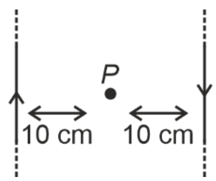
PHYSICS

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. Two infinite current carrying wires having current I in opposite directions are shown below. Find the magnetic field (in S.I. units) at point P.



(1) $\frac{7\mu_0 I}{\pi}$ (2) $\frac{10\mu_0 I}{\pi}$

(3) $\frac{5\mu_0 I}{\pi}$ (4) $\frac{\mu_0 I}{\pi}$

Answer (2)

Sol. $B = 2\times\frac{\mu_0 i}{2\pi d} = 2\times\frac{\mu_0 I}{2\pi\times 0.1} = \frac{10\mu_0 I}{\pi}$

2. If the diameter of earth becomes half keeping mass to be constant, then the acceleration due to gravity at surface of earth becomes

(1) Half (2) Four times

(3) Twice (4) Three times

Answer (2)

Sol. $g = \frac{GM}{R^2}$

$\Rightarrow\ g \propto \frac{1}{R^2}$

$\Rightarrow\ \frac{g'}{g} = \left(\frac{R}{\frac{R}{2}}\right)^2 = 4$

3. Two masses $m_1 = 4$ gm and $m_2 = 25$ gm are having same kinetic energy, find the ratio of magnitude of their linear momentum.

(1) 1 : 5 (2) 2 : 5

(3) 1 : 1 (4) 1 : 6

Answer (2)

Sol. $k = \frac{p^2}{2m}$

$\frac{p_1}{p_2} = \frac{\sqrt{m_1 k_1}}{\sqrt{m_2 k_2}}$ $(\because k_1 = k_2)$

$\frac{p_1}{p_2} = \sqrt{\frac{4}{25}} = \frac{2}{5}$

$\therefore\ p_1 : p_2 = 2 : 5$

4. A charge $Q = 10^{-6}$ C is placed at origin. Find the potential difference between two points A and B whose position vectors are $\left(\sqrt{3}\hat{i} + \sqrt{3}\hat{j}\right)$ m and $\left(\sqrt{6}\hat{j}\right)$ m respectively.

(1) Zero (2) 1000 volts

(3) 2000 volts (4) 500 volts

Answer (1)

Sol. $V = \frac{kQ}{r}$

Since $r_A = r_B$

$\Rightarrow\ \Delta V = 0$

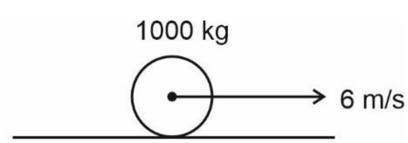
5. A body of mass 1000 kg is moving horizontally with velocity 6 m/s. Another body of mass 200 kg is added gently. Then what will be its new velocity?

(1) 5 m/s (2) 4 m/s

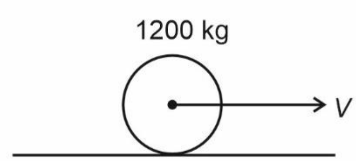
(3) 2 m/s (4) 3 m/s

Answer (1)

Sol. Initial =



Final =

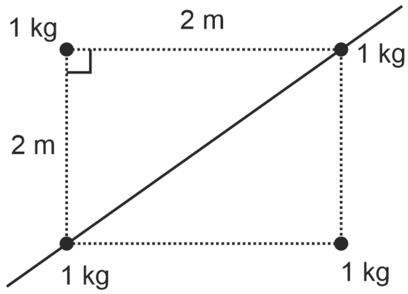


From momentum conservation $\rightarrow P_i = P_f,$

$6 \times 1000 = 1200V$

$V = 5$ m/s

6. Consider the system shown. Find the moment of inertia about the diagonal shown.



(1) 1 kg·m² (2) 2 kg·m²

(3) 4 kg·m² (4) 6 kg·m²

Answer (3)

