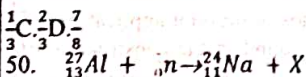
B. $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$ C. $I_{\text{rms}} = \frac{I_0}{2}$ D. $I_0 = \frac{I_{\text{rms}}}{\sqrt{2}}$

47. Which of the following graphs correctly illustrates the number of remaining atoms during a radioactive decay?



48. The threshold frequency for photoelectric effect depends on the A. intensity of incident light B. frequency of incident light C. material of the photocathode D. potential difference between the cathode and the anode.

49. After three half lives, the fraction of a radioactive material that has decayed is A. $\frac{1}{8}$ B. $\frac{1}{3}$ C. $\frac{2}{3}$ D. $\frac{7}{8}$



In the nuclear reaction above, the product denoted by X is A. a proton B. a gamma ray C. a helium particle D. an alpha particle.

1992 UME PHYSICS SOLUTION

1. B - Error = $\frac{1}{2} \times$ smallest division = $\frac{1}{2} \times 0.1 \text{ cm} = 0.05 \text{ cm}$

2. B - $T = 2\pi \sqrt{\frac{l}{g}}$

Thus, the period of a simple pendulum depends on its length and the acceleration due to gravity.

3. D - Since the train is moving with uniform speed, the coin will fall into his palm.

4. A - Distance covered in the third second

= $\frac{1}{2} a(t_2^2 - t_1^2)$
Where $t_1 = 2$ and $t_2 = 3$

Thus, Distance, $S = \frac{1}{2} \times 6(3^2 - 2^2) = \frac{1}{2} \times 6 \times 5 = 15 \text{ m}$

5. C - Range, $R = \frac{u^2 \sin 2\theta}{g}$
Range of stone Q, $R_Q = \frac{u^2 \sin(2 \times 75^\circ)}{10} = 0.05 \text{ U}$

Range of Stone R, $R_R = \frac{u^2 \sin(2 \times 15^\circ)}{10} = 0.05 \text{ U}$
Thus, the range is the same for Q and R

6. P - $P = \frac{mgh}{t} = \frac{Wh}{t} = \frac{800 \times 15}{12.5}$

7. D - KEY => For the rod to remain at equilibrium, total clockwise moment must equal total anticlockwise moment.

F_3 and F_4 constitute clockwise moment while F_1 and F_2 constitute anticlockwise moment.

$(F_1 \times a) + (F_2 \times b) = (F_3 \times c) + (F_4 \times d)$

$F_1 a + F_2 b = F_3 c + F_4 d$

Then, we can have:

$F_1 a + F_2 b + F_2 b - F_3 c - F_4 d = 0$

8. C - $T - \mu m_1 g = m_1 a$

$m_2 g - T = m_2 a$

Since the bodies are "on the verge of moving", $a = 0$. Then, the equations become:

$T - \mu m_1 g = 0; T = \mu m_1 g$

$m_2 g - T = 0; T = m_2 g$

Thus,

$m_2 g = \mu m_1 g$

Then,

$\mu = \frac{m_2 g}{m_1 g} = \frac{m_2}{m_1}$

9. B - Work input = 1000J

Work output = $(500 \times 1.5) \text{ J} = 750 \text{ J}$

Efficiency = $\frac{\text{Work output}}{\text{Work input}} \times 100\%$

= $\frac{750 \text{ J}}{1000 \text{ J}} \times 100\% = 75\%$

10. B - Tensile stress = $\frac{\text{Force}}{\text{Area}}$

Since load is a force and area of the wire depends on the radius of the wire ($A = \pi r^2$), it can be safely said that tensile stress depends on load and the radius of the wire.

11. C - $h_x \rho_x = h_y \rho_y$

$h_x \rho_x = h_y \rho_y$

$7.5 \times \rho_x = 22.5 \times \rho_y$

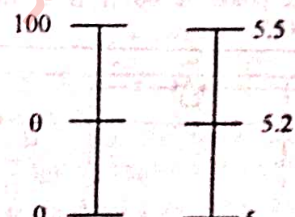
$\frac{\rho_x}{\rho_y} = \frac{22.5}{7.5} = 3$

$\frac{\rho_x}{\rho_y} = \frac{22.5}{7.5} = 3$

12. C - Since the mass of the sphere must be equal to the mass of the liquid displaced in each case, we can write: $0.5 \text{ V} \times 1000 = 0.4 \text{ V} \times d_{\text{oil}}$

$d_{\text{oil}} = \frac{0.5 \text{ V} \times 1000}{0.4 \text{ V}} = \frac{0.5 \times 1000}{0.4} = 1250 \text{ Kg m}^{-3}$

13. C -



$\frac{100 - 0}{\theta - 0} = \frac{5.5 - 5}{5.2 - 5}; \frac{100}{\theta} = \frac{0.5}{0.2}$

$\theta = \frac{100 \times 0.2}{0.5} = 40^\circ \text{C}$

14. C - KEY => The daily variation in its length refers to ΔL (the change in length)

$\alpha = \frac{\Delta L}{L \Delta \theta}; \Delta L = \alpha L \Delta \theta = 1.2 \times 10^{-5} \times 600 \times 2$

= 0.18 m

= $(0.18 \times 100) \text{ cm}$

- 18cm
15. A - It is applied in the construction of a thermostat.
16. C - $V \propto T$
But density, $\rho \propto \frac{1}{V}$
Therefore, density decreases as temperature increases.
17. B - $Q = mc\Delta\theta = 0.05 \times 390 \times (70 - 20) = 0.05 \times 390 \times 50 = 975J = 9.75 \times 10^2 J$
18. B - The water level will remain the same.
19. C - The vacuum between the walls prevents heat loss by conduction and convection. The silvery surface prevents heat loss by radiation.
20. B - $y = 0.005 \sin(\pi(0.5x - 200t)) = 0.005 \sin(0.5\pi x - 200\pi t)$
When compared to the standard equation, $y = A \sin\left(\frac{2\pi x}{\lambda} - 2\pi ft\right)$
 $\frac{2\pi x}{\lambda} = 0.5\pi t$. Then, $\lambda = \left(\frac{2}{0.5}\right)m = 4m$
 $2\pi ft = 200\pi t$
Then, $f = \left(\frac{200}{2}\right)Hz = 100Hz$
 $V = F\lambda = (100 \times 4)m/s = 400m/s$
21. D - The characteristics of sound wave harnessed for estimating the depth of a sea is reflection
 $V = \frac{2x}{t_{echo}}$; $x = \frac{V \cdot t_{echo}}{2}$
(x = depth of the sea, t_{echo} = time taken to receive the echo)
22. A - An octave of a note is a note of twice the frequency. The octave of 11Hz is 22Hz; that of 22Hz is 44Hz etc.
23. C - Frequency = No of holes \times revolutions per second
 $= (32 \times 25)Hz = 800Hz$
24. C - A convex mirror is suitable as a driving mirror because it has a wide field of view and the image is erect (upright).
25. D - An object placed between the principal focus and the pole of a concave mirror has an erect, virtual and magnified image.
26. B - $m = 3$; $m = \frac{v}{u}$; $3 = \frac{v}{u}$; $v = 3u$
 $r = 36cm$; $f = \frac{r}{2} = \frac{36cm}{2} = 18cm$, $u = ?$
 $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$; $\frac{1}{18} = \frac{1}{u} + \frac{1}{3u} = \frac{3+1}{3u} = \frac{4}{3u}$
 $u = \frac{4f}{3} = \frac{4 \times 18}{3} = 24cm$
27. D - In a long-sighted eye, rays of light from near objects are focused behind the retina.
28. C - $n = \frac{\text{Velocity in air}}{\text{Velocity in glass}}$
 $\text{Velocity in glass} = \frac{\text{Velocity in air}}{n} = \left(\frac{3 \times 10^8}{1.5}\right) = 2 \times 10^8 m/s$
29. A - $n = \frac{1}{\text{sinc}}$; $\text{sinc} = \frac{1}{n} = \frac{1}{2.0} = 0.5$
 $C = \sin^{-1} 0.5 = 30^\circ$
30. B - RIVUXG
Decreasing wavelength
GXUVIR
Increasing wavelength
31. B - Since the arrows are pointing towards the two magnets, the magnets are both of south poles.
32. D - It is known as the angle of dip or angle of inclination.
33. A - $F = Eq = (10^8 \times 1.6 \times 10^{-19})N = 1.6 \times 10^{-11}N$

34. B - An ebonite rod rubbed with fur acquires a negative charge.

A glass rod rubbed with silk acquires a positive charge.

35. B - Size of the cell does not affect the emf.

36. B - $R = \frac{\rho l}{A}$; $A = \frac{\rho l}{R} = \left(\frac{1.8 \times 10^{-6} \times 15}{0.27}\right)m^2 = 10^{-4}m^2$

37. C - $\frac{R}{60} = \frac{2}{40}$; $R = \left(\frac{2 \times 60}{40}\right)\Omega = 3\Omega$

38. C - The current that passes through W equals that through Y and each is greater than the current through X.

39. B - $V = 5V$, $C = 2\mu F = 2 \times 10^{-6}F$
 $Q = VC = (5 \times 2 \times 10^{-6})C = 1 \times 10^{-5}C = 10\mu C$

40. A - $P = IV$; $I = \frac{P}{V}$

(A) $I = \frac{60}{240} = 0.25A$

(B) $I = \frac{60}{40} = 1.5A$

(C) $I = \frac{60}{12} = 3.333A$

(D) $I = \frac{60}{8} = 8A$

Lowest fuse rating = 0.25A

41. A - $E = \frac{1}{2}CV^2$

$C = 10\mu F = 10^{-5}F$, $V = 12V$

$E = \frac{1}{2} \times 10^{-5} \times 12^2 = 7.2 \times 10^{-4}J$

42. D - $H = I^2Rt$ (I = current, R = resistance, t = time)

43. A - According to Fleming's left hand rule, the coil will move upward.

44. C - To convert a galvanometer into a voltmeter, a high resistance wire (known as the multiplier) is connected with it in series

$R_m = \frac{V}{I_g} - r_g = \frac{100}{0.05} - 10 = 1990\Omega$

45. B - Impedance is measured in ohms

Voltage is measured in volt

Frequency is measured in Hertz.

