PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. Five identical convex lenses are placed one after the other in close contact. The power of this arrangement is 25 D. Then, power of one such lens is

(1) 10 D

(2) 5 D

(3) 125 D

(4) 20 D

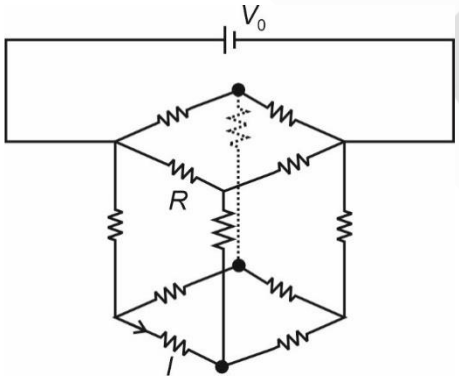
Answer (2)

Sol. $P = \sum \frac{1}{f_i}$

$= 5 \times \frac{1}{f}$

$\Rightarrow \frac{5}{f} = 25$

$\Rightarrow P = 5$ D

2. 

A cubical arrangement of 12 resistors each of R. Each having resistance R is shown. Find I.

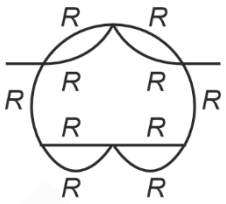
(1) $\frac{V_0}{3R}$

(2) $\frac{V_0}{6R}$

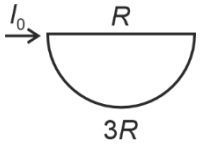
(3) $\frac{V_0}{4R}$

(4) $\frac{V_0}{8R}$

Answer (2)

Sol. 

$R_{eq} \equiv 3R \,||\, R$



$R_{eq} \equiv \frac{3R}{4}$

$i_{3R} = \frac{I_0}{4}$

$I = \frac{I_0}{8}$

$\Rightarrow i = \frac{1}{8}\left\{\frac{V_0}{3R/4}\right\} = \frac{V_0}{6R}$

3. On a given rough inclined plane, a solid sphere and a hollow cylinder are rolled one by one, with same speed. Ratio of heights attained by solid sphere and hollow cylinder is

(1) $\frac{9}{10}$

(2) $\frac{3}{10}$

(3) $\frac{7}{10}$

(4) $\frac{6}{10}$

Answer (3)

Sol. Conserving energy :

$$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgh$$

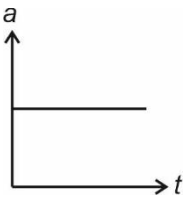
$$\Rightarrow \quad \frac{7}{10}mv^2 = mgh_1$$

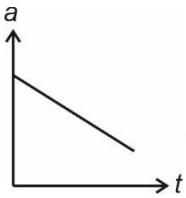
$$\& \quad m'v^2 = m'gh_2$$

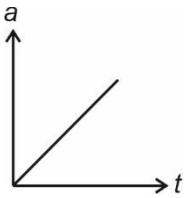
$$\Rightarrow \quad \boxed{\frac{7}{10} = \frac{h_1}{h_2}}$$

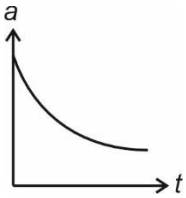
4. A wooden block is initially at rest. Now a horizontal force is applied on the block which increases linearly with time.

The acceleration - time (a - t) graph for the block would be

(1)


(2)


(3)


(4)


Answer (3)

Sol. $\vec{F} = m\vec{a}$

$\Rightarrow$ a - t graph is also linearly increasing.

5. An electron is projected along the axis of solenoid, the trajectory of electron shall be

(1) Circular path

(2) Uniform motion along the axis

(3) Uniform accelerated motion in straight line

(4) Parabolic path

Answer (2)

Sol. $\vec{F} = q(\vec{v} \times \vec{B})$

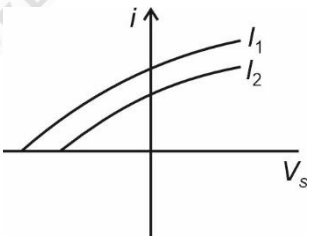
$\because \ \vec{v} \parallel \vec{B} \quad \therefore \ \vec{F} = 0$