Sol. $I = \sum m_i \cdot r_i^2$

$= 0 + 0 + 1(2\sin 45°)^2 \times 2$ kg·m²

$= 4$ kg·m²

7. A rod of length l having resistance R, is cut into two equal parts. These parts are connected in parallel then new resistance shall be

(1) R

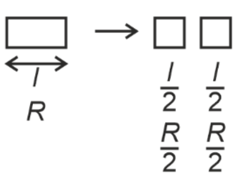
(2) $\frac{R}{2}$

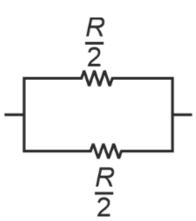
(3) $\frac{R}{4}$

(4) $2R$

Answer (3)

Sol. $R = f\frac{l}{A}$ $\quad R \propto l$





$\therefore$ Req $= \frac{R}{4}$

8. **Statement-I :** Linear momentum and moment of force have same dimensions.

Statement-II : Planck's constant and angular momentum have same dimension.

(1) Statement-I is correct while statement-II is false

(2) Statement-I is false while statement-II is correct

(3) Both statements are correct

(4) Both statements are false

Answer (2)

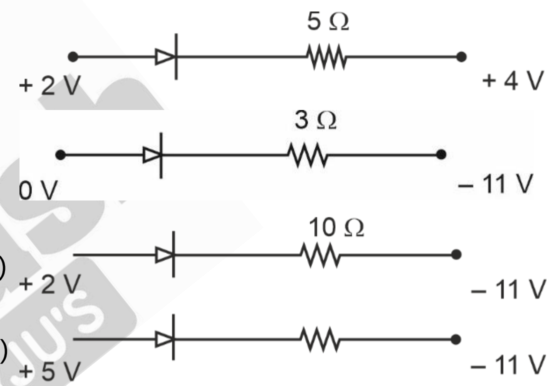
Sol. Linear momentum (p) $\Rightarrow$ [MLT^{-1}]

Angular momentum (L) $\Rightarrow$ [ML^2T^{-1}]

Torque $\Rightarrow$ [ML^2T^{-2}]

Planck's constant $\Rightarrow$ [ML^2T^{-1}]

9. In which of the following circuits the diode is reverse biased?



(1) (ii) (2) (i) and (iv)

(3) (iv) (4) (i)

Answer (4)

Sol. For reverse bias $V_P < V_N$

10. A prism has a refractive index $\cot\left(\frac{A}{2}\right)$, where A is the refracting angle of the prism. The minimum deviation due to this prism is

(1) $\pi - 3A$ (2) $\pi - 2A$

(3) A (4) $\frac{A}{2}$

Answer (2)

Sol. $\delta_{min.} = 2\sin^{-1}\left[\mu \sin\frac{A}{2}\right] - A$

$= 2\sin^{-1}\left[\cot\left(\frac{A}{2}\right)\sin\frac{A}{2}\right] - A$

$= \pi - 2A$

11. A particle performing simple harmonic motion in such that it's amplitude is 4 m and speed of particle at mean position is 10 m/s. Find the distance of particle from mean position where velocity became 5 m/s.

(1) $\sqrt{3}$ m
(2) $2\sqrt{3}$ m
(3) $\frac{\sqrt{3}}{2}$ m
(4) $\frac{1}{\sqrt{2}}$ m

Answer (2)

Sol. $v = \omega\sqrt{A^2 - x^2}$

In 1st case : at $x = 0$, $v = 10$ m/s

then $10 = \omega\sqrt{(4)^2 - 0^2}$

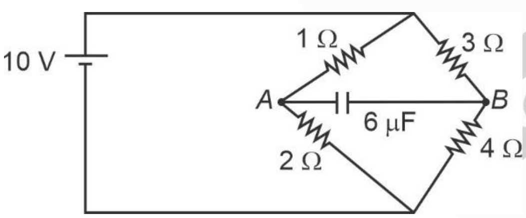
$$\omega = \frac{10}{4} = \frac{5}{2} \text{ rad/s}$$