46. B - $I_{r.m.s} = \frac{I_0}{\sqrt{2}}$

47. D - As time passes, the number of remaining atoms decreases, albeit non-linearly

48. C - The threshold frequency depends on the nature (of the material) of the photocathode.

49. D - Fraction remaining after time t =

$\left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$

Since we need the fraction after three half-lives,

$t = 3t_{1/2}$

Then,

$\text{Fraction} = \left(\frac{1}{2}\right)^{\frac{3t_{1/2}}{t_{1/2}}} = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$

50. D - ${}_{13}^{27}Al + {}_0^1n \rightarrow {}_{11}^{24}Na + {}_2^4He$

$27 + 1 = 24 + a$, $a = 27 + 1 - 24 = 4$

$13 + 0 = 11 + b$, $b = 13 - 11 = 2$

Thus, ${}_2^4He = \alpha$ particle

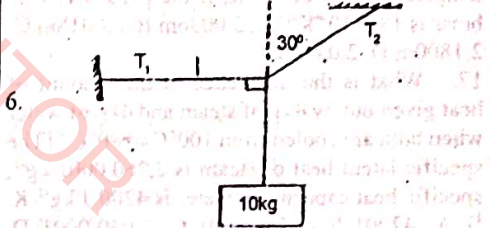
1991 UME PHYSICS QUESTIONS

1. Which of the following is the most suitable for use as an altimeter? A. A mercury barometer B. A fortin barometer C. A mercury manometer D. An aneroid barometer
2. A body of weight W N rests on a smooth plane inclined at an angle θ° to the horizontal. What is the resolved part of the weight in Newtons along the plane? A. $W \sin \theta$ B. $W \cos \theta$ C. $W \sec \theta$ D. $W \tan \theta$.

3. A small metal ball is thrown vertically upwards from the top of a tower with an initial velocity of 20ms⁻¹. If the ball took a total of 6s to reach ground level, determine the height of the tower A. 60m B. 80m C. 100m D. 120m [$g = 10ms^{-2}$]

4. An object moves with uniform speed round a circle. Its acceleration has A. constant magnitude and constant direction B. constant magnitude and varying direction C. varying magnitude but constant direction D. varying magnitude and varying direction.

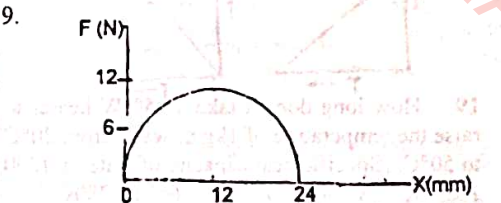
5. A body of mass 100g moving with a velocity of 10.0ms⁻¹ collides with a wall. If after the collision, it moves with a velocity of 2.0ms⁻¹ in the opposite direction, calculate the change in momentum. A. 0.8Ns B. 1.2Ns C. 12.0Ns D. 80.0Ns



6. Find the tension T_1 in the diagram above if the system is in equilibrium. A. $200\sqrt{3}$ N B. $100\sqrt{3}$ N C. $300\sqrt{3}$ N D. 100N [$g = 10ms^{-2}$]

7. A spring of force constant 1500 Nm⁻¹ is acted upon by a constant force of 75N. Calculate the potential energy stored in the spring.

8. A wheel and axle have radii 80cm and 10cm respectively. If the efficiency of the machine is 0.85, an applied force of 1200N to the wheel will raise a load of A. 8.0N B. 6.8N C. 8160.0N D. 9600.0N



9. A body is under the action of a force F such that the force - displacement graph of the body is semicircular as shown above. The work done on the body by the force in moving through 24 metres is A. 36πJ B. 72πJ C. 144πJ D. 288πJ

10. A 20kg mass is to be pulled up a slope inclined at 30° to the horizontal. If the efficiency of the plane is 75%, the force required to pull the load up the plane is A. 13.3N B. 73.5N C. 133.3N D. 533.2N [$g = 10ms^{-2}$].

11. The spiral spring of a spring balance is 25.0cm long when 5N hangs on it and 30.0cm long, when the weight is 10N. What is the length of the spring if the weight is 3N assuming Hooke's Law is obeyed? A. 15.0cm B. 17.0cm C. 20.0cm D. 23.0cm

12. The mass of a stone is 15.0g when completely immersed in water and 10.0g when completely immersed in a liquid of relative density 2.0. The mass of the stone in air is A. 5.0g B. 12.0g C. 20.0g D. 25.0g.

13. A pilot records the atmospheric pressure outside his plane as 63cm of Hg while a ground observer records a reading of 75cm of Hg for the atmospheric pressure on the ground. Assuming

that the density of the atmosphere is constant, calculate the height of the plane above the ground. (Relative density of Hg = 13.0 and that of air = 0.0013) A. 1200m B. 6300m C. 7500m D. 13800m

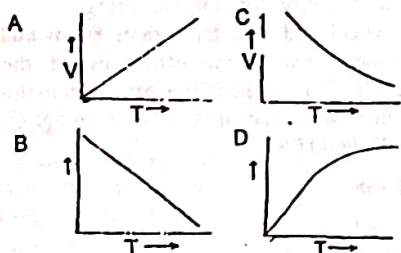
14. In which of the following is surface tension important? A. The floating of a ship in water B. The floating of a dry needle in water C. The floating of a balloon in air D. The diffusion of sugar solution across a membrane.

15. A thermometer with an arbitrary scale, S, of equal divisions registers -30°S at the ice point and +90°S at the steam point. Calculate the Celsius temperature corresponding to 60°S. A. 25.0°C B. 50.0°C C. 66.7°C D. 75.0°C

16. A brass rod is 2m long at a certain temperature. What is the length for a temperature rise of 100K, if the expansivity of brass is $18 \times 10^{-6} \text{K}^{-1}$? A. 2.0036m B. 2.0018m C. 2.1800m D. 2.0360m

17. What is the difference in the amount of heat given out by 4kg of steam and 4kg of water when both are cooled from 100°C to 80°C? [The specific latent heat of steam is 2,260,000 J kg⁻¹, specific heat capacity of water is 4200 J kg⁻¹ K⁻¹] A. 4200J B. 2,260,000J C. 9,040,000J D. 9,380,000J

18. The graphs below show the variation of volume (V) against temperature (T) in Kelvin for a given mass of gas at constant pressure. Which of the graphs depicts the behaviour of an ideal gas?



19. How long does it take a 750-W heater to raise the temperature of 1kg of water from 20°C to 50°C. [Specific heat capacity of water = 4200 J kg⁻¹ K⁻¹] A. 84s B. 112s C. 168s D. 280s

20. The saturated vapour pressure of a liquid increases as the A. volume of the liquid increases B. volume of the liquid decreases C. temperature of the liquid decreases D. temperature of the liquid increases

21. The absolute temperature of a perfect gas is proportional to the average. A. potential energy of the molecules B. separation between the molecules C. kinetic energy of the molecules D. velocity of the molecules.

22. A room is heated by means of a charcoal fire. An occupant of the room standing away from the fire is warmed mainly by A. convection B. radiation C. conduction D. reflection

23. A boy timed 30 oscillations of a certain pendulum thrice and obtained 1 min. 10s, 1 min. 12s and 1 min 7s respectively. The mean period of oscillation of the pendulum is A. 0.14s B. 0.43s C. 2.32s D. 6.97s

24. Which of the following is TRUE of light and sound waves? A. They both transmit energy B. They both need a medium for propagation C. They are both transverse waves D. Their velocities in air are equal.

25. The image in a pin-hole camera is A. erect and formed by refraction through a lens B. virtual and formed by dispersion C. erect and gets sharper as the hole becomes larger D. inverted and formed by the light from each point travelling in a straight line.

26. When a plane mirror at which a ray is incident is rotated through an angle θ , the reflected ray will be rotated through A. $\frac{1}{2}\theta$ B. θ C. 2θ D. 3θ .

27. A trough 12.0cm deep is filled with water of refractive index $\frac{4}{3}$. By how much would a coin at the bottom of the trough appear to be displaced when viewed vertically from above the water surface? A. 3.0cm B. 6.0cm C. 9.0cm D. 16.0cm

28. In a ray diagram for a thin converging lens, a ray that is not parallel to the optic axis but passes through the optic centre will A. pass through undeviated B. pass through the centre of curvature after refraction C. emerge parallel to the principal axis D. pass through the principal focus after refraction.

29. Which of the following correctly describes the image of an object, 4cm from a diverging lens of focal length -12cm? A. The image is virtual, 3cm in front of the lens B. The image is real, 6cm behind the lens C. The image is virtual, 6cm in front of the lens D. The image is real, 3cm in front of the lens.

30. Two tuning forks of frequencies 256 Hz and 260 Hz are sounded close to each other. What is the frequency of the beats produced? A. 2 Hz B. 4 Hz C. 8 Hz D. 258 Hz

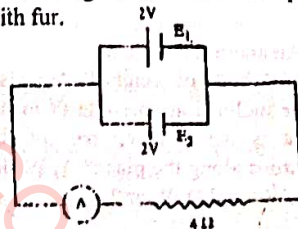
31. A man hears his echo from a nearby hill 2s after he shouted. If the frequency of his voice is 260 Hz and the wavelength is 1.29m, how far away is the hill? A. 330.0m B. 335.4m C. 660.0m D. 670.8m

32. When the bottom tip of a vibrating tuning fork is held in contact with a wooden box, a louder sound is heard. This phenomenon is known as A. beats B. echoing C. resonance D. reverberation.

33. Which of the following statements is CORRECT about the earth's magnetic field? A. The angle of dip is the angle which a freely suspended magnet makes with the vertical. B. The angle of declination is the angle between the magnetic meridian and the geographic meridian C. The angle of declination is the angle which a magnetic compass makes with the magnetic meridian D. The angle of inclination is the difference between the angle of dip and the angle of declination.

34. An insulated rod when rubbed with a material acquires A. a negative charge if it is made of glass and rubbed with silk B. no charge if it is made of glass and rubbed with fur C. no charge if it is made of copper and rubbed with silk D. a positive charge if it is made of copper and rubbed with fur.

35.

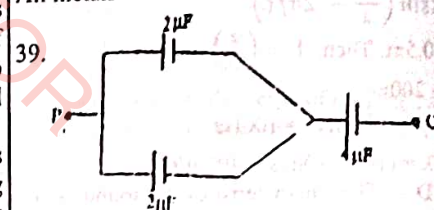


The internal resistance of each of the cell's E_1 and E_2 shown in the figure above is 2 Ω . Calculate the total current in the circuit. A. 0.80A B. 0.50A C. 0.40A D. 0.004A

36. The function of the system of granulated carbon mixed with manganese (IV) oxide in a Leclanche cell is to A. increase the e.m.f. of the cell to 2.0V B. prevent local action in the cell C. prevent polarisation in the cell D. make the cell black and hence a good radiator

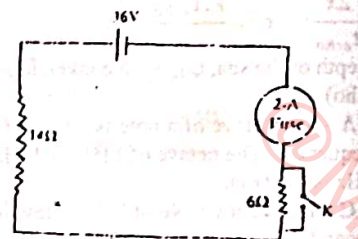
37. A moving coil galvanometer of 300 Ω resistance gives full scale deflection for 1.0mA. The resistance, R, of the shunt that is required to convert the galvanometer into a 3.0A ammeter is A. 899.70 Ω B. 10.00 Ω C. 0.10 Ω D. 0.01 Ω

38. Which of the following obeys Ohm's Law? A. Glass B. Diode C. All electrolytes D. All metals



The net capacitance in the circuit shown above is A. 8.0 μF B. 6.0 μF C. 4.0 μF D. 2.0 μF

40.



