### PART: PHYSICS

1. The ratio of KE : PE of an e⁻ in 5th orbit?

   - (1) \( \frac{1}{2} \)
   - (2) \( \frac{1}{2} \)
   - (3) 2
   - (4) \(-2\)

**Ans.** (2)

**Sol.** For orbiting electrons.
2. Find current through Zener diode

\[
\begin{align*}
E &= \frac{-K}{2} \\
KE &= \frac{1}{2} \\
PE &= \frac{1}{2} \\
K &= \frac{1}{2} \\
U &= \frac{1}{2}
\end{align*}
\]

\[
\text{Ans.} \quad (1)
\]

\[
\text{Sol.}
\]

\[
\begin{align*}
I_A &= \frac{1}{10} \text{ A} \\
I_B &= \frac{1}{10} \text{ A}
\end{align*}
\]

3. At what temp \( V_{\text{rms}1} \) is same as \( V_{\text{rms}2} \) at temperature 47°C.

\[
\begin{align*}
(1) \quad 94 \text{ K} & \quad (2) \quad 283 \text{ K} & \quad (3) \quad 20 \text{ K} & \quad (4) \quad 40 \text{ K}
\end{align*}
\]

\[
\text{Ans.} \quad (3)
\]

\[
\text{Sol.}
\]

\[
\begin{align*}
V_{\text{rms}1} &= \sqrt{\frac{3RT_1}{M}} \\
V_{\text{rms}2} &= \frac{3RT_2}{3RT_1} \times \frac{M_{\text{rms}1}}{M_{\text{rms}2}} \\
&= \frac{T_2}{\left(273 + 47\right)} \times \left(\frac{32}{2}\right) \times 1 \\
&= \frac{320}{16} \\
&= 20 \text{ K}
\end{align*}
\]

4. The electrostatic potential due to a dipole at a distance \( r \) varies as:

\[
\begin{align*}
(1) \quad \frac{1}{r} & \quad (2) \quad \frac{1}{r} & \quad (3) \quad r & \quad (4) \quad r^2
\end{align*}
\]

\[
\text{Ans.} \quad (1)
\]

\[
\text{Sol.}
\]
5. If Young’s modulus of a wire is $Y$ and its length is $L$ and its cross sectional area is "A". If the length of the wire is doubled and cross sectional area is halved then Young’s modulus of the wire will be?

(1) $Y$  
(2) $2Y$  
(3) $\frac{Y}{4}$  
(4) $\frac{Y}{2}$

**Ans.** (1)

**Sol.** Young’s modulus is the property of material. It does not depend on shape or geometry.

.: Young’s modulus remains constant.

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6. Two current carrying ring of radius "R" are mutually perpendicular and their centre coincide. Find net magnetic field at the centre.

(1) $\frac{\mu_0 I}{4R}$  
(2) $\frac{\mu_0 I}{R}$  
(3) $\frac{\sqrt{2}\mu_0 I}{R}$  
(4) $\frac{\sqrt{2}\mu_0 I}{\sqrt{2}R}$

**Ans.** (4)

**Sol.**

\[ B_x = \sqrt{2}B \]
\[ B_y = \frac{\mu_0 I}{2R} \]
\[ B_z = \frac{\mu_0 I}{\sqrt{2}R} \]

7. If work function of a material is 3 eV then find maximum wavelength for which photoelectric effect takes place.

(1) 0.30 µm  
(2) 0.41 µm  
(3) 0.60 µm  
(4) 0.1 µm

**Ans.** (2)

**Sol.**

\[ \frac{hc}{\lambda_{\text{max}}} = \phi = 3 \text{ eV} \]
\[ \Rightarrow \lambda_{\text{max}} = \frac{1.24 \times 10^{-6}}{3} \text{ m} \]
\[ \Rightarrow \lambda_{\text{max}} = 0.41 \text{ µm} \]
8. A ball of mass 100 gm is dropped from a height of 10 m above the ground. It rebounds and reaches to a height of 5m above the ground. Find impulse of force exerted on ball by the ground (in N-S)

\[
\begin{align*}
(1) & \quad 1 + \sqrt{2} \\
(2) & \quad 1 + \frac{1}{\sqrt{2}} \\
(3) & \quad 3 + \sqrt{2} \\
(4) & \quad \frac{1}{\sqrt{2}} 
\end{align*}
\]

Ans. (1)

