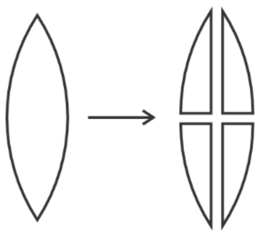
PHYSICS

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. An equiconvex lens of focal length f, is cut into four parts as shown in the diagram. The focal length of each part is



(1) f (2) $2f$

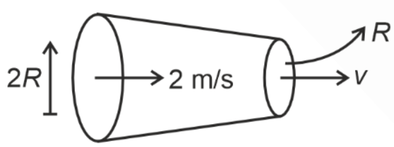
(3) $f/2$ (4) $4f$

Answer (2)

Sol. $f = \dfrac{R}{2(\mu-1)}$ (equiconvex lens)

$f' = \dfrac{R}{(\mu-1)}$ (plans convex lens)

$f' = 2f$

2. 

Radius of a tube decreases from $2R$ to R in which ideal liquid is flowing at same level.

Speed at one end is 2 m/s as shown, find speed v at other end

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

(3) 2 m/s (4) 8 m/s

Answer (4)

Sol. $A_1v_1 = A_2 = v_2$ equation of continuity

$\pi(2R)^2 \cdot 2 = \pi R^2 v$

$v = 8$ m/s

3. The dimensional formula of capacitance is

(1) $[M^{-1}L^{2}T^{2}A^{-3}]$ (2) $[M^{-1}L^{-2}T^{4}A^{3}]$

(3) $[M^{-1}L^{-2}T^{4}A^{2}]$ (4) $[M^{-1}L^{-2}T^{2}A^{2}]$

Answer (3)

Sol. The energy stored in capacitor in term of charge

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

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

$$[C] = \frac{[A^2T^2]}{[ML^2T^{-2}]}$$

$$= [M^{-1}L^{-2}T^{4}A^{2}]$$

4. A proton is moving with uniform velocity of 2×10^8 m/s in uniform magnetic and electric fields which are perpendicular to each other. If electric field is switched off then proton moves in circular path of radius 1.6×10^{-5} m. Then magnetic field is B

(1) 5×10^{-5} T (2) 1.2×10^{5} T

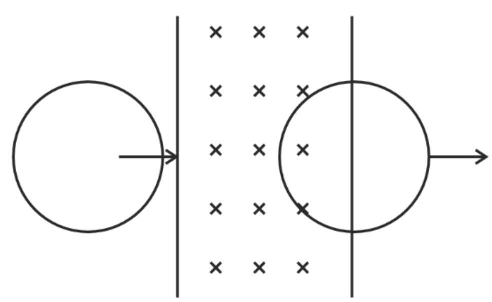
(3) 2.5×10^{4} T (4) 2.5×10^{2} T

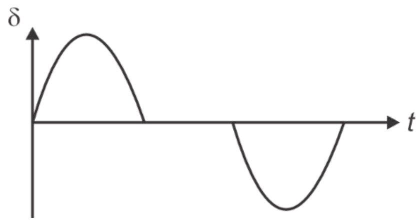
Answer (2)

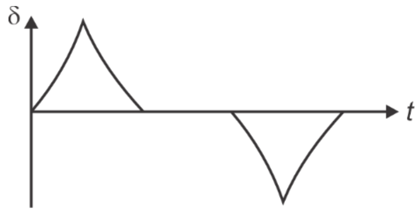
Sol. $r = \dfrac{mv}{qB} \Rightarrow 1.6\times10^{-5} = \dfrac{1.6\times10^{-27}\times2\times10^{8}}{1.6\times10^{-19}\times B}$

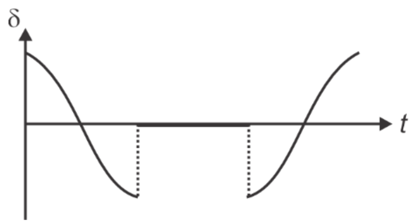
$$B = \frac{5}{4}\times10^{5} = 1.25\times10^{5}\ \text{T}$$