In the above circuit, the fuse wire melts when A. k is opened B. k is closed C. the 14 Ω resistor is doubled with k closed D. the 6 Ω resistor is doubled with k closed.

41. An equipment whose power is 1500W and resistance is 375 ohms would draw a current of A. 0.10A B. 2.00A C. 4.00A D. 77.5A

42. To convert an alternating current dynamo into a direct current dynamo, the A. number of turns in the coil is increased B. strength of the field magnet is increased C. slip rings are replaced with a split ring commutator D. coil is wound on a soft iron armature.

43. If a current carrying coil is mounted on a metal frame, the back e.m.f. induced in the coil causes A. inductance B. eddy currents C. electro-magnetism D. dipole moment

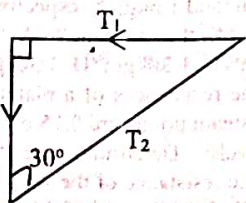
44. The electrochemical equivalent of platinum is $5.0 \times 10^{-7} \text{kg C}^{-1}$. To plate-out 1.0kg of platinum, a current of 100A must be passed through an appropriate vessel for A. 5.6 hours B. 56 hours C. 1.4×10^4 hours D. 2.0×10^4 hours.

45. Which of the following statements are TRUE of isotopes? I. Isotopes of an element have the same chemical properties because they have the same number of electrons II. Isotopes of elements are normally separated using physical properties III. Isotopes of an element have the same number of protons in their nuclei. A. I and II only B. I and III only C. II and III only D. I, II and III.

46. When an atom loses or gains a charge, it becomes A. an electron B. an ion C. a neutron D. a proton
47. 4g of a radioactive material of half-life 10 days is spilled on a laboratory floor. How long would it take to disintegrate 3.5g of the material? A. 1 1/4 days B. 8 1/4 days C. 30 days D. 80 days.
48. In a nuclear fusion process, four protons each of mass M_p were fused to produce a nucleus X of mass M_x . Which of the following equations is CORRECT? A. $4M_p > M_x$ B. $4M_p = M_x$ C. $4M_p < M_x$ D. $M_p = M_x$
49. Which of the following are TRUE for a decay I. Mass number decreases by four II. Atomic number decreases by two III. Mass number does not change A. I and II only B. II and III only C. I and III only D. I, II and III.
50. Which of the following phenomena is called photoelectric effect? A. High energy electrons impinge on a metallic anode which then emits photons B. A high energy photon emits photons as it is slowed down C. A metal absorbs quanta of light and then emits electrons D. Two electrons are created from a quantum of light.

1991 UME PHYSICS SOLUTION

1. D - The aneroid barometer does not make use of any liquid. It consists of a partially evacuated and sealed metal can which contracts or expands in response to changes in atmospheric pressure. It is used as an altimeter.
2. A - The component along the plane = $W \sin \theta$. The component perpendicular to the plane = $W \cos \theta$
3. A - Let us get the time the ball takes to get to the maximum height.
 $v = 0, u = 20 \text{ m/s}, a = -10 \text{ m/s}^2, t = ?$
 $v = u + at; 0 = 20 + (-10)t$
 $10t = 20, t = \frac{20}{10} = 2 \text{ s}$
 It takes 2s to reach the maximum height and another 2s to return to the original level of projection (which is the top of the tower). Thus, time taken to travel down from the top of the tower = $6 \text{ s} - 2 \text{ s} - 2 \text{ s} = 2 \text{ s}$.
 Let us now use the time obtained to get the height of the tower
 $a = +10 \text{ m/s}^2, u = 20 \text{ m/s}, t = 2 \text{ s}, s = ?$
 $s = ut + \frac{1}{2}at^2 = (20 \times 2) + \frac{1}{2} \times 10 \times 2^2 = 60 \text{ m}$
4. B - The magnitude of the acceleration is constant but the direction is constantly changing!
5. B - $u = 10 \text{ m/s}$
 $v = -2 \text{ m/s}$ (since it is in the opposite direction)
 $m = 100 \text{ g} = 0.1 \text{ kg}$
 $\Delta p = m(v - u) = 0.1(-2 - 10)$
 $= -1.2 \text{ kg m/s}$
 $= -1.2 \text{ N s}$
 (The negative sign only shows direction)
6. A - a a



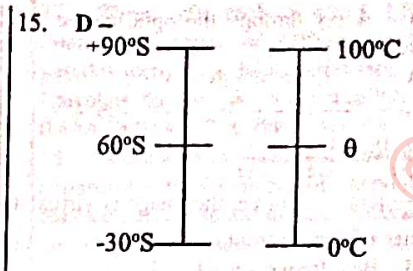
$$\cos 30^\circ = \frac{100}{T_2}; T_2 = \frac{100}{\cos 30^\circ}$$

- $= 100 \div \frac{\sqrt{3}}{2}$
 $= 100 \times \frac{2}{\sqrt{3}} = 200\sqrt{3} \text{ N}$
7. A - $F = ke; e = \frac{F}{k} = \frac{75 \text{ N}}{1500 \text{ Nm}^{-1}} = 0.05 \text{ m}$
 Energy = $\frac{1}{2}Fe = (1/2 \times 75 \times 0.05) \text{ J} = 1.875 \text{ J}$
8. C - $V.R = \frac{80 \text{ cm}}{10 \text{ cm}} = 8$
 $e = \frac{M.A}{V.R} \times 100\%$
 $\frac{e}{100} = \frac{M.A}{V.R}$
 $0.85 = \frac{M.A}{8}$
 $M.A = 8 \times 0.85 = 6.8$
 $M.A = \frac{\text{Load}}{\text{Effort}}; 6.8 = \frac{\text{Load}}{1200 \text{ N}}$
 Load = $(6.8 \times 1200) \text{ N} = 8160 \text{ N}$
9. B - Workdone = Area of the graph
 = Area of a semi-circle
 $= \frac{\pi r^2}{2}$
 $r = 12 \text{ m}$
 $W = \frac{\pi \times 12^2}{2} = \frac{144\pi}{2} = 72\pi \text{ J}$
10. C - $V.R = \frac{1}{\sin 30^\circ} = \frac{1}{0.5} = 2$
 $M.A = \frac{e \times V.R}{100} = \frac{75 \times 2}{100} = 1.5$
 Effort = $\frac{\text{Load}}{M.A} = \left(\frac{200}{1.5}\right) \text{ N} = 133.33 \text{ N}$

11. D - $\frac{F_1}{L_1 - L_0} = \frac{F_2}{L_2 - L_0} = \frac{F_3}{L_3 - L_0}$
 $\frac{5}{25 - L_0} = \frac{10}{30 - L_0}$
 $5(30 - L_0) = 10(25 - L_0)$
 $30 - L_0 = 2(25 - L_0)$
 $30 - L_0 = 50 - 2L_0$
 $-L_0 + 2L_0 = 50 - 30$
 $L_0 = 20 \text{ cm}$
 When the load is 3N, we have:
 $\frac{F_1}{L_1 - L_0} = \frac{F_3}{L_3 - L_0}; \frac{5}{25 - L_0} = \frac{3}{L_3 - L_0}$
 Since $L_0 = 20 \text{ cm}$, we have:
 $\frac{5}{25 - 20} = \frac{3}{L_3 - 20}$
 $3(25 - 20) = 5(L_3 - 20)$
 $L_3 - 20 = \frac{3 \times 5}{5} = 3$
 $L_3 = (3 + 20) \text{ cm} = 23 \text{ cm}$

12. C - $R.D = \frac{\text{mass of stone in air} - \text{mass of stone in liquid}}{\text{mass of stone in air} - \text{mass of stone in water}}$
 $2 = \frac{x - 10}{x - 15}; 2(x - 15) = x - 10$
 $2x - 30 = x - 10$
 $x - 10 + 30 = 20 \text{ g}$
13. A - Pressure difference = $75 \text{ cmHg} - 63 \text{ cmHg} = 12 \text{ cmHg}$
 $= \left(\frac{12}{100}\right) \text{ mHg} = 0.12 \text{ mHg}$
 When converted to Nm^{-2} , we have:
 $P = h \rho g = (0.12 \times 13 \times 10^3 \times 10) \text{ Nm}^{-2}$
 $= 15600 \text{ Nm}^{-2}$
 Then,
 $15600 = h_{air} \rho_{air} g$
 $h = \left(\frac{15600}{0.00013 \times 10^3 \times 10}\right) \text{ m} = 1200 \text{ m}$

14. B - Surface tension enables a needle to float on the surface of water. Generally speaking, surface tension is a force that makes the surface of a liquid behave as if it is covered by an elastic skin.



Mass remaining	Mass that has decayed	Time (days)
4g	0g	0
2g	2g	10
1g	3g	20
0.5g	3.5g	30

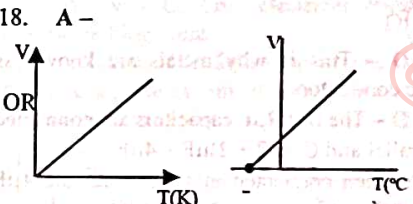
$$\frac{90 - (-30)}{60 - (-30)} = \frac{100 - 0}{\theta - 0};$$

$$\frac{90 + 30}{60 + 30} = \frac{100}{\theta}$$

$$\frac{120}{90} = \frac{100}{\theta}$$

$$\theta = \left(\frac{90 \times 100}{120}\right) = 75^\circ \text{C}$$

16. A - $L_2 = L_1(1 + \alpha \Delta \theta)$
 $= 2(1 + 18 \times 10^{-6} \times 100)$
 $= 2.0036 \text{ m}$
17. C - Difference = $mc\Delta \theta + mL_v - mc\Delta \theta$
 $= mL_v = (4 \times 2,260,000) \text{ J}$
 $= 9,040,000 \text{ J}$



19. C - Power \times time = $mc\Delta \theta$
 $750t = 1 \times 4200 \times (50 - 20) = 4200 \times 30$
 $t = \left(\frac{4200 \times 30}{750}\right) \text{ s} = 168 \text{ s}$

20. C - The saturated vapour pressure of a liquid increases as the temperature increases.
21. C - It is proportional to the average kinetic energy of the molecules. The higher the temperature, the faster the molecules.
22. B - The heat transfer is mainly by radiation.
23. C - Time = $1 \text{ min} \cdot 10 \text{ s} + 1 \text{ min} \cdot 12 \text{ s} + 1 \text{ min} \cdot 7 \text{ s}$
 $= (60 + 10) + (60 + 12) + (60 + 7)$
 $= (70 + 72 + 67) \text{ s} = 209 \text{ s}$
 $T = \frac{t}{n} = \frac{t_1 + t_2 + t_3}{n_1 + n_2 + n_3} = \left(\frac{209}{30 + 30 + 30}\right) \text{ s}$
 $= \left(\frac{209}{90}\right) \text{ s} = 2.32 \text{ s}$

24. A - Since both light and sound are waves, they both transmit energy. Light is an electromagnetic wave while sound is a mechanical wave.
25. D - The image is a pin-hole camera is inverted and is formed by the light from each point travelling in a straight line.
26. C - When the mirror is rotated through a particular angle, the reflected ray is rotated through twice the angle.
27. A - $n = \frac{R.D.}{A.D.}; A.D. = \frac{R.D.}{n} = \frac{12 \text{ cm}}{\frac{4}{3}} = 9 \text{ cm}$
 Displacement = $R.D. - A.D. = 12 \text{ cm} - 9 \text{ cm} = 3 \text{ cm}$

28. A - A ray through the optic centre will pass undeviated.

29. A - $f = -12\text{cm}$, $u = 4\text{cm}$, $v = ?$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}; \frac{1}{-12} = \frac{1}{4} + \frac{1}{v}; \frac{1}{-12} - \frac{1}{4} = \frac{1}{v}$$

$$\frac{1}{v} = \frac{1-(-3)}{-12} = \frac{4}{-12}$$

$v = \left(\frac{-12}{4}\right)\text{cm} = -3\text{cm}$ i.e. the image is virtual at a distance of 3cm in front of the lens.

