# 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. What is the dimensional formula of $\frac{1}{\mu_0 \varepsilon_0}$ (where $\mu_0$ is permeability and $\varepsilon_0$ is permittivity of free space).

(1) $LT^{-1}$ (2) $L^2T^{-2}$

(3) $MLT^{-1}$ (4) $ML^2T^{-1}$

**Answer (2)**

**Sol.** $\frac{1}{\sqrt{\mu_0 \varepsilon_0}} = C$

$\frac{1}{\mu_0 \varepsilon_0} = C^2$

2. An equilateral prism is made of a material of refractive index $\sqrt{2}$. Find angle of incidence for minimum deviation of the light ray.

(1) 60° (2) 30°

(3) 37° (4) 45°

**Answer (4)**

**Sol.** $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$

$\frac{60^\circ + \delta_m}{2} = 45^\circ$

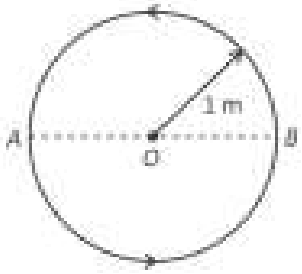
$\delta_m = 30^\circ$

$\delta_m = i + e - A$

$30 = 2i - 60 \quad (i = e)$

$i = 45^\circ$

3. A particle moves on a circular path of radius 1 m. Find its displacement when it moves from $A \to B \to A \to B$. Also its distance as it moves from $A \to B \to A \to B \to A$.




(1) Distance = 2 m, displacement = 4π m

(2) Distance = 2 m, displacement = 5π m

(3) Distance = 4π m, displacement = 2 m

(4) Distance = 5π m, displacement = 2 m

**Answer (3)**

**Sol.** Displacement = Shortest distance between find and initial positions = 2 m (One and half cycle)

Distance = Total path length covered

= 4π m (Two cycles)

4. The moment of inertia of a ring of mass $M$ and radius $R$ about an axis passing through tangential point in the plane of ring is

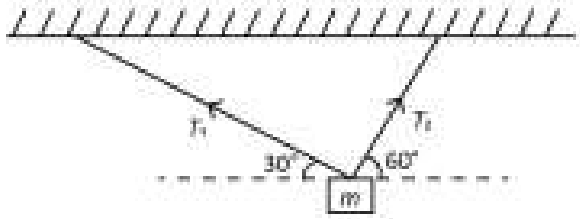
(1) $\frac{5MR^2}{2}$ (2) $\frac{3MR^2}{2}$

(3) $\frac{4MR^2}{3}$ (4) $\frac{2MR^2}{3}$

**Answer (2)**

**Sol.** It $= \frac{MR^2}{2} + MR^2 = \frac{3MR^2}{2}$

5. A block of mass m is suspended in a vertical plane with the help of two light strings as shown. Find the ratio of tensions $\frac{T_1}{T_2}$




(1) 3 (2) $\frac{1}{3}$

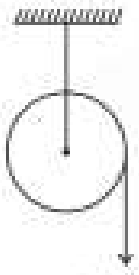
(3) $\frac{1}{\sqrt{3}}$ (4) $\sqrt{3}$

**Answer (3)**

**Sol.** $T_1\cos30° = T_2\cos60°$

$$\frac{T_1}{T_2} = \frac{\cos60°}{\cos30°} = \frac{1}{\sqrt{3}}$$

6. A disc of mass M and radius 2 m is hinged keeping axis horizontal. If angular acceleration of disc is 2rad/s$^2$. Find moment of inertia




(1) 10 kg m$^2$ (2) 5 kg m$^2$

(3) 6 kg m$^2$ (4) 20 kg m$^2$

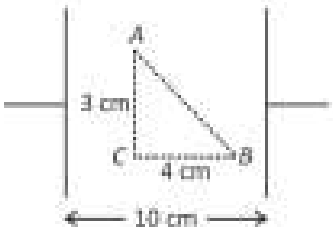
**Answer (1)**

**Sol.** $\tau = I\alpha$

$10 \times 2 = 2I$

$I = 10$ kg m$^2$

7. The figure shows the plates of a parallel plate capacitor with a separation 10 cm and charged to a potential difference V. Find the potential difference between B and A.