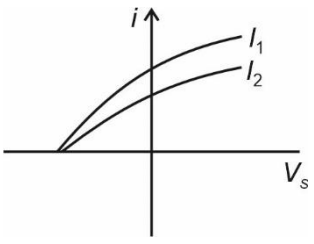
And magnetic force can never do work

$\Rightarrow$ Straight line and uniform motion

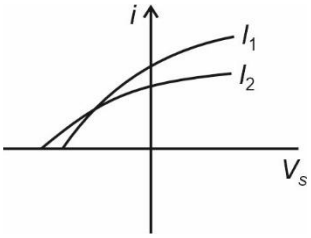
6. Which graph correctly represents the photocurrent (i) versus stopping potential (V_s) for same frequency but different intensity?

(Here intensity I_1 > intensity I_2)

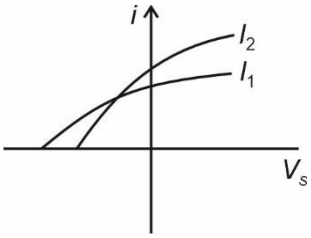
(1)


(2)


(3)



(4)

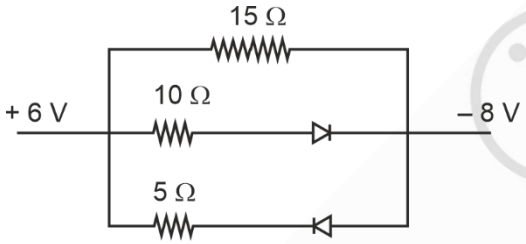


Answer (2)

Sol. f same $\Rightarrow$ same stopping potential

$I_1 > I_2 \Rightarrow$ Saturation current is higher for higher intensity photons.

7. Consider the network shown :



The equivalent resistance of the network is

(1) 12 Ω

(2) 36 Ω

(3) 20 Ω

(4) 6 Ω

Answer (4)

Sol. One diode: short

One diode: open

$$\Rightarrow \quad R_{eq} = \frac{15\times10}{15+10}\ \Omega$$

$= 6\ \Omega$

8. Instantaneous current in a circuit is $i(t) = \left[6 + \sqrt{54}\sin\left(2\pi t + \frac{\pi}{3}\right)\right]$A. RMS value of current is

(1) $2\sqrt{6}$ A

(2) 7 A

(3) $3\sqrt{7}$ A

(4) $6\sqrt{2}$ A

Answer (3)

Sol. $i(t) = i_1 + i_2\sin(\omega t + \phi)$

$$\Rightarrow \quad i_{RMS} = \sqrt{\frac{\int\left[i_1 + i_2\sin(\omega t+\phi)\right]^2 dt}{T}}$$

$$= \sqrt{i_1^2 + \frac{i_2^2}{2}}$$

9. The equation of stationary wave is given as $y = 2A\sin\left(\frac{2\pi}{\lambda}nt\right)\cos\left(\frac{2\pi}{\lambda}x\right)$, then which of the following is not correct.

(1) Dimension of x is [L]

(2) Dimension of n is [LT^{-1}]

(3) Dimension of $\frac{n}{\lambda}$ is [T]

(4) Dimension of nt is [L]

Answer (3)

Sol. From dimensional analyses

$$\frac{nt}{\lambda} \Rightarrow M^0L^0T^0$$

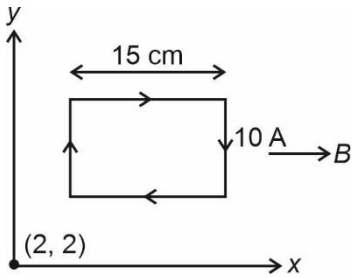
$$\frac{nT}{L} = M^0L^0T^0$$

$$n = [LT^{-1}]$$

Again $\frac{x}{\lambda} = M^0L^0T^0$

x = [L]

10. In magnetic field varying with x-axis as $B(x) = (1 + 0.2x)\hat{i}$, a square loop of side 15 cm is placed such that its sides are parallel to x & y axes and one corner is at (2, 2) as shown. Net magnetic force on the loop is



(Current in loop is 10 amperes)

(1) 40 mN

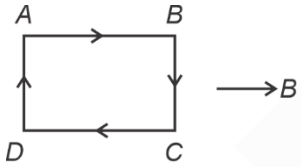
(2) 10 mN

(3) Zero

(4) 45 mN

Answer (4)

Sol.