30. B - Beat frequency = $F_2 - F_1$
 $= (260 - 256)\text{Hz} = 4\text{Hz}$

31. B - $V = \frac{2x}{t_{\text{echo}}}$; $x = \frac{V \cdot t_{\text{echo}}}{2}$

$$V = F\lambda = (1.29 \times 260)\text{m/s} = 335.4\text{m/s}$$

$$x = \frac{335.4\text{m/s} \times 2\text{s}}{2} = 335.4\text{m}$$

32. C - It is known as resonance

33. B - The angle of declination is the angle between the magnetic meridian and the geographic meridian.

34. B - Glass acquires a positive charge when rubbed with silk. Ebonite rod acquires a negative charge when rubbed with fur.

35. C - Since the cells are connected in parallel, the overall e.m.f. = 2V

The internal resistance, r is given by:

$$\frac{1}{r} = \frac{1}{2} + \frac{1}{2} = 1$$

$$r = 1\Omega$$

36. C - Manganese (iv) oxide acts as a depolarizer in the leclanche cell

37. C - $R_s = \frac{I_g \times R_g}{I - I_g} = \frac{1(10^{-3}) \times 300}{3 - 1(10^{-3})} = \left(\frac{0.3}{2.999}\right)\Omega$

38. D - This is why metals are known as ohmic conductors

39. D - The two $2\mu\text{F}$ capacitors are connected in parallel and $C = (2 + 2)\mu\text{F} = 4\mu\text{F}$

This is then connected in series with the $4\mu\text{F}$ capacitor

Effective capacitance

$$\frac{1}{C_{\text{eff}}} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4} = \frac{1}{2}$$

$$C_{\text{eff}} = 2\mu\text{F}$$

OR

$$C_{\text{eff}} = \left(\frac{4 \times 4}{4+4}\right)\mu\text{F} = \left(\frac{36}{20}\right)\mu\text{F} = 2\mu\text{F}$$

40. A - If K is closed, $I = \left(\frac{36}{14+6}\right)\text{A} = \left(\frac{36}{20}\right)\text{A} = 1.8\text{A}$

If K is opened, $I = \left(\frac{36}{14}\right)\text{A} = 2.57\text{A}$

Thus, the fuse wire will not melt when the key, K is closed since the circuit current (1.8A) is less than the fuse rating (2A)

The fuse will melt if the key is opened as this causes the current to increase to 2.57A, which is greater than the fuse rating

41. B - $P = I^2R$; $I^2 = \frac{P}{R}$; $I = \sqrt{\frac{P}{R}} = \left(\sqrt{\frac{1500}{375}}\right)\text{A} = 2\text{A}$

42. C - the slip rings are to be replaced with split ring commutator.

43. B - It causes eddy current.

44. A - $m = zIt$; $t = \frac{m}{zI} = \frac{1}{5 \times 10^{-7} \times 100} = 2 \times 10^4\text{s}$
 $= \left(\frac{2 \times 10^4}{3600}\right)\text{hr} = 5.6\text{hr}$

45. D - All the three statements are correct.

46. B - When an atom loses or gains a charge (electron), it becomes an ion. If a loss of electron is involved, the ion will be positive. If a gain is involved, the ion will be negative.

47. C -

Method 2

If 3.5g has decayed, mass remaining $4\text{g} - 3.5\text{g} = 0.5\text{g}$

$$N_t = N_0 \left(\frac{1}{2}\right)^{\frac{t}{T}}; 0.5 = 4 \left(\frac{1}{2}\right)^{\frac{t}{10}}$$

$$0.125 = \left(\frac{1}{2}\right)^{\frac{t}{10}}$$

Introducing \log_{10} , we have:

$$\log_{10} 0.125 = \log_{10} \left(\frac{1}{2}\right)^{\frac{t}{10}} = \frac{t}{10} \log_{10} 0.5$$

$$\frac{t}{10} = \frac{\log_{10} 0.125}{\log_{10} 0.5} = 3$$

$$t = (10 \times 3) = 30\text{ days}$$

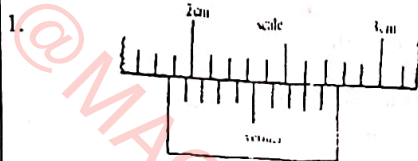
48. A - M_x will be less than 4Mp. The remaining mass has been traded for the binding energy:

$$4Mp = M_x + \text{Binding energy}$$

49. A - From the symbol ${}^4_2\alpha$ of alpha particle, it can be easily deduced that alpha decay causes the mass number to decrease by 4 and the atomic number by 2.

50. C - Light causes electron to be released from a metallic surface during photoelectricity.

1990 UME PHYSICS QUESTIONS

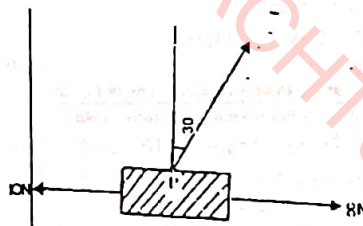


What is the reading of the vernier scale above?

A. 1.88cm B. 1.80cm C. 1.28cm D. 1.97mm

2. Which of the following is a fundamental unit? A. Newton B. Watt C. Joule D. Second

3.



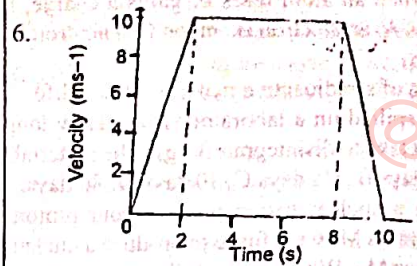
Two horizontal forces, 10N and 8N and another force F_1 inclined at 30° to the vertical acting as shown in the diagram above, keep the body P in equilibrium. The weight of the body is A. $\frac{2\sqrt{3}}{3}\text{N}$

B. $\sqrt{3}\text{N}$ C. $\frac{4\sqrt{3}}{3}\text{N}$ D. $2\sqrt{3}\text{N}$

4. A car moving with a speed of 90km/h was brought uniformly to rest by the application of the brakes in 10s. How far did the car travel after the brakes were applied? A. 125m B. 150m C. 250m D. 15km

5. A particle of mass M which is at rest splits up into two. If the mass and velocity of one of the particles are m and v respectively, calculate the velocity of the second particle. A. $\frac{Mv}{M}$ B. $\frac{Mv}{M-m}$

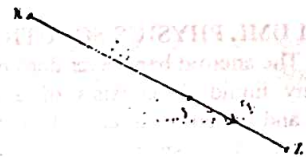
C. $\frac{Mv}{M+m}$ D. $\frac{mv}{M-m}$



What is the average velocity of the sprinter whose velocity-time graph is shown in the figure above? A. 85.0ms^{-1} B. 17.0ms^{-1} C. 8.5ms^{-1} D. 1.7ms^{-1}

7. Which of the following statements are correct about an object in equilibrium under parallel forces? I. The total clockwise moments of the forces about any point equals the total anticlockwise moments about the same point. II. The total forces in one direction equals the total forces in the opposite direction III. The resolved components along the x-axis equals the resolved components along the y-axis. A. I and II only B. I and III only C. II and III only D. I, II and III

8.



A force of 5N acts at a point Y on a rod XYZ as shown in the diagram above. If XY is 2m, what is the moment of the force about point X? A. 0Nm B. 3Nm C. 7Nm D. 10Nm

9. To keep a vehicle moving at a constant speed v, requires power P, from the engine. The force provided by the engine is A. $\frac{P}{v}$ B. $\frac{1}{2}v$ C. $\frac{P}{v^2}$ D. $\frac{P}{\sqrt{2}}$

10. A stone of mass m kg is held h meters above the floor for 50s. The work done in joules over this period is A. mh B. mgh C. $\frac{mgh}{50}$ D. 0

11. A body of mass 10kg rests on a rough inclined plane whose angle of tilt θ is variable. θ is gradually increased until the body starts to slide down the plane at 30° . The coefficient of limiting friction between the body and the plane is A. 0.30 B. 0.50 C. 0.58 D. 0.87

12. An inclined plane which makes an angle of 30° with the horizontal has a velocity ratio of A. 2 B. 1C. 0.866 D. 0.50

13. What is the length of the liquid column in a barometer tube that would support an atmospheric pressure of 102000Nm^{-2} if the density of the liquid is 2600kgm^{-3} ? [$g = 10\text{ms}^{-2}$] A. 0.75m B. 0.76m C. 3.92m D. 39.23m

14. 40m^3 of liquid is mixed with 60m^3 of another liquid Q. If the density of P and Q are 1.00kgm^{-3} and 1.6kgm^{-3} respectively, what is the density of the mixture? A. 0.05kgm^{-3} B. 1.25kgm^{-3} C. 1.30kgm^{-3} D. 1.36kgm^{-3}

15. The resistances of a platinum wire at the ice and steam points are 0.75 ohm and 1.05 ohm respectively. Determine the temperature at which the resistance of the wire is 0.90 ohm. A. 43.0°C B. 50.0°C C. 69.9°C D. 87.0°C

16. A bar of initial length l_0 is heated through a temperature change Δt to a new length l. The

linear expansivity, α , of the bar is A. $\frac{l-l_0}{l_0 \Delta t}$ B. $\frac{l-l_0}{l_0 \Delta t}$
 C. $l_0(1 + \Delta t)$ D. $\frac{l-l_0}{l_0 \Delta t}$

17. The pressure of a gas when cooled at constant volume will decrease because the molecules A. collide less frequently with the walls of the container B. have the same average kinetic energy C. break up into smaller molecules D. decrease in number

18. 1kg of copper is transferred quickly from boiling water to a block of ice. Calculate the mass of ice melted, neglecting heat loss. [Specific heat capacity of copper - $400 \text{ J kg}^{-1} \text{ K}^{-1}$ and latent heat of fusion of ice - $333 \times 10^3 \text{ J kg}^{-1}$]. A. 60g B. 67g C. 120g D. 133g

19. Which of the following conditions will make water boil at a temperature of 100°C when the atmospheric pressure is 750mm Hg? A. Increase the external pressure B. Reduce the external pressure C. Heat more rapidly at the same pressure D. Reduce the external pressure by a quarter.