Sol. \[ I = m \sqrt{2g} h_1 - m \sqrt{2g} h_2 \]
\[ I = 100 \times 10^{-3} \times \sqrt{2} \times 10 (\sqrt{10} + \sqrt{5}) \]
\[ I = 1 + \sqrt{2} \]

9. Half life of radioactive sample is 36 hours, how much fraction remains un decayed after 24 hours. Antiog (0.2) = 1.587

(1) 0.63  (2) 0.37  (3) 0.75  (4) 0.80

Ans. (2)

Sol. \[ t_1 = \frac{36}{2} \text{ hr} \]

Remaining fraction
\[ \frac{N}{N_0} = e^{-\frac{t}{t_{1/2}}} \]
\[ \frac{N}{N_0} = \frac{\ln 2}{36} \]
\[ \frac{N}{N_0} = 0.37 \]

10. (a) Surface Tension \[ (i) [M^{1} L^{-1} T^{-2}] \]
(b) Coefficient of viscosity \[ (ii) [M^{-1} L T^{-1}] \]
(c) Angular momentum \[ (iii) [M L^{2} T^{-1}] \]
(d) Rotational kinetic energy \[ (iv) [M^{2} L^{2} T^{-2}] \]

(1) (a) – (iv), b – (ii), c – (iii), d – (i)
(2) (a) – (iv), b – (iii), c – (i), d – (i)
(3) (a) – (i), b – (iii), c – (iv), d – (i)

Ans. (2)
11. A particle of mass $m$ is projected at an angle of $30^\circ$ with initial velocity $u$. Find its angular momentum about point of projection at maximum height.

\[
\text{(1)} \quad \frac{\mu^2}{4g} \\
\text{(2)} \quad \frac{\sqrt{3}\mu^2}{16g} \\
\text{(3)} \quad \frac{\sqrt{2}\mu^2}{2g} \\
\text{(4)} \quad \frac{3\mu^2}{2g}
\]

**Ans.** (2)

**Sol.**

![Diagram showing a particle projected at an angle of 30° with initial velocity $u$.]

Angular momentum from point of projection

\[L_0 = mvr_1 = m(u \cos 30^\circ)H\]

\[= m \left( \frac{\sqrt{3}}{2} \frac{u^2 \sin^2 30^\circ}{2g} \right)\]

\[= m \left( \frac{\sqrt{3}}{2} \frac{u^2}{16g} \right) = \frac{3\mu^2}{16g}\]
Find velocity at h=1/2

\[ \frac{1}{2}mv^2 = mgh \]

\[ v = \sqrt{2gh} \]

\[ = \sqrt{2g \times \frac{1}{2}} \]

\[ = \sqrt{g} \]

\[ = \sqrt{10} \]

13. Find acceleration of 2 Kg block.

1. g
2. \( \frac{g}{3} \)
3. \( \frac{g}{4} \)
4. \( \frac{g}{2} \)

Ans. (2)
14. Resistance of resistor at 27°C is 60 Ω. Temperature coefficient of resistance is \( \alpha = 2 \times 10^{-4} \) Per°C. Find the temperature of resistance when voltage and current across resistance will be 210 Volt and 2.75 A.

(1) 1250 °C  
(2) 890 °C  
(3) 1693 °C  
(4) 2015 °C

Ans. (3)

Sol.

\[ R_1 + \frac{V}{I} = 80 \]
\[ R = R_0 (1 + \alpha \Delta T) \]
\[ 80 = 60 (1 + \alpha \Delta T) \]
\[ 20 = 60 \alpha \Delta T \]
\[ \Delta T = \frac{20}{60} = \frac{10}{3} \times 10^{-4} = 1666 °C \]
\[ I = 1666 + 27 = 1693 °C \]

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15. In given electrical circuit Voltage drop across E_2 will be-

(1) 6  
(2) 10  
(3) 3  
(4) 40

Ans. (1)

Sol.

\[ E_1 > E_2 \]
\[ I = \frac{E_2 - 2}{2 + 4} = \frac{5}{6} = 1 \text{amp} \]
\[ V_{\text{drop}} = 1 \times 2 = 2 \text{V} \]

16. In an electric circuit a resistance of 3.3 kΩ is connected with seven 100 Ω resistance in series. If all resistances are connected to a 4V battery then the reading of voltmeter connected across last 5 identical resistances will be-

(1) \( \frac{1}{5} \) V  
(2) \( \frac{1}{2} \) V  
(3) 2 V  
(4) 4 V

Ans. (2)
17. Find the work done by gas in cyclic process.