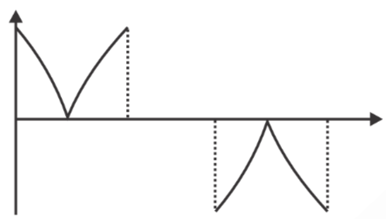
5. A conducting circular ring is moving with a constant velocity in a uniform magnetic field as shown. Identify the correct graph between induced emf vs time



(1) 

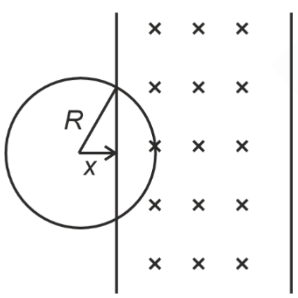
(2) 

(3) 

(4) 

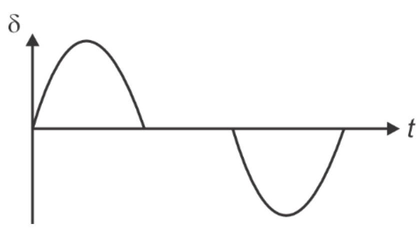
Answer (1)

Sol.



$\delta = 2Bv\sqrt{R^2 - x^2}$ (Equation of an ellipse)

$x = R - vt$



6. The displacement of a particle moving under the action of a force $\vec{F} = 2\hat{i} + b\hat{j} + \hat{k}$ is $\vec{d} = \hat{i} + \hat{j} + \hat{k}$. Find the value of b if the work done by the force is zero.

(1) 0 (2) +3

(3) –3 (4) –1

Answer (3)

Sol. Work = $\vec{F} \cdot \vec{s} = (2\hat{i} + b\hat{j} + \hat{k}) \cdot (\hat{i} + \hat{j} + \hat{k})$

= 2 + 1 + 1 = 3 + b = 0

$\Rightarrow$ $b = -3$

7. In a series LCR circuit the maximum amplitude of current is I_0 when the resistance is R. What is the maximum amplitude of current if the resistor is replaced by a resistor of resistance $\frac{R}{2}$.

(1) I_0 (2) $2I_0$

(3) $\frac{I_0}{2}$ (4) $\frac{2I_0}{3}$

Answer (2)

Sol. Current has maximum amplitude at resonance.

$$I_0 = \frac{\xi_0}{R}$$

$$\Rightarrow \quad I_0' = \frac{\xi_0}{R/2} = \frac{2\xi_0}{R} = 2I_0$$

8. **Statement-I :** Fringe width of red light is more than fringe width of violet light.

Statement-II : Fringe width is directly proportional to the wavelength of light used.

Choose the correct option.

(1) Statement-I is correct and statement-II is incorrect

(2) Both statement-I and statement-II are correct

(3) Statement-I is incorrect and statement-II is correct

(4) Both statement-I and statement-II are incorrect

Answer (2)

Sol. Fringe width $(\beta) = \frac{\lambda D}{d}$

9. For non-vibrating diatomic gas has adiabatic constant of γ_1 & for vibrating diatomic gas has adiabatic constant of γ_2 then

(1) $\gamma_1 > \gamma_2$
(2) $\gamma_1 < \gamma_2$
(3) $\gamma_1 = \gamma_2$
(4) None of these

Answer (1)

Sol. $\gamma_1 = 1 + \frac{2}{5} = \frac{7}{5} = 1.4$

$\gamma_2 = 1 + \frac{2}{7} = \frac{9}{7} = 1.28$

Therefore $\gamma_1 > \gamma_2$

10. A force $\vec{F} = \left(\hat{i} + 2\hat{j} - 3\hat{k}\right)N$ acts on point whose position vector is given as $\vec{r} = \left(2\hat{i} - 3\hat{j} + 7\hat{k}\right)m$. Find torque about origin.