20. Which of the following statements are correct? I. Land and sea breezes are natural convection currents. II. Convection may occur in liquids or gases but not in solids. III. The vacuum in a thermos flask prevents heat loss due to convection only. A. I and II only B. II and III only C. I and III only D. I, II and III.

21. A light wave of frequency $5 \times 10^{14} \text{ Hz}$ moves through water which has a refractive index of $\frac{4}{3}$. Calculate the wavelength in water if the velocity of light in air is $3 \times 10^8 \text{ ms}^{-1}$. A. $4.5 \times 10^{-7} \text{ m}$ B. $6.0 \times 10^{-7} \text{ m}$ C. $1.7 \times 10^6 \text{ m}$ D. $2.2 \times 10^6 \text{ m}$

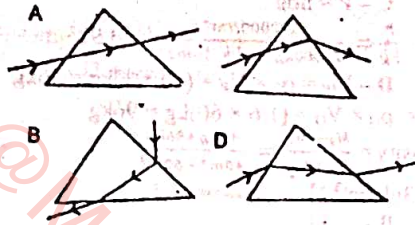
22. A wave disturbance travelling in air enters a medium in which its velocity is less than that in air. Which of the following statements is true about the wave in the medium? A. Both the frequency of the wave and the wavelength are decreased B. The frequency of the wave is decreased while the wavelength is increased C. The frequency of the wave is unaltered while the wavelength is decreased. D. The frequency of the wave is decreased while the wavelength is unaltered.

23. Shadows and eclipses result from the A. refraction of light B. rectilinear propagation of light C. diffraction of light D. reflection of light.

24. An object which is 3cm high is placed vertically 10cm in front of a concave mirror. If this object produces an image 40cm from the mirror, the height of the image is A. 0.75cm B. 4.00cm C. 8.00cm D. 12.00cm

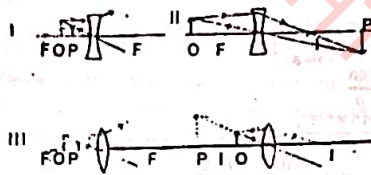
25. A boy looks at the image of an object in a plane mirror. He observes two images, a main bright one and the other faint. The observed images result from A. reflection only B. refraction only C. diffraction and interference D. reflection and refraction

26. Which of the diagrams below correctly illustrates the path of a ray of light through a glass prism?



27. What must be the distance between an object and a converging lens of focal length 20cm to, produce an erect image two times the object height? A. 20cm B. 15cm C. 10cm D. 5cm

28. Which of the following correctly represents the diagram for locating the image P of an object O in a lens if F is the focal point of the lens?



A. I and II only B. II and III only C. III and IV only D. I and IV only

29. For a short sighted person, light rays from a point on a very distant object is focused A. in front of the retina B. on the retina by a converging lens C. behind the retina by a diverging lens D. in front of the retina a distance 2F from the lens.

30. When light is incident on an object which is magenta in colour, which of the following colours would be absorbed? A. Red and blue B. Green only C. Red and green D. Red only

31. In a resonance tube experiment, the effective length of the air column for the first resonance is 20cm when set into vibration by a tuning fork of frequency 480 Hz. Neglecting end effect, the velocity of sound in air is A. 96 ms^{-1} B. 255 ms^{-1} C. 340 ms^{-1} D. 384 ms^{-1}

32. An organ pipe closed at one end is 80cm long. Determine the frequency of the fundamental note assuming that the speed of sound in air is 340ms. A. 106Hz B. 213Hz C. 318Hz D. 425Hz

33. A sonometer wire of length 100cm under a tension of 10N, has a frequency of 250 Hz. Keeping the length of the wire constant, the tension is adjusted to produce a new frequency of 350 Hz. The new tension is A. 5.1N B. 7.1N C. 14.0N D. 19.0N

34. One of the properties of the earth's magnetic field is that the A. north pole lies in the northern hemisphere B. geographic and magnetic meridians coincide C. earth's magnetic flux is entirely horizontal at a place where the magnetic dip is zero D. earth's magnetic flux is entirely vertical at a place where the magnetic dip is zero.

35. Which of the following statements are true of an insulated charged body carrying a positive charge? I. It contains excess positive charges II. It creates an electric field III. It possesses potential energy IV. It carries electric current A. I and IV only B. I and II only C. I, II and III only D. I, II, III and IV.

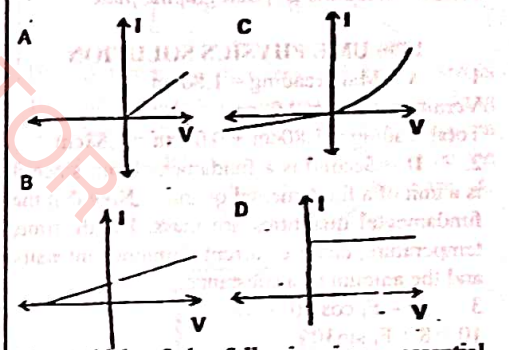
36. Which of the following is a vector? A. Electric charge B. Electric field C. Electric potential difference D. Electrical capacitance.

37. Three cells each of e.m.f. 1.5V and an internal resistance of 1.00 are connected in parallel across a load resistance of 2.670. Calculate the current in the load? A. 0.26A B. 0.41A C. 0.50A D. 0.79A

38. When a known standard resistor of 2.00 is connected to the 0.0cm end of a meter bridge, the balance point is found to be at 55.0cm. What is the value of the unknown resistor? A. 1.10 Ω B. 1.64 Ω C. 2.44 Ω D. 27.50 Ω

39. The total energy required to send a unit positive charge round a complete electrical circuit is the A. kinetic energy B. potential difference C. electromotive force D. electrical energy.

40. Which of the following graphs of current against voltage illustrates Ohm's law?



41. Which of the following is an essential physical property of the wires used for making fuses? A. Low density B. High thermal conductivity C. Low electrical resistivity D. Low melting point

42. Which of the following is most suitable for protecting the circuit of a 2000W electric iron connected to a 250V mains? A. 13A B. 8A C. 5A D. 3A

43. Electrical power is transmitted at a high voltage rather than low voltage because the amount of energy loss is reduced due to A. heat dissipation B. production of eddy currents C. excessive current discharge D. excessive voltage discharge.

44. A lamp is rated 240V, 60W. The resistance of the filament is A. 960 Ω B. 16 Ω C. 15 Ω D. 4 Ω

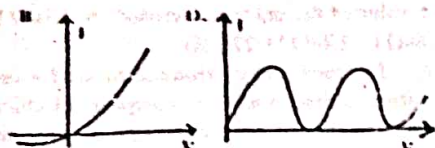
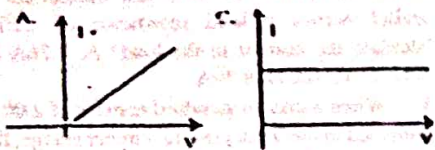
45. A 0 - 10mA galvanometer with a coil resistance of 30 Ω can be converted to a 0 - 10A ammeter by using A. 0.03 Ω series resistor B. 0.03 Ω shunt resistor C. 9.99 Ω shunt resistor D. 9.99 Ω series resistor.

46. The number of neutrons contained in the nucleus of is A. 92 B. 146 C. 238 D. 330

47. What precaution should a manufacturer take to ensure that energy loss in a transformer is minimized? A. The winding of the transformer should be made of high resistance wires B. The core should be made of thin sheets of metal C. No magnetic material should be used to make the core D. The flux linking the primary with the secondary coils should be minimum.

48. A substance has a half of 3min. After 6min, the count rate was observed to be 400. What was its count rate at zero time? A. 200 B. 1200 C. 1600 D. 2400

49. Which of the following graphs represents a voltage current characteristic curve for a diode?

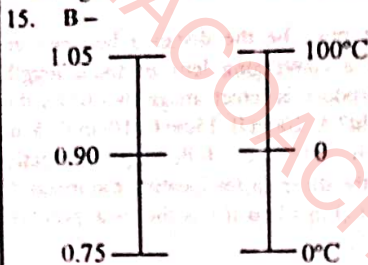


50. The photocell works on the principle of the
 A. voltaic cell B. emission of electrons by incident radiation
 C. emission of protons by incident electrons D. photographic plate.

1990 UME PHYSICS SOLUTION

- A - Main reading = 1.80cm
 Vernier reading = 0.08cm
 Total reading = 1.80cm + 0.08cm = 1.88cm
- D - Second is a fundamental unit since it is a unit of a fundamental quantity. Note that the fundamental quantities are mass, length, time, temperature, electric current, luminous intensity and the amount of a substance.
- D - $F_1 \cos 30^\circ = W$
 $10 = 8 + F_1 \sin 30^\circ$
 $10 = 8 + 0.5F_1$; $F_1 = \left(\frac{2}{0.5}\right)N = 4N$
 $W = F_1 \cos 30^\circ$
 $= 4 \times \frac{\sqrt{3}}{2} = 2\sqrt{3}$
- A - $u = 90 \text{ km/h} = \left(\frac{90 \times 1000}{3600}\right) \text{ m/s} = 25 \text{ m/s}$,
 $V = 0$, $S = ?$, $t = 10\text{s}$
 $S = \left(\frac{u+V}{2}\right)t = \left(\frac{25+0}{2}\right)10 = 125\text{m}$
- D - The original particle has a velocity of zero since it is at rest. From the principle of conservation of linear momentum:
 $M \times 0 = m_1v + m_2v_2$
 But $m_2 = M - m_1$
 $0 = m_1v + (M - m_1)v_2$
 $v_2 = \frac{-m_1v}{M - m_1}$
 (the negative sign only shows direction)
- Distance covered = $\frac{1}{2}(6 + 10)10 = 80\text{m}$
 Total time = 10s
 Average velocity (magnitude) = $\frac{80\text{m}}{10\text{s}} = 8\text{m/s}$
- A - 'I' and 'II' are the conditions required for equilibrium under parallel coplanar force. 'III' is for the equilibrium under non-parallel coplanar force.
- A - If the force and the distance are parallel to each other (as they are here) moment is 0.
- A - Power = Force \times velocity,
 $\text{Force} = \frac{\text{Power}}{\text{velocity}}$
- D - The only work done is that with which the stone is raised to the given height. For the period of 50s when the stone was held stationary, no work is done. Recall: "work is said to be done when a force applied causes motion in its direction".
- C - $\mu = \tan \theta = \tan 30^\circ = 0.5774 = 0.5\sqrt{3}$
- A - $V \cdot R = \frac{1}{\sin \theta} = \frac{1}{\sin 30^\circ} = \frac{1}{0.5} = 2$