$F_{AB} = F_{CD} = 0$

$F_{AD} = i\ell B_1$ $\quad B_1 = (1 + 0.2 \times 2) = 1.4T$

$F_{BC} = i\ell B_2$ $\quad B_2 = (1 + 0.2 \times 2.15) = 1.43T$

$|F_{net}| = i\ell(B_2 - B_1)$

$$= 10 \times \frac{15}{100} \times 0.03$$

$$= \frac{4.50}{100} N = 45 \text{ mN}$$

11. The correct products of the reaction

$${}^{235}_{92}U + {}^{1}_{0}n \longrightarrow$$

are

(1) ${}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^{1}_{0}n$

(2) ${}^{141}_{56}Ba + {}^{92}_{36}Kr + 4{}^{1}_{0}n$

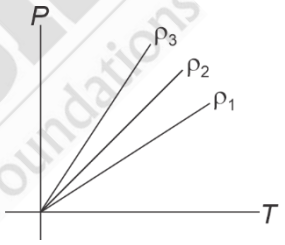
(3) ${}^{20}_{10}Ne + {}^{122}_{51}Sb + 3{}^{1}_{0}n$

(4) ${}^{20}_{10}Ne + {}^{122}_{51}Sb + 4{}^{1}_{0}n$

Answer (1)

Sol. Conserving charge and mass, we get option (1) as correct

12. A given gas is taken through 3 different processes at 3 different densities ρ_1, ρ_2 and ρ_3. The corresponding P – T graphs are given. Then :



(1) $\rho_3 > \rho_2 > \rho_1$

(2) $\rho_3 < \rho_2 > \rho_1$

(3) $\rho_3 < \rho_2 < \rho_1$

(4) $\rho_3 > \rho_2 < \rho_1$

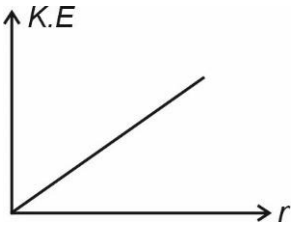
Answer (1)

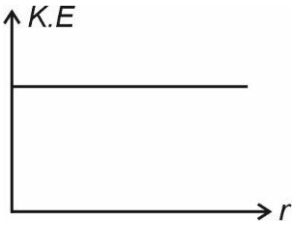
Sol. $PM = \rho RT$

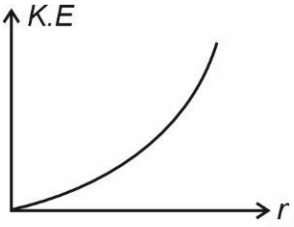
$\Rightarrow$ Slope $\propto \rho^1$

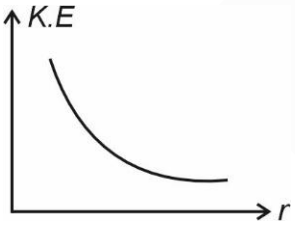
$\Rightarrow$ $\rho_3 > \rho_2 > \rho_1$

13. The graphical representation of variation of kinetic energy with radius in case of electron revolving around nucleus of atom is correctly represented by

(1) 

(2) 

(3) 

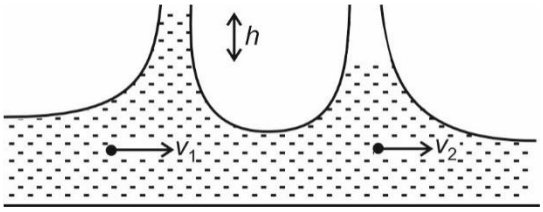
(4) 

Answer (4)

Sol. $\frac{kze^2}{r^2} = \frac{mv^2}{r}$

$$\frac{1}{2}mv^2 = \frac{1}{2}\frac{kze^2}{r}$$

14. In a pipe, speed of ideal liquid is v_1 at A and v_2 at B. The correct relations between v_1, v_2 and h is



(g is acceleration due to gravity and ρ is density of liquid)

(1) $v_2^2 = v_1^2 + 2gh$

(2) $v_1v_2 = 2gh$

(3) $v_1^2v_2 = \rho gh^2$

(4) $v_2^2 - v_1^2 + 2gh = 0$

Answer (1)

Sol. $\frac{1}{2}\rho v_1^2 + \rho gh = \frac{1}{2}\rho v_2^2$

$$v_2^2 = v_1^2 + 2gh$$

15. A wire of mass M and length l bent in form of semicircle. A particle of mass m was kept at the centre of the semicircle. Find net gravitational force on particle.