In 2nd case :

$$5 = \frac{5}{2}\sqrt{(4)^2 - x^2}$$

$$x = 2\sqrt{3} \text{ m}$$

12. Find charge on capacitor in the given circuit at steady state.



(1) $\frac{40}{7}\mu C$
(2) $\frac{20}{7}\mu C$
(3) $\frac{60}{7}\mu C$
(4) $\frac{10}{7}\mu C$

Answer (1)

Sol. $V_A = 10 - \frac{10}{3} = \frac{20}{3}$ V

$$V_B = 10 - \frac{3}{7} \times 10 = \frac{40}{7} \text{ V}$$

$$V_A - V_B = 20\left[\frac{1}{3} - \frac{2}{7}\right]$$

$$= \frac{20}{21} \text{ V}$$

$$Q = CV_{AB}$$

$$= 6 \times \frac{20}{21} \mu C$$

$$= \frac{40}{7} \mu C$$

13. A proton having velocity $\vec{v}_0$ passes through a region having electric field E and magnetic field B. If the velocity of proton does not change, then which of the following may be true?

(a) $E = 0, B = 0$
(b) $E = 0, B \neq 0$
(c) $E \neq 0, B = 0$
(d) $E \neq 0, B \neq 0$

(1) a, b, c, d
(2) a
(3) a, b, d
(4) a, b

Answer (3)

Sol. $\vec{F}_E = q\vec{E}$

$$\vec{F}_B = q\left(\vec{v} \times \vec{B}\right)$$

Case b is correct when $\vec{v} \parallel \vec{B}$

Case d is correct when $\vec{E} \perp \vec{B} \perp \vec{v}$ and $v = \frac{E}{B}$

14. A particle has initial ($t = 0$) velocity $\vec{u} = 5\hat{i}$ and is at origin at this instant. Its acceleration is given by $(3\hat{i} + 4\hat{j})$. When particle's x co-ordinate is 16 units, then its speed is

(1) 13 units
(2) $\sqrt{161}$ units
(3) 12 units
(4) $\sqrt{185}$ units

Answer (4)

Sol. $S = ut + \frac{1}{2}at^2$

$$\Rightarrow \quad 16 = 5t + \frac{3}{2}t^2$$

$$\Rightarrow \quad t = 2$$

$$\Rightarrow \quad \vec{v} = \vec{u} + \vec{a}t = 11\hat{i} + 8\hat{j}$$

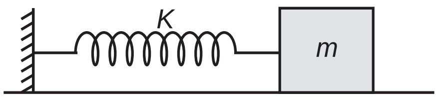
15. A spherometer is used to measure

(1) Radius of curvature of a lens
(2) Length of rod
(3) Density of a solid
(4) Viscosity of a liquid

Answer (1)

Sol. A spherometer is an instrument used for precise measurement of the radius of curvature of curved surface.

16. A particle performing simple harmonic motion according to y = A sinωt. Then its kinetic energy (K.E.), potential energy (P.E.) and speed (V) at position $y = \frac{A}{2}$ are



(1) K.E. $= \frac{kA^2}{8}$

P.E. $= \frac{3kA^2}{8}$

$V = \frac{A}{3}\sqrt{\frac{k}{m}}$

(2) K.E. $= \frac{3kA^2}{8}$

P.E. $= \frac{kA^2}{8}$

$V = \frac{A}{2}\sqrt{\frac{3k}{m}}$

(3) K.E. $= \frac{3kA^2}{8}$

P.E. $= \frac{kA^2}{4}$

$V = A\sqrt{\frac{3k}{m}}$

(4) K.E. $= \frac{kA^2}{4}$

P.E. $= \frac{3kA^2}{8}$

$V = \frac{A}{4}\sqrt{\frac{3k}{m}}$

Answer (2)