13. $C - P = h\rho g$
 $h = \frac{P}{\rho g} = \frac{102000 \text{ Nm}^{-2}}{26000 \text{ kg m}^{-3} \times 1 \text{ ms}^{-2}} = 3.92 \text{ m}$
 14. $D - M_P = \rho_P \times V_P = (40 \times 1) \text{ kg} = 40 \text{ kg}$
 $M_Q = \rho_Q \times V_Q = (1.6 \times 60) \text{ kg} = 96 \text{ kg}$
 $\text{Density} = \frac{M_P + M_Q}{V_P + V_Q} = \frac{40 \text{ kg} + 96 \text{ kg}}{40 \text{ m}^3 + 60 \text{ m}^3}$
 $= 1.36 \text{ kg m}^{-3}$



$\frac{1.05 - 0.75}{0.9 - 0.75} = \frac{100 - 0}{\theta - 0}$
 $\frac{0.3}{0.15} = \frac{100}{\theta}$
 $\theta = \left(\frac{0.15 \times 100}{0.3}\right) = 50^\circ\text{C}$

- B - $\alpha = \frac{\Delta L}{L \Delta \theta} = \frac{l - l_0}{l_0 \Delta \theta}$
 Linear expansivity is defined as the increase in length per unit length per degree rise in temperature.
- A - As the temperature decreases, the number of collisions between the gas molecules and the walls of the container decreases and vice-versa
- C - $m_c c_{c_w} \Delta \theta_{c_w} = m L_s$
 $1 \times 400 \times (100 - 0) = m \times 333 \times 10^3$
 $40000 = 33 \times 10^3 m$
 $m = \left(\frac{40000}{33 \times 10^3}\right) \text{ kg} = 0.120 \text{ kg} = 120 \text{ g}$
- A - the external pressure should be increased. Don't forget that the standard external atmosphere pressure is 769 mmHg. It is then that water can boil at 100°C.
- A - The vacuum in a thermos flask prevent heat loss both by convection and conduction.
- A - $\lambda = \frac{v}{f} = \left(\frac{3 \times 10^8}{5 \times 10^{14}}\right) \text{ m} = 6 \times 10^{-7} \text{ m}$
 $\lambda_w = \frac{\text{wavelength of light in air}}{\text{wavelength of light in water}}$
 $\frac{4}{3} = \frac{6 \times 10^{-7}}{\lambda_w}$; $\lambda_w = \frac{3 \times 6 \times 10^{-7}}{4}$
 4.5×10^{-7}
- C - The frequency will not change while the wavelength will decrease (since velocity has decreases).
- B - Shadows, eclipses and pin-hole cameras are manifestation of the rectilinear propagation of light.
- D - $m = \frac{v}{u} = \frac{IH}{OH}$
 ($V =$ image distance, $U =$ object distance, $OH =$ object height and $IH =$ image height).
 $\frac{40}{10} = \frac{IH}{1}$; $IH = \frac{40 \times 1}{10} = 12 \text{ cm}$
- D - This is because reflection and refraction occur in thick mirrors.
- B - The path of the light ray will be as shown in 'B'.
- C - $f = 20 \text{ cm}$, $v = -2u$ (negative because the image is virtual and erect)
 $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$; $\frac{1}{20} = \frac{1}{-2u} + \frac{1}{u}$
 $\frac{1}{20} = \frac{1}{-2u} - \frac{1}{2u} = \frac{2-1}{2u} = \frac{1}{2u}$
 $u = \left(\frac{20}{2}\right) \text{ cm} = 10 \text{ cm}$

28. D - 'I' describes the image formed by a diverging lens. 'IV' describes the image formed by a simple microscope.

29. A - In long sightedness, light rays from near objects are focused behind the retina. In short sightedness, light rays from distant objects are focused in front of the retina.

30. B - White = Red + Green + Blue light
 Since magenta is red and blue, only green will be absorbed.

31. $D - F_0 = \frac{v}{4l}$
 ($F_0 = 480 \text{ Hz}$, $l = 20 \text{ cm} = 0.2 \text{ m}$)
 $480 = \frac{v}{4 \times 0.2}$; $v = (480 \times 0.2) \text{ m/s} = 384 \text{ m/s}$

32. $A - F_0 = \frac{v}{4l} = \frac{340}{4 \times \left(\frac{85}{100}\right)} = \left(\frac{340}{4 \times 0.85}\right) \text{ Hz} = 106 \text{ Hz}$

33. $D - F = \frac{1}{2l} \sqrt{\frac{T}{\mu}}$; $F \propto \sqrt{T}$

Thus, we have:
 $\frac{F_1}{\sqrt{T_1}} = \frac{F_2}{\sqrt{T_2}}$; $\frac{250}{\sqrt{16}} = \frac{350}{\sqrt{T_2}}$
 $\sqrt{T_2} = \frac{350 \times \sqrt{16}}{250} = 4.427$
 $T_2 = 4.427^2 = 19.6 \text{ N}$

34. C - The earth's magnetic flux is entirely horizontal at a place where the magnetic dip is zero.

35. C - The insulated charged body is not carrying electric current as the charge is not able to flow.

36. B - Electric charge, potential difference and capacitance are scalar quantities while electric field is a vector quantity.

37. C - $E_{\text{net}} = 1.5 \text{ V}$ (since the cells are connected in parallel).

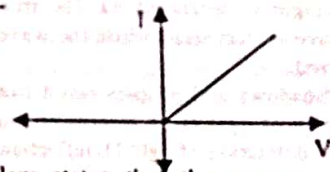
$\frac{1}{r} = \frac{1}{1} + \frac{1}{1} = \frac{1}{1} = 1$
 $r = \frac{1}{1} = 0.3333 \Omega$

$I = \frac{E}{R+r} = \frac{1.5}{2.67 + 0.3333} = \frac{1.5}{3} = 0.5 \text{ A}$

38. B
 $\frac{R_1}{L_1} = \frac{R_2}{L_2}$; $\frac{2}{55} = \frac{R_2}{45}$; $R_2 = \left(\frac{2 \times 45}{55}\right) \Omega = 1.64 \Omega$

39. B - This represents potential difference.

40. A -



Ohm's law states that the current passing through a metallic conductor is directly proportional to the potential difference across its ends.

41. D - The wire for making fuse must have a low melting point so that it can quickly melt if large current tries to flow through the appliance.

42. $B - I = \frac{P}{V} = \frac{2000 \text{ W}}{250 \text{ V}} = 8 \text{ A}$

Note that if a higher rating (such as 13A) is used, it will permit current greater than 8A to pass through the appliance (which requires only 8A) and consequently damages it.

43. A - High voltage (or low current) transmission is to reduce heat loss.

44. $A - P = \frac{V^2}{R}$; $R = \frac{V^2}{P} = \frac{240^2}{60} = 960 \Omega$

45. A - To convert a galvanometer to an ammeter, a low resistance wire (known as the shunt) must be connected in parallel with it.

$$R_s = \frac{I_g \times R_g}{I - I_g} = \frac{0.10(10^{-3}) \times 30}{0.10 - 0.10(10^{-3})} = \frac{3 \times 10^{-3}}{9.99 \times 10^{-2}} = 0.03\Omega$$

46. **B** - Neutron number = mass number - proton number
= 238 - 92
= 146

47. **B** - The energy loss can be reduced by making the core with thin sheets of metal - this is known as lamination.

48. **C** -

Count rate	Time (min)
x	0
$\frac{x}{2}$	3
$\frac{x}{4}$	6

$$\frac{x}{4} = 400; x = 400 \times 1600$$

49. **B** - The graph is as shown in 'B'

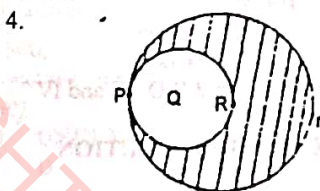
50. **B** - Photocell works on the principle of photoelectric emission.

U.M.E PHYSICS 1989 QUESTIONS

1. Which of the following is a set of vectors?
A. Force, mass and moment B. Acceleration, velocity and moment C. Mass, weight and density D. Mass, volume and density.

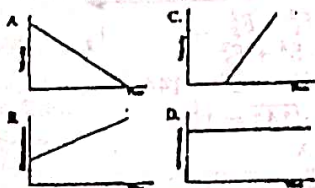
2. The magnitude of the resultant of two mutually perpendicular forces, F_1 and F_2 is 13N. If the magnitude of F_1 is 5N, what is the magnitude of F_2 ? A. 2.6N B. 8.0N C. 12.0N D. 18.0N

3. Two points on a velocity-time graph have coordinates (5s, 10ms^{-1}) and (20s, 20ms^{-1}). Calculate the mean acceleration between the two points. A. 0.67ms^{-2} B. 0.83ms^{-2} C. 1.50ms^{-2} D. 2.00ms^{-2}



The figure above shows a uniform circular Object, centre R and diameter PS. A circular section, centre Q and diameter PR is cut away from it. If PQRS is a straight line, where is the centre of gravity of the figure? A. Q B. R C. A point between P and R. D. A point between R and S

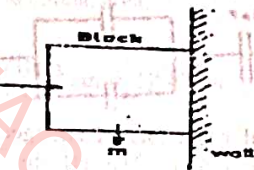
5. Which of the following graphs represents motion with uniform velocity?



A simple pendulum of mass m moves along an arc of a circle radius R in a vertical plane as shown in the figure above. What is the work done by gravity in a downward swing through

the angle θ to 00° ? A. $mgR \sin\theta$ B. $mgR (1 - \cos\theta)$ C. mgR D. $mgR (1 + \sin\theta)$

7.

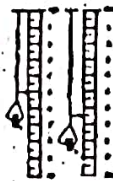


A block of mass m is held in equilibrium against a vertical wall by a horizontal force. If the coefficient of friction between the block and the wall is μ , the minimum value of the horizontal force is A. μmg B. $(1 - \mu)mg$ C. $(1 + \mu)mg$ D. $\frac{mg}{\mu}$

8. A thin film of liquid is trapped between two glass plates. The force required to pull the plates apart will increase if the A. surface tension of the liquid is reduced B. perpendicular distance between the plates is increased C. area of the liquid surface in contact with the plates is increased D. Pressure of the air is decreased.

9. A block-and-tackle system is used to lift a load of 20N through a vertical height of 10m. If the efficiency of the system is 40%, how much work is done against friction? A. 80J B. 120J C. 300J D. 500J

10.



In the figure above $W_1 = 200\text{g}$ and $W_2 = 450\text{g}$. Calculate the extension of the spring per unit load. [$g = 10\text{ms}^{-2}$]. A. $6.0 \times 10^{-5}\text{mN}^{-1}$ B. $2.5 \times 10^{-4}\text{mN}^{-1}$ C. $6.0 \times 10^{-3}\text{mN}^{-1}$ D. $2.5 \times 10^{-2}\text{mN}^{-1}$

11. Which of the following devices are used to measure pressure? I. Aneroid barometer II. Hydrometer III. Hygrometer IV. Manometer A. I and III B. II and III C. III and IV D. I and IV.