(1) $\frac{2V}{5}$

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

(3) $\frac{3V}{5}$

(4) $\frac{V}{5}$

**Answer (1)**

**Sol.** $V = E\,(10\text{ cm})$

$V' = E\,(4\text{ cm})$

$V' = \frac{2}{5}V$

8. Binding energy per nucleon in $_1^2H$ is x and for $_2^4He$ is y. Find energy released in the given reaction

$_1^2H + {}_2^4He \rightarrow {}_2^4He$

(1) $2x - 2y$

(2) $-4x + 4y$

(3) $4x - 4y$

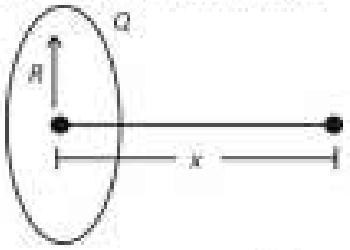
(4) $2y - 4x$

**Answer (2)**

**Sol.** $BE = 4y - (2x + 2x)$

$= 4y - 4x$

9. Figure shows a uniformly charged ring having charge $Q$ and radius $R$. Find the distance from the centre on the axis of the ring where electric field is maximum




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

(3) $2R$ (4) $R$

**Answer (2)**

**Sol.** $E = \frac{kQx}{\left(R^2 + x^2\right)^{3/2}}$

$\frac{dE}{dx} = 0$

$x = \frac{R}{\sqrt{2}}$

10. Two identical drops of radius $R$ and surface tension '$T$' coalesce to form a bigger drop. The change in surface energy in this process is

(1) $4\pi R^2 T\left[1 - 2^{-\frac{1}{3}}\right]$ (2) $8\pi R^2 T\left[1 + 2^{\frac{1}{3}}\right]$

(3) $4\pi R^2 T\left[1 + 2^{\frac{1}{3}}\right]$ (4) $8\pi R^2 T\left[2^{\frac{1}{3}} - 1\right]$

**Answer (4)**

**Sol.** Volume of bigger drop $= \frac{4}{3}\pi R_1^3 = 2\left(\frac{4}{3}\pi R^3\right)$

$R_1 = R(2)^{\frac{1}{3}}$

Initial energy $= (4\pi R^2 T) \times 2$

Final energy $= 4\pi R^2 (2)^{\frac{2}{3}} T$

11. Two galvanometers $G_1$ and $G_2$ are having resistors $R_1 = 5\Omega$ and $R_2 = 7\Omega$, number of turns $N_1 = 21$, $N_2 = 15$, magnetic fields $B_1 = 0.25$ T, $B_2 = 0.50$ T and area of coil $A_1 = 3.6 \times 10^{-3}$ cm$^2$ and $A_2 = 1.8 \times 10^{-4}$ cm$^2$. Find the ratio of their voltage sensitivity

(1) $\frac{49}{25}$ (2) $\frac{7}{5}$

(3) $\frac{5}{7}$ (4) $\frac{49}{20}$

**Answer (1)**

**Sol.** $\tau = NIAB = K\theta$

$\frac{\theta}{V} = \frac{\theta}{RI} = \frac{NAB}{LKR}$

Ratio of voltage sensitivity $= \left(\frac{N_1 A_1 B_1}{N_2 A_2 B_2}\right)\frac{R_2}{R_1}$

$= \frac{21}{15} \times \frac{3.6}{1.8} \times \frac{0.25}{0.50} \times \frac{7}{5}$

$= \frac{49}{25}$

12. Match the List-I with the List-II

(i) Heat capacity (a) J kg$^{-1}$ K$^{-1}$

(ii) Specific heat capacity (b) J K$^{-1}$

(iii) Latent heat (c) W m$^{-1}$ K$^{-1}$

(iv) Thermal conductivity (d) J kg$^{-1}$

(1) (i)-(b), (ii)-(d), (iii)-(c), (iv)-(a)

(2) (i)-(b), (ii)-(a), (iii)-(c), (iv)-(a)

(3) (i)-(b), (ii)-(c), (iii)-(d), (iv)-(a)

(4) (i)-(b), (ii)-(a), (iii)-(d), (iv)-(c)

**Answer (4)**

13. In a system of measurement, electric charge ($Q$), permeability ($\mu_0$) and electric current ($I$) are considered as fundamental quantity. The dimension of linear momentum in this system is

(1) $\left[Q^2\mu_0^2 I\right]$ (2) $\left[Q\mu_0 I\right]$

(3) $\left[Q\mu_0 I^2\right]$ (4) $\left[Q^2\mu_0 I\right]$

**Answer (2)**

**Sol.** Let $P \propto (Q)^a(\mu_0)^b(I)^c$

$$\left[MLT^{-1}\right] = K\left[M^aL^aT^{a-2b}A^{a-2b+c}\right]$$

$a = 1, b = 1, c = 1$

14. Which of the following items (labelled i, ii, iii, iv and v) are true

When an ideal gas undergoes adiabatic process, (symbols have their usual meaning)

(i) $\Delta U = 0$

(ii) $w = -\Delta U$

(iii) $PV$ = Constant

(iv) $VT$ = Constant

(v) $W \propto |T_2 - T_1|$

(1) (i), (ii), (iv)