(1) $\left(+5\hat{i} - 12\hat{j} + 7\hat{k}\right)N.m$

(2) $\left(-5\hat{i} - 12\hat{j} + 8\hat{k}\right)N.m$

(3) $\left(-5\hat{i} + 13\hat{j} + 7\hat{k}\right)N.m$

(4) $\left(-5\hat{i} + 13\hat{j} - 7\hat{k}\right)N.m$

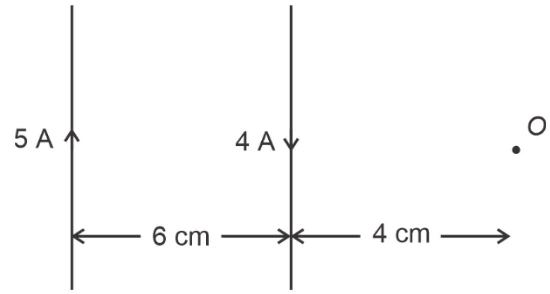
Answer (3)

Sol. $\vec{T} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -3 & 7 \\ 1 & 2 & -3 \end{vmatrix}$

$= \hat{i}(9 - 14) - \hat{j}(-6 - 7) + \hat{k}(4 + 3)$

$= (-5\hat{i} + 13\hat{j} + 7\hat{k})\ N.m$

11. The net magnetic field at point *O* due to the two infinite current carrying wires shown in the figure is



(1) 1×10^{-5} T
(2) 1.2×10^{-5} T
(3) 1.5×10^{-5} T
(4) 2×10^{-5} T

Answer (1)

Sol. $B_{net} = \left|\frac{\mu_0(5\ A)}{2\pi(10\ cm)} - \frac{\mu_0(4\ A)}{2\pi(4\ cm)}\right|$

$= \frac{25\mu_0}{\pi} = 10^{-5}$ T

12. Read the statements and select the correct option.

Statement I : A pendulum is taken from Earth to another planet having mass four times and radius double than earth, then time period of pendulum remain same as on earth.

Statement II : The time period of pendulum only depends on the gravity of the planet.

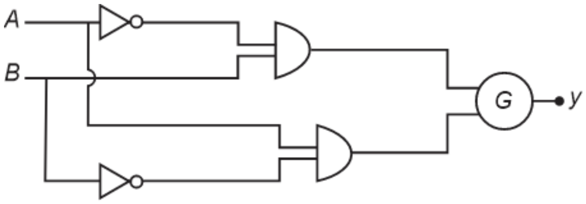
(1) Statement I is true but statement II is false.
(2) Statement II is true but statement I is false.
(3) Both statements are false.
(4) Both statements are true.

Answer (1)

Sol. On earth $T = 2\pi\sqrt{\frac{l}{g}}$

On other planet, $g' = \frac{G(4M)}{(2R)^2} = g$

So, time period will remain same and her *T* depends on g as well as *l*.

13. 

For a given logic circuit truth table is given identify the gate G.

A	B	y
0	0	1
1	0	0
0	1	0
1	1	1

(1) AND (2) NOR

(3) NAND (4) OR

Answer (2)

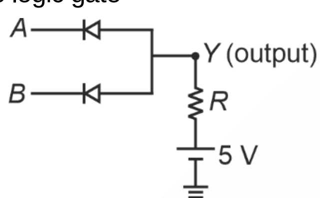
Sol. From truth table

we know its XNOR gate

i.e. $y = \overline{\bar{A}B + A\bar{B}}$

therefore gate G must be NOR gate.

14. Name the logic gate



(1) OR (2) AND

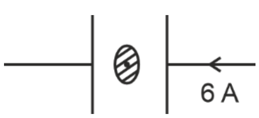
(3) NOT (4) NAND

Answer (2)

Sol. If both A and B are high only then Y is high, otherwise Y is low.

$\therefore$ AND Gate.