12. A piece of wood of mass 40g and uniform cross-sectional area of 2cm^2 floats upright in water. The length of the wood immersed is A. 80cm B. 40cm C. 20cm D. 2cm

13. The pressure on the gas of constant gas thermometer at the ice point is, 325mm of mercury and at the steam point 875mm of mercury. Find the temperature when the pressure of the gas is 190mm of mercury. A. 30k B. 243k C. 300k D. 303k

14. A column of air 10.0cm long is trapped in a tube at 27°C . What is the length of the volume at 100°C ? A. 12.4cm B. 13.7cm C. 18.5cm D. 37.0cm

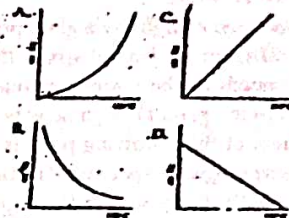
15. A mass of gas at 7°C and 70cm of mercury has a volume of 1200cm^3 . Determine its volume at 27°C and pressure of 75cm of mercury. A. 1200cm^3 B. 1378cm^3 C. 4320cm^3 D. 4629cm^3

16. An electric heater is used to melt a block of ice, mass 1.5kg. If the heater is powered by a 12V battery and a current of 20A flows through the coil, calculate the time taken to melt the block of ice at 0°C . (Specific latent heat of fusion of ice = $336 \times 10^3\text{J kg}^{-1}$). A. 76.0min B. 35.0mm C. 21.0mm D. 2.9mm

17. From the kinetic theory of gases, temperature is a A. form of energy and is

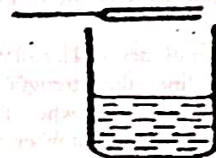
proportional to the total kinetic energy of the molecules. B. form of energy and is proportional to the average kinetic energy of the molecules. C. physical property and is proportional to the total kinetic energy of the molecules D. physical property and is proportional to the average kinetic energy of the molecules.

18. Which of the following correctly represents the variation of the saturated vapour pressure of water with temperature?



19. A vibrator of frequency 60 Hz is used in generating transverse stationary waves in a long thin wire. If the average distance between successive nodes on the wire is 45cm, find the speed of the transverse waves in the wire. A. 27ms^{-1} B. 54ms^{-1} C. 90ms^{-1} D. 108ms^{-1}

20.

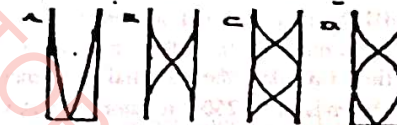


The air column as shown in the figure above is set into vibration by the tuning fork. In this state of resonance, the waves in the air column will be A. stationary and transverse B. stationary and longitudinal C. progressive and transverse D. progressive and longitudinal.

21. When the tension in a sonometer wire is doubled, the ratio of the new frequency to the initial frequency is A. $\frac{1}{2}$ B. $\frac{1}{\sqrt{2}}$ C. $\sqrt{2}$ D. 2

22. In a sound wave in air, the adjacent rarefactions and compressions are separated by a distance of 17cm. If the velocity of the sound wave is 340ms^{-1} determine the frequency. A. 10Hz B. 20 Hz C. 1000 Hz D. 5780 Hz

23. In which of the following diagrams is the length of the tube equal to one wavelength?



24. Light of wavelength $5000 \times 10^{-4}\text{cm}$ travels in free space with a velocity of $3 \times 10^8\text{ms}^{-1}$. What is its wavelength in glass of refractive index 1.5? A. $3333 \times 10^{-8}\text{cm}$ B. $5000 \times 10^{-8}\text{cm}$ C. $6666 \times 10^{-8}\text{cm}$ D. $7500 \times 10^{-8}\text{cm}$.

25. An object is placed $5.6 \times 10^{-4}\text{m}$ in front of a converging lens of focal length $1.0 \times 10^{-4}\text{m}$. The image formed is A. real, erect and magnified B. virtual, erect and magnified C. real, inverted and magnified D. virtual, erect and diminished.

26. The magnification of the image of an object placed in front of a convex mirror is $\frac{1}{3}$. If the radius of curvature of the mirror is 24cm, what is the distance between the object and its image? A. 8cm B. 16cm C. 24cm D. 32cm

27. The plane mirrors in a kaleidoscope are usually placed. A. at an angle of 60° B. parallel

to one another C. perpendicular to one another D. at an angle of 45° .

28. A far sighted person cannot see objects that are less than 100cm away. If this person wants to read a book at 25cm, what type and focal length of lens does he need? A. convex, 20cm B. concave, 20cm C. convex, 33cm D. concave, 33cm

29. When a yellow card is observed through a blue glass, the card would appear. A. black B. green C. red D. white

30. Dispersion of light by a glass prism is due to the A. different hidden colours of the glass B. different speeds of the various colours in glass C. defects in the glass D. high density of glass.

31. Which of the following pairs is NOT part of the electromagnetic spectrum? I. Radio waves II. Beta rays III. Gamma rays IV. Alpha rays A. I and II B. III and IV C. I and III D. II and IV.

32. Two insulated charged spheres of different sizes and carrying opposite charges are connected together by a metallic conductor. Current will flow from one sphere to the other until both spheres A. carry the same magnitude and sign of charge B. are at the same potential C. are at the same temperature D. are of the same size.

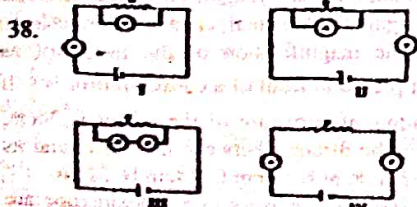
33. When a number of identical small magnets are arranged in a line, the strength of the resultant magnet A. is largest when they are arranged end to end B. is greatest when they are arranged parallel with like poles adjacent to each other C. depends only on the number of magnets provided they are parallel D. is greater when the magnets are arranged on a wooden surface than on a metal surface.

34. A bar magnet is most effectively demagnetized by A. placing it in a N-S position and hitting it with a hammer B. subjecting it to an electric current from a battery C. bringing its north pole in contact with the north pole of a very strong magnet D. heating the magnet.

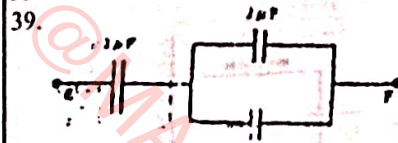
35. The resistance of a 5m uniform wire of cross-sectional area $0.2 \times 10^{-6} \text{ m}^2$ is 0.425. What is the resistivity of the material of the wire? A. $1.10 \times 10^{-6} \Omega \text{ m}$ B. $4.25 \times 10^{-6} \Omega \text{ m}$ C. $2.40 \times 10^{-7} \Omega \text{ m}$ D. $1.70 \times 10^{-4} \Omega \text{ m}$

36. Three resistors, with substances 250 Ω , 500 Ω and 1k Ω are connected in series. A 6V battery is connected to either end of the combination. Calculate the potential difference between the ends of the 250 Ω resistor. A. 0.20V B. 0.86V C. 1.71V D. 3.43V.

37. A calibrated potentiometer is used to measure the e.m.f. of a cell because the A. internal resistance of a cell is small compared with that of the potentiometer B. potentiometer has a linear scale C. potentiometer takes no current from the cell D. resistance of the potentiometer is less than that of a voltmeter.

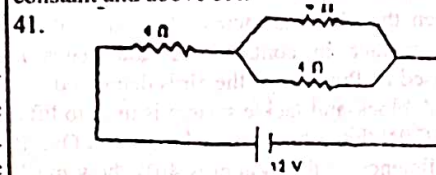


In the above circuit diagrams, A is the ammeter and V the voltmeter. Which of the circuits is correct for finding the value of the resistance R? A. I B. II C. III D. IV



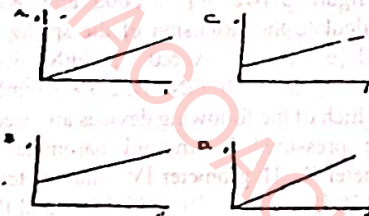
39. Three 2- μF capacitors are arranged as shown in the above circuit. The effective capacitance between E and F is A. 0.75 μF B. 1.33 μF C. 3.00 μF D. 6.00 μF .

40. The function of a 5-A fuse included in a circuit supplying a household refrigerator with power is to keep the A. temperature of the refrigerator low and constant B. current supplied to the refrigerator below 5A C. voltage supply constant D. current supplies to the refrigerator constant and above 5A.



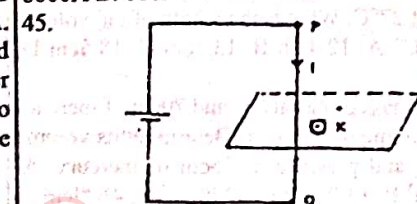
41. The total power drawn from the cell in the circuit diagram above is A. 12W B. 24W C. 32W D. 40W

42. Which of the following correctly represents the relationship between the temperature rise θ and the current I in an experiment to illustrate the heating effect of electric current?



43. An ammeter of resistance 0.1 Ω has a full-scale deflection of 50 mA. Determine the resultant full-scale deflection of the meter when a shunt of 0.011 Ω is connected across its terminals. A. 400 mA B. 450 mA C. 500 mA D. 550 mA

44. The electrochemical equivalent of silver is 0.0012g/C. If 36.0g of silver is to be deposited by electrolysis on a surface by passing a steady current for 5.0 minutes, the current must be A. 6000A B. 100A C. 10A D. 1A



45. The figure above shows a conductor PQ carrying a current I in the direction shown. At a particular position near the conductor is a compass needle K. Neglecting the earth's magnetic field, the compass needle will A. settle in any direction B. settle fixed direction only if conductor PQ is a magnetic material C. settle in a fixed direction whether conductor PQ is a magnetic material or not D. be stationary

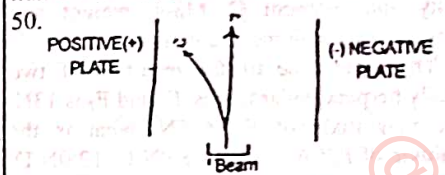
46. A radioactive substance has a half-life of 2 years. If the initial mass is 40g, which of the following rows correctly gives the mass of substance left at the times stated?

	2 years	3 years	4 years	5 years
A	20g		10g	0g
B	30g	20g	10g	0g
C	30g	20g	15g	0g
D	20g		10g	0g

47. When a radiation strikes a metal surface, electrons may be ejected from the metal. The maximum kinetic energy which may be acquired by an ejected electron depends on the A. intensity of the radiation B. source of the radiation C. wavelength of the radiation D. detection device for the electron.