(2) (ii) and (v)

(3) (ii), (iii), (v)

(4) (i), (ii), (v)

**Answer (2)**

**Sol.** $\Delta Q = 0$

$\Rightarrow W = -\Delta U$

$= -nC_v(T_2 - T_1)$

15. A wave is travelling along a string. The wavelength ($\lambda$) of the wave is 7.5 m and amplitude is 2 cm. At $t = 0$, there is a crest at $x = 0$ and in 0.3 seconds it travels a distance of 12 cm in +ve $x$-direction. The equation of the wave is

(1) $2\sin\left(\frac{2\pi}{15}x + \frac{6\pi}{25}t\right)$ cm (2) $2\cos\left(\frac{4\pi}{15}x - \frac{8\pi}{75}t\right)$ cm

(3) $2\cos\left(\frac{4\pi}{15}x + \frac{6\pi}{25}t\right)$ cm (4) $2\sin\left(\frac{4\pi}{15}x - \frac{8\pi}{75}t\right)$ cm

**Answer (2)**

**Sol.** $\lambda = 7.5$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{7.5} = \frac{4\pi}{15}$$

$$v = \frac{12}{0.3} = 40 \text{ cm/s}$$

$$\frac{\omega}{k} = 40 \text{ cm/s}$$

$$\omega = \frac{40}{100} \times \frac{4\pi}{15} = \frac{40\pi}{375} = \frac{8\pi}{75}$$

$$y = 2\cos\left(\frac{4\pi}{15}x - \frac{8\pi}{75}t\right) \text{ cm}$$

16. An equiconvex lens of radius $R = \frac{1}{6}$ m is having power $P$. Another Bi convex lens of radii $R_1$ and $R_2$ is having same power $P$, then

(1) $R_1 = \frac{1}{9}$m, $R_2 = \frac{1}{3}$m (2) $R_1 = \frac{1}{6}$m, $R_2 = \frac{1}{3}$m

(3) $R_1 = \frac{1}{9}$m, $R_2 = \frac{1}{4}$m (4) $R_1 = \frac{1}{4}$m, $R_2 = \frac{1}{5}$m

**Answer (1)**

**Sol.** $\frac{1}{f_1} = (\mu - 1)\left(\frac{2}{R}\right) = (\mu - 1)12$

$$\frac{1}{f_2} = (\mu - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = (\mu - 1)12$$

$$\frac{1}{R_1} + \frac{1}{R_2} = 12$$

17. The area of a solenoid is A, length is L, magnetic field inside is $B_0$ and the relative permeability of medium is 2. The energy stored due to the magnetic field is

(1) $\frac{B_0^2 AL}{2\mu_0}$ (2) $\frac{B_0^2 AL}{4\mu_0}$

(3) $\frac{4B_0^2 AL}{\mu_0}$ (4) $\frac{2B^2 AL}{\mu_0}$

**Answer (2)**

**Sol.** $E = \frac{B^2}{2\mu} \times AL$

$= \frac{B_0^2 AL}{4\mu_0}$

18.

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.

21. The radius of first Bohr orbit of $Li^{2+}$ is $\frac{a_0}{X}$, where $a_0$ is the radius of the first Bohr orbit of H. Find X

**Answer (3)**

**Sol.** $r = a_0 \frac{n^2}{Z}$

For $Li^{2+}$ is ground state $n = 1$ and $Z = 3$

$\Rightarrow r = a_0 \frac{(1)^2}{3} = \frac{a_0}{3}$

22. The length of the string in 104 m when the tension in it is 5 N. The length becomes 1.56 m when the tension in it is 7 N. The natural length of the string is ____ m.

**Answer (1)**

**Sol.** $T = k(l - l_0)$

$\Rightarrow 5 = k(1.4 - l_0)$

$\Rightarrow 7 = k(1.56 - l_0)$

$\Rightarrow 7(1.4 - l_0) = 5(1.56 - l_0)$

$l_0 = \frac{7(1.4) - 5(1.56)}{2} = 1\,m$

23. A concave mirror and a convex mirror of same focal length are given. A real object is placed in front of the mirror at a distance equal to half the focal length. The ratio of lateral magnification in the image produced by concave mirror to that produced by the convex mirror is

**Answer (3)**

**Sol.** $m = \frac{f}{f - u}$

$m_{concave} = \frac{-f}{-f - \left(-\frac{f}{2}\right)} = 2$

$m_{convex} = \frac{+f}{+f - \left(-\frac{f}{2}\right)} = \frac{2}{3}$

$\frac{m_{concave}}{m_{convex}} = 3$

24.

25.