Sol. $V = \omega\sqrt{A^2 - x^2}$, $k = m\omega^2$, $\omega = \sqrt{\frac{k}{m}}$

$$V = \sqrt{\frac{k}{m}(A^2 - x^2)}$$

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

$$= \frac{1}{2}m.\frac{k}{m}(A^2 - x^2)$$

$$= \frac{k}{2}\left(A^2 - \frac{A^2}{4}\right)$$

$$= \frac{3kA^2}{8}$$

$$\text{P.E.} = \frac{1}{2}kx^2$$

$$= \frac{1}{2}k.\frac{A^2}{4}$$

$$= \frac{kA^2}{8}$$

$$\text{Speed } (V) = \sqrt{\frac{k}{m}\left(A^2 - \frac{A^2}{4}\right)}$$

$$= \sqrt{\frac{k}{m}\left(\frac{3A^2}{4}\right)}$$

$$= \left(\sqrt{\frac{3k}{m}}\right).\frac{A}{2}$$

17. What should be the elevation of outer track of the train to move in a circular path of radius R, width of the track is w (< < R) and speed of the train is v ? (Neglect friction)

(1) $\frac{v^2w}{Rg}$

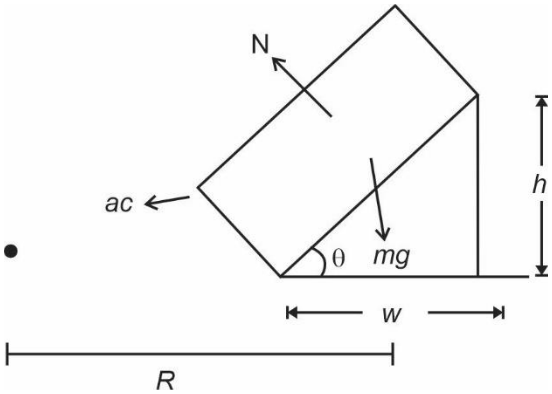
(2) $\frac{v^2w}{2Rg}$

(3) $\frac{gwv^2}{R}$

(4) $\frac{R}{gwv^2}$

Answer (1)

Sol.



$N\sin\theta = \frac{mv^2}{R}$

$N\cos\theta = mg$

$\tan\theta = \frac{v^2}{Rg} = \frac{h}{w}$

$\therefore \boxed{h = \frac{v^2 w}{Rg}}$

18. Out of air and liquid, which substance is more viscous?

(1) Air

(2) Liquid

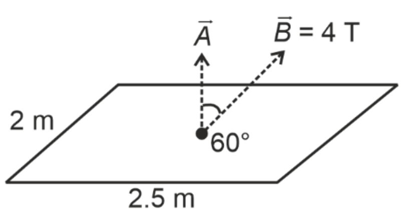
(3) Both have same viscosity

(4) None of these

Answer (2)

Sol. In general, liquids are more viscous than air because of higher density and intermolecular forces.

19. A metallic frame of given dimension has area vector at 60° with external magnetic field as shown. The frame is taken out from the field in 10 seconds. Find arrange emf induced in the frame.



(1) 1 V

(2) 2 V

(3) 3 V

(4) 4 V

Answer (1)

Sol. $\phi = \vec{B}\cdot\vec{A}$

$\Rightarrow \quad \varepsilon = \frac{\Delta\phi}{\Delta t} = \frac{10}{10}\text{ V} = 1\text{ V}$

20. An electromagnetic wave is given as $E = 200\sin(1.5x - 4.5\times10^8 t)$, here E is electric field in N/C. If energy density in electromagnetic field is given as $N \times 10^{-8}$ J/m^3. Then N is

($\varepsilon_0 = 9\times10^{-12}$ SI units.)

(1) 9

(2) 18

(3) 36

(4) 72

Answer (2)

Sol. $\bar{\varepsilon} = \frac{1}{2}\varepsilon_0 E_{ms}^2 + \frac{B_{ms}{}^2}{2\mu_0}$

$= \varepsilon_0 E_{ms}{}^2 = \frac{1}{2}\varepsilon_0 E_0^2$

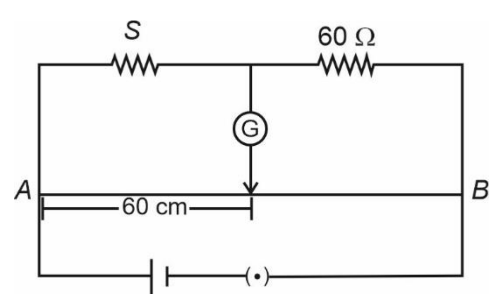
$= \frac{1}{2}\times 9\times10^{-12}\times200\times200$