48. Which of the following is TRUE of the particles emitted in radioactive disintegration? A. The alpha particle is the helium nucleus B. The alpha particle is lighter than the beta particle C. The alpha particle is deflected more than the beta particle in a magnetic field D. The beta particle is deflected more than the alpha particle in a magnetic field

49. Eight alpha decays and six beta decays are necessary before an atom of U achieves stability. The final product in the chain has an atomic number of A. 70 B. 78 C. 82 D. 90

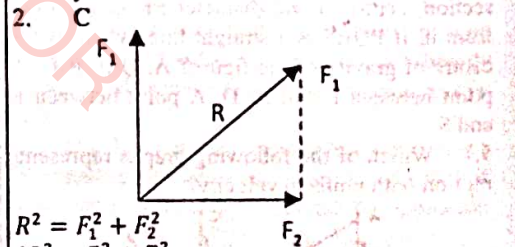


50. A beam of radiation is passed between a pair of charged plates as indicated in the diagram above. Beam P is undeflected while Q is deflected to the left. P and Q respectively could be

- I. γ -rays β -rays
 - II. x-rays β -rays
 - III. γ -rays x-rays
 - IV. x-rays x-rays
- A. I only B. III only C. I and II D. III and IV

1989 UME PHYSICS SOLUTION

1. B
Acceleration, weight, velocity, moment and force are vectors while mass, volume and density are scalars.



$$R^2 = F_1^2 + F_2^2$$

$$13^2 = 5^2 + F_2^2$$

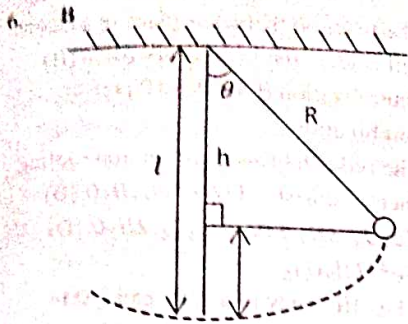
$$F_2^2 = 13^2 - 5^2 = 144$$

$$F_2 = \sqrt{144} = 12N$$

3. A
 $a = \frac{\Delta v}{\Delta t} = \frac{(20-10)\text{m/s}}{(20-5)\text{s}} = \frac{10}{15} \text{ m/s}^2$
 $= 0.67 \text{ m/s}^2$

4. D
The centre of gravity will be located at a point between R and S

5. B
In a motion with uniform velocity, the rate of change of displacement with time is constant.



$R = l$ (length of the pendulum is constant throughout)

$$\cos \theta = \frac{h}{R} \quad h = R \cos \theta$$

The distance (vertical) of the bob from the equilibrium position $= l - h$

$$= R - R \cos \theta$$

$$= R(1 - \cos \theta)$$

Thus, workdone $= mgr(1 - \cos \theta)$

7. D
KEY \Rightarrow The reaction from the vertical wall must be equal to the force F applied. Frictional force must also be equal to the weight (study the diagram)

$$F_r = \mu R$$

$$\text{But } F_r = mg \text{ and } R = F$$

$$mg = \mu F; F = \frac{mg}{\mu}$$

8. C

The force required to pull the plates apart will increase if the area of the liquid surface in contact with the plates is increased.

9. C

$$\text{Work done by load} = (20 \times 10)J = 200J$$

$$\epsilon = \frac{\text{Workdone by load}}{\text{Workdone by effort}} \times 100\%$$

$$\frac{40}{100} \% = \frac{200}{\text{Workdone by effort}}$$

$$\text{Workdone by effort} = \left(\frac{200 \times 100}{40}\right)J$$

$$= 500J$$

$$\text{Workdone against friction} = 500J - 200J = 300J$$

10. UNCLEAR CALIBRATIONS

11. D

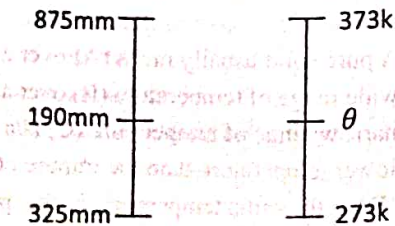
Aneroid barometer is used for measuring atmospheric pressure while manometer is used for measuring fluid pressure.

12. C

KEY \Rightarrow Mass of the floating wood must be equal to the mass of water displaced. Also, volume of water displaced = Volume of wood immersed.

$$\text{Depth immersed} = \frac{40cm^3}{2cm^2} = 20cm$$

13. B



$$\frac{875-325}{190-325} = \frac{373-273}{\theta-273}$$

$$\frac{550}{-135} = \frac{100}{\theta-273}$$

$$\theta - 273 = \frac{-135 \times 100}{550} = -24.5$$

$$\theta = -24.5 + 273 = 248.5k$$

14. A

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$V_1 = 10 \times A; t_1 = 27^\circ C = 300k$$

$$T_2 = 100^\circ C = 373k, V_2 = l_2 \times A$$

Where A = cross-sectional area)

$$\frac{10 \times A}{300} = \frac{l_2 \times A}{373}$$

$$l_2 = \frac{10 \times 373}{300} = \left(\frac{3730}{300}\right)cm = 12.43cm$$

15. A

$$T_1 = 7^\circ C = 280k, P_1 = 70cmHg,$$

$$V_1 = 1200cm^3$$

$$T_2 = 27^\circ C = 300k, P_2 = 75cmHg$$

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1} = \left(\frac{70 \times 1200 \times 300}{75 \times 280}\right)cm^3 = 1200cm^3$$

16. B

$$IVt = ml_f$$

$$t = \frac{ml_f}{IV} = \left(\frac{1.5 \times 336 \times 10^3}{20 \times 12}\right) = 2100s$$

$$= \left(\frac{2100}{60}\right)min = 35min$$

17. D

Temperature is a physical property that is proportional to the average kinetic energy of the molecules.

18. A

As temperature increases, the saturated vapour pressure increases, albeit in a non-linear fashion.

19. B

$$F = 60Hz$$

$$\text{Distance between successive nodes} = \frac{1}{2}\lambda$$

$$45cm = \frac{1}{2}\lambda$$

$$\lambda = (45 \times 2)cm = 90cm = 0.9m$$

$$V = F\lambda = (60 \times 0.9)m/s = 54m/s$$

20. A

The waves will be stationary and transverse.

21. C

$$\frac{F_1}{\sqrt{r_1}} = \frac{F_2}{\sqrt{r_2}}; \frac{F_2}{\sqrt{r_1}} = \frac{\sqrt{r_2}}{\sqrt{r_1}} = \frac{\sqrt{2r_1}}{\sqrt{r_1}} = \sqrt{2}$$

22. C

$$L = \frac{\lambda}{2}$$

$$0.17 = \frac{\lambda}{2}; \lambda = (2 \times 0.17)m = 0.34m$$

$$F = \frac{v}{\lambda} = \frac{340}{0.34} = 1000Hz$$

23. C

$$\text{In option A, } L = \frac{\lambda}{4}$$

$$\text{In option B, } L = \frac{\lambda}{2}$$

$$\text{In option C, } L = \lambda$$

$$\text{In option D, } L = \frac{3\lambda}{4}$$

24. A

$$n_g \lambda_g = \text{wavelength in air } (\lambda_a)$$

$$1.5 = \frac{5000 \times 10^{-8} cm}{\lambda_g}$$

$$\lambda_g = \frac{5000 \times 10^{-8} cm}{1.5} = 3333 \times 10^{-8} cm$$

25. B

Since the object distance is less than the focal length, the image produced by the converging mirror will be virtual, erect and magnified.

26. B

$$m = \frac{1}{3}, v = \frac{u}{3} \text{ (since } m = \frac{v}{u})$$

Since it is a convex mirror (a diverging surface)

$$v = -\frac{u}{3}$$

$$f = \frac{r}{2} = \frac{24cm}{2} = 12cm$$

$$(f = -12cm \text{ since it is convex})$$

$$-\frac{1}{12} = \frac{1}{u} - \frac{1}{3} = \frac{1}{u} - \frac{3}{3}$$

$$= -\frac{1}{12} = \frac{-2}{u}; u = 24cm$$

The negative sign means that the image will be on the same side as the object. Thus, distance between the object and its image $= 24cm - 8cm = 16cm$

27. A

Plane mirrors in a kaleidoscope are inclined to each other at 60°

28. C

$$u = 25cm, v = -100cm$$

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{25} + \frac{1}{-100} = \frac{1}{25} - \frac{1}{100} = \frac{4-1}{100} = \frac{3}{100}$$

$$f = \frac{100}{3} = 33.33cm$$

Since f is positive, the lens required is a convex or converging lens.

29. A

Yellow = red + green

Note that the blue glass allows only blue colour to pass through it. Hence, the yellow card will appear black.

30. B

Dispersion of light by a glass prism is due to the different speeds of the various colours in glass.

31. D

The components of the electromagnetic spectrum are radio waves, infra-red rays, visible light, ultraviolet rays, x-ray and gamma ray.

32. B

The flow of charge will continue until both spheres are at the same potential.

33. A

It is largest when they are arranged end-to-end. Repulsion sets in when like poles are adjacent to each other.

34. D

The solenoid method is the best method for demagnetizing a magnet. Nott to it is the heating method.

35. D

$$R = \frac{\rho l}{A}$$

$$0.425 = \frac{\rho \times 5}{0.2 \times 10^{-6}}; \rho = \frac{0.425 \times 0.2 \times 10^{-6}}{5}$$

$$= 1.7 \times 10^{-8} \Omega m$$

36. B

$$\text{Total resistance} = 25 = \Omega + 500\Omega + 1000\Omega = 1750\Omega$$

$$I = \frac{V}{R} = \left(\frac{6}{1750}\right)A$$

$$V_{250} = I_{250} \times R_{250} = \left(\frac{6}{1750} \times 250\right)V = 0.86V$$

37. C

It is because the potentiometer draws no current from the cell.

38. A

The voltmeter should be connected in parallel with the resistor while the ammeter should be connected in series with the resistor.

39. B

$$C_{effective} = \frac{2 \times (2+2)}{2+(2+2)} = \left(\frac{2 \times 4}{2+4}\right) \mu F = \frac{8}{6} \mu F$$

40. B

A 5-A fuse is to keep the current through the appliance at and below 5-A

41. B

$$R_T = 4 + \left(\frac{4 \times 4}{4+4}\right) = (4 + 2)\Omega = 6\Omega$$

$$P = \frac{V^2}{R} = \frac{12^2}{6} = 24W$$

42. D

$$\text{Heat} = MC\Delta\theta = 1^2 R t$$

Thus, $I^2 \propto \Delta\theta$

This is as shown by graph 'D'

43. C

$$R_s = \frac{I_g \times R_g}{I_g - I_g}; \quad 0.0111 = \frac{50(10^{-3}) \times 0.1}{I - 50(10^{-3})}$$

$$0.0111 = \frac{0.005}{I - 0.05}$$

Then,

$$I - 0.05 = \frac{0.005}{0.0111} = 0.45$$

$$I = (0.45 + 0.05)A = 0.5A = 500mA$$

44. B

$$m = zIt, \quad I = \frac{m}{zt} = \frac{36}{0.0012 \times 5 \times 60}$$

$$\frac{36}{0.36} = 100A$$

45. C

This is because the current will create its own magnetic field.

46. A

The mass will reduce to 20g after 2 years. After another 2 years (making a total of 4 years), the mass will remain 10g