(1) $\frac{2GMm\pi}{l^2}$

(2) $\frac{2GMm}{l^2}$

(3) $\frac{GMm\pi}{l^2}$

(4) $\frac{3GMm\pi}{l^2}$

Answer (1)

Sol. $R = \frac{l}{\pi}$

E at centre = $\frac{2GM}{\pi R^2}$

Force on particle = $\frac{2GMm}{\pi R^2} = \frac{2GM}{\pi \cdot l^2} \times \pi^2 \cdot m$

$= \frac{2GMm\pi}{l^2}$

16. The circuit in which phase between maximum current (I_{max}) and maximum voltage (V_{max}) is $\frac{\pi}{2}$

(a) L-circuit

(b) R-circuit

(c) C-circuit

(d) LC-circuit

(1) a, b, c

(2) a, c, d

(3) b, c

(4) c, d

Answer (2)

Sol. For L-circuit $\rightarrow$ Phase between I_{max} and V_{max} is $\frac{\pi}{2}$

For C-circuit $\rightarrow$ Phase between I_{max} and V_{max} is $\frac{\pi}{2}$

For LC-circuit $\rightarrow$ Phase between I_{max} and V_{max} is $\frac{\pi}{2}$

17. For an electromagnetic wave, electric field is given as $\vec{E} = 40i\cos\left(\omega\left(t - \frac{Z}{C}\right)\right)$ where C is speed of light. (symbols have their usual meanings). The variation of magnetic field is given as

(1) $\vec{B} = \frac{40}{C}\hat{j}\cos\left(\omega\left(t + \frac{Z}{C}\right)\right)$

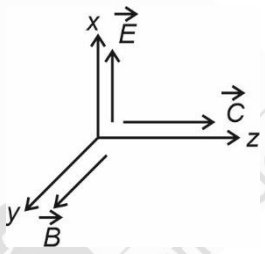
(2) $\vec{B} = 40C\hat{j}\cos\left(\omega\left(t - \frac{Z}{C}\right)\right)$

(3) $\vec{B} = \frac{40}{C}\hat{j}\cos\left(\omega\left(t - \frac{Z}{C}\right)\right)$

(4) $\vec{B} = -40C\hat{j}\cos\left(\omega\left(t + \frac{Z}{C}\right)\right)$

Answer (3)

Sol.



$\vec{E} \times \vec{B} \uparrow\uparrow \vec{C}$

Also $E = CB$

$\Rightarrow$ B is along $+y$

18. A charged particle is moving in $x - y$ plane where its co-ordinate (x, y) are varying with time t is $x = 2 + 4t$; $y = 3t + 8t^2$. The motion of charged particle is

(1) Uniform motion

(2) Uniform accelerated motion along straight line

(3) Non uniform accelerated motion

(4) Uniform accelerated motion in a parabolic path

Answer (4)

Sol. $\vec{r} = (2+4t)\hat{i} + (3t+8t^2)\hat{j}$

$\vec{u} = 4\hat{i} + (3+16t)\hat{j}$

$\vec{a} = 16\hat{j} \Rightarrow$ Uniform accelerated

At $t = 0$ $\vec{v} = 4\hat{i} + 3\hat{j}$ is not parallel to $\vec{a}$

$\Rightarrow$ Parabolic

19. u is object distance and v is image distance formed by convex lens of focal length f. The error in focal length shall be. (Error in measuring u & v are Δu & Δv)

