# PHYSICS

**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 $\dfrac{1}{\mu_0 \varepsilon_0}$ (where $\mu_0$ is permeability and $\varepsilon_0$ is permittivity of free space).

   (1) $LT^{-1}$

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

   (3) $MLT^{-1}$

   (4) $ML^2T^{-2}$

**Answer (2)**

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

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

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

$\dfrac{60° + \delta_m}{2} = 45°$
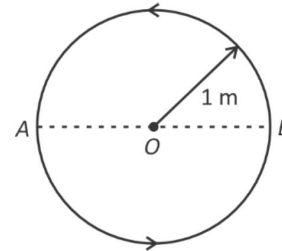
$\delta_m = 30°$

$\delta_m = i + e - A$

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

$i = 45°$

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



   (1) Distance = 2 m, displacement = $4\pi$ m

   (2) Distance = 2 m, displacement = $5\pi$ m

   (3) Distance = $4\pi$ m, displacement = 2 m

   (4) Distance = $5\pi$ 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

$= 4\pi$ 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
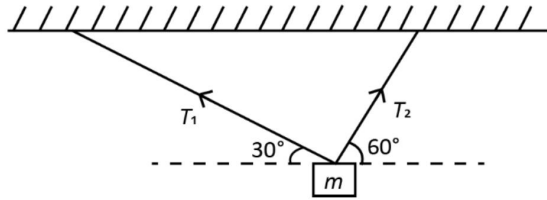
   (1) $\dfrac{5MR^2}{2}$

   (2) $\dfrac{3MR^2}{2}$

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

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

**Answer (2)**

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

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 $\frac{T_1}{T_2}$
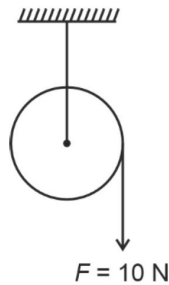


(1) 3

(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



$F = 10$ N

(1) 10 kg m$^2$

(2) 5 kg m$^2$

(3) 6 kg m$^2$

(4) 20 kg m$^2$

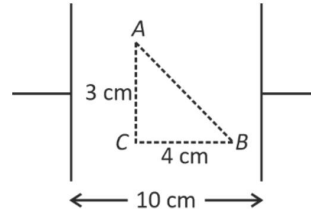**Answer (1)**

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

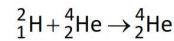(3) $\frac{3V}{5}$

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

**Answer (1)**

**Sol.** $V = E$ (10 cm)

$V' = E$ (4 cm)

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

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

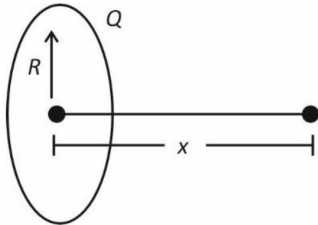$$^2_1\text{H} + ^4_2\text{He} \rightarrow ^4_2\text{He}$$

(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) $\dfrac{R}{\sqrt{2}}$

(3) $2R$

(4) $R$

**Answer (2)**

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

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

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

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 $= \dfrac{4}{3}\pi R_1^3 = 2\left(\dfrac{4}{3}\pi R^3\right)$

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

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 $A_2 = 1.8 \times 10^{-3}$ cm$^2$. Find the ratio of their voltage sensitivity

(1) $\dfrac{49}{25}$

(2) $\dfrac{7}{5}$

(3) $\dfrac{5}{7}$

(4) $\dfrac{49}{20}$

**Answer (1)**

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

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

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

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

$= \dfrac{49}{25}$

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) $\left\lfloor Q^2\mu_0^2 i \right\rfloor$

(2) $\left\lfloor Q\mu_0 i \right\rfloor$

(3) $\left\lfloor Q\mu_0 i^2 \right\rfloor$

(4) $\left\lfloor Q^2\mu_0 i \right\rfloor$

**Answer (2)**

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

$$\left\lfloor MLT^{-1} \right\rfloor = K \left[ M^b L^b T^{a-2b} A^{a-2b+c} \right]$$

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

**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) $W \alpha |T_2 - T_1|$

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

(2) (ii) and (v)

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

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

**Answer (2)**

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

$\Rightarrow W = -\Delta U$

$= -nC_v (T_2 - T_1)$

**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) $2\sin\left(\dfrac{2\pi}{15}x + \dfrac{6\pi}{25}t\right)$ cm

(2) $2\cos\left(\dfrac{4\pi}{15}x - \dfrac{8\pi}{75}t\right)$ cm

(3) $2\cos\left(\dfrac{4\pi}{15}x + \dfrac{6\pi}{25}t\right)$ cm

(4) $2\sin\left(\dfrac{4\pi}{15}x - \dfrac{8\pi}{75}t\right)$ 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 $R = \dfrac{1}{6}$ m is having power $P$. Another $Bi$ convex lens of radii $R_1$ and $R_2$ is having same power $P$, then

(1) $R_1 = \dfrac{1}{9}$m, $R_2 = \dfrac{1}{3}$ m

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

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

(4) $R_1 = \dfrac{1}{4}$m, $R_2 = \dfrac{1}{5}$ m

**Answer (1)**

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

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

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

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) $\dfrac{B_0^2 AL}{2\mu_0}$

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

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

(4) $\dfrac{2B^2 AL}{\mu_0}$

**Answer (2)**

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

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

18.

19.

20.

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**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.

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

**Answer (3)**

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

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

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

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

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

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

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

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

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.** $m = \dfrac{f}{f - u}$

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

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

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

24.

25.