15. Displacement current in capacitor of area 16 cm^2 is 6 A at an instant. Find displacement current across area 3.2 cm^2



(1) 1.2 A (2) 1.6 A

(3) 2.1 A (4) 0.5 A

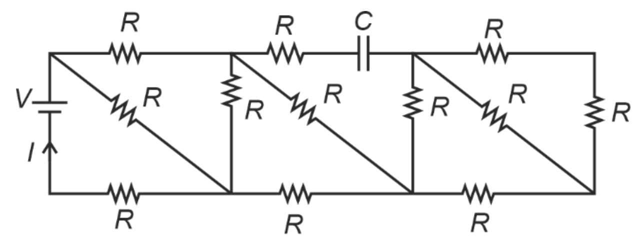
Answer (1)

Sol. $i_d = \epsilon_0 \dfrac{d\phi_E}{dt} = \epsilon_0 A \dfrac{dE}{dt} \Rightarrow i_d \propto A$

$\Rightarrow i' = \left(\dfrac{3.2}{16}\right) i_d$

$= 1.2$ A

16. In the RC circuit shown, find I.



(1) $\dfrac{V}{5R}$ (2) $\dfrac{5V}{3R}$

(3) $\dfrac{8V}{13R}$ (4) $\dfrac{3V}{R}$

Answer (3)

Sol. At stead state, C behaves as open-circuit

$$R_{eq} = \frac{13}{8}R$$

$$I = \frac{V}{R_{eq}} = \frac{8V}{13R}$$

17. A glass slab of refractive index $\mu_g = 1.44$ is coated with a thin film of refractive index $\mu_f = 2$. The minimum thickness of the film so that maximum transmission of green light of wavelength $\lambda = 5000\ \text{Å}$ (incident normally) takes place is

(1) 0.500 μm (2) 0.250 μm

(3) 0.125 μm (4) 1.00 μm

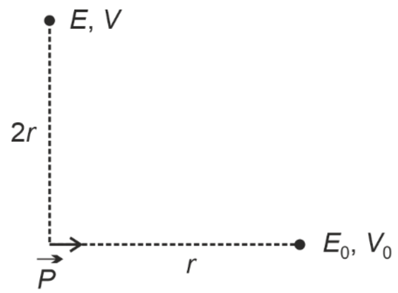
Answer (3)

Sol. For maximum transmission of light incident normally

$2\mu_f t = n\lambda$ $(n = 1, 2, 3 \ldots\ldots.)$

$$t_{min} = \frac{\lambda}{2\mu_f} = \frac{5000\times10^{-10}}{2(2)} \text{ m} = 0.125\ \mu\text{m}$$

18. For the electric dipole shown in the figure, the electric field and the electric potential are E_0, V_0 at a distance r on the axis. Then what is the electric field and the electric potential at a point on the equatorial plane at a distance $2r$.



(1) $\frac{E_0}{16}$, 0

(2) $\frac{E_0}{4}$, 0

(3) E_0, V_0

(4) $\frac{E_0}{8}$, 0

Answer (1)

Sol. $E_{\text{axis}} = \frac{2kP}{r^3} = E_0$

$$E_{\text{equatorial}} = \frac{kP}{(2r)^3} = \frac{kP}{8r^3} = \frac{E_0}{16}$$

$$V = \frac{kP\cos\theta}{r^2}$$

$$V_{\text{axis}} = \frac{kP\cos 0^\circ}{r^2} = \frac{kP}{r^2}$$

$$V_{\text{equatorial}} = \frac{kP\cos 90^\circ}{(2r)^3} = 0$$

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

Choose the correct answer:

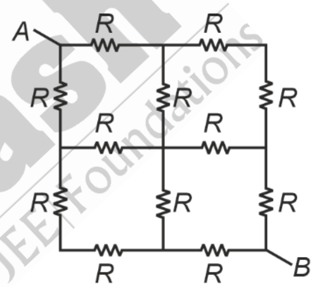
21. A projectile is fired with speed of 20 m/s at angle of 60° with horizontal. The speed at highest point of trajectory is x m/s then x is

Answer (10)

Sol. $V_H = 4\cos\theta$

$= 20\cos 60° = 10$ m/s

22. If equivalent resistance across AB is $\frac{NR}{2}$, find N



Answer (3)

Sol. Line of symmetry problem

$$R_{\text{eq}} = \frac{3R}{4} \times 2 = \frac{3R}{2}$$

23.

24.

25.