(1) $2f\left(\frac{\Delta v}{v} + \frac{\Delta u}{u}\right)$

(2) $f^2\left(\frac{\Delta v}{v^2} + \frac{\Delta u}{u^2}\right)$

(3) $f\left(\left(\frac{\Delta v}{v}\right)^2 + \left(\frac{\Delta u}{u}\right)^2\right)$

(4) $\frac{\Delta v}{v} + \frac{\Delta u}{u}$

Answer (2)

Sol. $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\frac{-1}{f^2}df = \frac{-1}{v^2}dv + \frac{1}{u^2}du$

$\Rightarrow (df) = f^2\left\{\frac{|dv|}{v^2} + \frac{|du|}{u^2}\right\}$

20. A rubber ball fall on the floor from height h and bounces back upto height $\frac{h}{2}$. Then percentage loss in energy and velocity of ball just before striking are respectively.

(1) 50%, $\sqrt{2gh}$

(2) 40%, $\sqrt{2gh}$

(3) 50%, $\sqrt{gh}$

(4) 40%, $\sqrt{gh}$

Answer (1)

Sol. $\Delta E = \frac{mgh}{2}$

% change in ΔE = 50%

Velocity just before collision = $\sqrt{2gh}$

SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Because of forces (separately) of 3 N and 2 N, elongations in spring are found to be 'a' and 'b' unit respectively then ($2a - 3b$) is

Answer (0)

Sol. $a = \frac{3}{k}$

$b = \frac{2}{k}$

$\Rightarrow$ $2a - 3b = 0$

22. For a temperature change of 40°C, the corresponding temperature change in °F is

Answer (72)

Sol. $F = 32 + \frac{9C}{5}$

$\Rightarrow \quad \Delta F = \frac{9}{5}\Delta C = 72°F$

23. A particle covers 102.5 m in n^{th} second and 115 m in $(n + 2)^{th}$ second. Then the acceleration of the particle is x m/s^2. Find $4x$.

Answer (25)

Sol. $s_n = u + \frac{a}{2}[2n-1]$

$\Rightarrow \quad 102.5 = u + \frac{a}{2}[2n-1]$

and $115 = u + \frac{a}{2}[2n+3]$

$\Rightarrow \quad 12.5 = \frac{a}{2}(4) \Rightarrow a = \frac{25}{4}$ m/s^2

24. The resistance of platinum wire at ice point and steam point are 10 Ω and 2 Ω respectively. After that wire is dipped in hot bath of temperature 400°C. The resistance of the wire at temperature 400°C is _____ Ω.

Answer (34)

Sol. $\frac{R - R_{M\cdot P}}{R_{B\cdot P} - R_{M\cdot P}} = \frac{T-0}{100-0}$

$R = 34\ \Omega$

25. A soap bubble has initial radius of 3.5 cm. Work 36960 erg is done on it to blow it. Surface tension = 40 dyne/cm. The new radius is _____ cm.

Answer (7)

Sol. $W = \Delta U = 8\pi\,[R^2 - r^2] \cdot S$

$\Rightarrow \quad \frac{36960}{8 \times \frac{22}{7} \times 40} = R^2 - 3.5^2$

$\Rightarrow \quad R^2 = 3.5^2 + \frac{147}{4}$

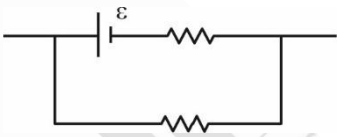
$= \frac{49 + 147}{4} = 49$

$R = 7$ cm

26. In an experiment to determine internal resistance of battery using potentiometer for external resistance of 10 Ω, balancing length is 50 cm and for external resistance of 1 Ω, balancing length is 40 cm then internal resistance of battery is x ohms then 7x is____

Answer (2)

Sol.



$\varepsilon - \frac{\varepsilon\gamma}{(R+r)} = \frac{\varepsilon R}{R+r} = V = kl$

$\frac{\varepsilon R_1}{R_1 + r} = k50 = \frac{10\varepsilon}{10+r}$

$\frac{\varepsilon R_2}{R_2 + r} = k40 = \frac{\varepsilon}{1+r}$

$\Rightarrow \quad \frac{5}{4} = \frac{10}{(10+r)}(1+r)$

$50 + 5r = 40 + 40r$

$10 = 35r$

$r = \frac{2}{7}\Omega$

27.

28.

29.

30.