$= \frac{36}{2}\times10^{-8} = 18\times10^{-8}\text{ J/m}^3$

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. In the given meter bridge circuit, null point is found at 60 cm from end A. The unknown resistance S (in Ω) is



Answer (90.00)

Sol. $\frac{S}{60} = \frac{60}{(100-60)}$

$S = 90\ \Omega$

22. A particle is moving in one dimension, its displacement – time relation is given as $s = (2t^2 + 5)$ where s is in meters and t is in seconds. Find its velocity (in m/s) at $t = 1$ second.

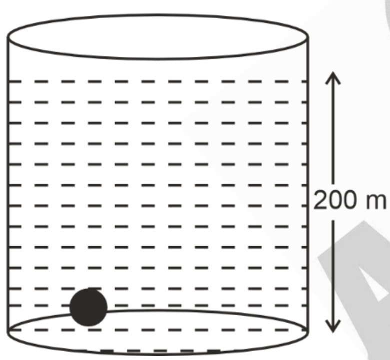
Answer (04.00)

Sol. $s = 2t^2 + 5$

$v = \frac{ds}{dt} = 4t$

at $t = 1$, $v = 4$ m/s

23. A sphere of small size is at the bottom of a lake of depth 200 m. Due to pressure its fractional change in volume is $\alpha \times 10^{-7}$. What is value of α, if bulk modulus of sphere is 5×10^{12} Pa? (Use $g = 10$ m/s^2)



Answer (04.00)

Sol. $B = \frac{|\Delta P|}{\left|\frac{\Delta V}{V}\right|}$

$$\left|\frac{\Delta V}{V}\right| = \frac{|\Delta P|}{B} = \frac{h\rho g}{B} = \frac{200 \times 10^3 \times 10}{5 \times 10^{12}} = 40 \times 10^{-8}$$

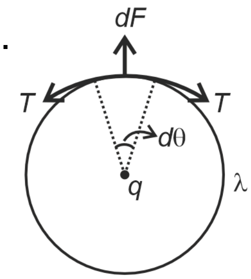
$= 4 \times 10^{-7}$

$\Rightarrow \quad \alpha = 4$

24. A ring has a uniformly distributed charge of 2π C and radius of 3 cm. A charge 10^{-6} C is placed at the centre of the ring. Tension developed in the ring is 10^{x} N. Find x.

Answer (07.00)

Sol.



$\Rightarrow \quad dF = Td\theta$

$$\Rightarrow \quad Td\theta = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q \cdot \lambda R d\theta}{R^2}$$

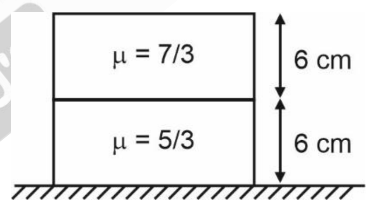
$$\Rightarrow \quad T = \frac{1}{4\pi\varepsilon_0} \frac{q\lambda}{R}$$

$$= 9 \times 10^9 \times 10^{-6} \times \frac{2\pi}{2\pi R^2}$$

$$= \frac{9 \times 10^3}{9} \times 10^4 \text{ N}$$

$= 10^7$ N

25. Two slabs of same thickness of 6 cm each are placed over one other as shown on table.



Apparent depth of table surface is N cm. (N is nearest integer)

Answer (06.00)

Sol. $h_{app} = \frac{t_1}{\mu_1} + \frac{t_2}{\mu_2} = \frac{6}{7} \times 3 + \frac{6}{5} \times 3$

$= \frac{18}{7} + \frac{18}{5}$

$= 2.57 + 3.60 = 6.17$ cm $\Rightarrow N = 06$

26.

27.

28.

29.

30.