\[ I = \frac{4}{3300 + 100} = \frac{1}{100} \text{ A} \]

\[ V = I \times 5 \times 100 = \frac{1}{2} \text{ V} \]

(1) 200 J  (2) 200KJ  (3) -200J  (4) -200KJ

**Ans. (3)**

**Sol.**

\[ W = \text{Area enclosed in loop} \]

\[ W = \frac{1}{2} \times (30 - 10) \times (30 - 10) \times 10^3 \times 10^{-3} \text{ J} \]

\[ W = -200 \text{ J} \]

18. A particle travels 125 m with change in velocity as 50 m/s in t to (t + 1) second. Find the displacement in (t + 2) sec.

(1) 100 m  (2) 175 m  (3) 225 m  (4) 275 m

**Ans. (2)**
19. In a convex lens the distance between object and image is 45 cm and magnification produced by lens is \(2\). Then what would be the focal length of the lens.

(1) 30 cm  (2) 45 cm  (3) 60 cm  (4) 90 cm

Ans. (4)

Sol.

\[ \frac{|v| - |u|}{2u - u} = \frac{u}{45} \]

\[ \frac{1}{1} = \frac{1}{2u - u} \]

\[ |v| - |u| = u = 45 \text{ cm} \]

\[ f = \frac{|v| - |u|}{2} = 90 \text{ cm} \]
For second alternating EMF we can say that angular frequency of second alternating EMF is double of first alternating EMF.

\[ \omega_2 = 2\omega \]

Now power factor for second EMF

\[ P.F. = \frac{R}{\sqrt{R^2 + 4\omega^2 L^2}} \]

\[ R = \omega L \]

\[ \therefore \ P.F. = \frac{R}{\sqrt{R^2 + 4\omega^2 L^2}} = \frac{1}{\sqrt{5}} \]

21. A disc of mass \( m \) and radius \( R \) is rotating with angular speed \( \omega \) about an axis passing through the centre of mass. Another identical disc is gently placed on it. Find out loss in kinetic energy of system.

\[ \begin{align*}
(1) & \quad \frac{1}{2} mR^2 \omega^2 \\
(2) & \quad \frac{1}{4} mR^2 \omega^2 \\
(3) & \quad \frac{1}{6} mR^2 \omega^2 \\
(4) & \quad \frac{1}{6} mR^2 \omega^2
\end{align*} \]

Ans. (4)

Sol.

\( \omega = \text{initial angular velocity} \)

\( \omega' = \text{Common angular velocity} \)

After placing same disc on rotating disc

By angular momentum conservation C.O.M.

\[ \frac{1}{2} mR^2 \omega = \left( \frac{1}{2} mR^2 + \frac{1}{2} mR^2 \right) \omega' \]

\[ \omega' = \frac{\omega}{2} \]

22. If current through a wire is \( \sqrt{2} \) A then find force per unit length of wire due to a magnetic field of \( 3.5 \times 10^{-6} \) T in the direction 45° from wire.

\( F = i B \sin \theta \)

\[ \begin{align*}
(1) & \quad \frac{7}{2} \times 10^{-6} \frac{N}{m} \\
(2) & \quad 3.5 \times 10^{-6} \frac{N}{m} \\
(3) & \quad 3.5 \sqrt{2} \times 10^{-6} \frac{N}{m} \\
(4) & \quad 7 \times 10^{-6} \frac{N}{m}
\end{align*} \]

Ans. (2)

Sol.

\[ F = i B \sin \theta \]

\[ F = \left( \sqrt{2} \right) \left( 3.5 \times 10^{-6} \right) \sin (45°) \]

\[ F = 3.5 \times 10^{-6} \frac{N}{m} \]
23. \( E = E_0 \sin((\omega t - kz)), \) then \( B \) will be

(1) \( B = \frac{E_0}{c} \sin((\omega t - kz)) \)

(2) \( B = \frac{E_0}{c} \sin((\omega t - k\hat{z})) \)

(3) \( B = \frac{E_0}{c} \sin((\omega t - k\hat{j})) \)

(4) \( B = \frac{E_0}{c} \sin((\omega t - k\hat{j})) \)

Ans. (2)
Sol.

\[ B = \frac{k \times E}{c} \]

\[ = \frac{(k \times i)}{a/k} E_0 \sin(\omega t - k\hat{z}) \]

\[ = \left( \frac{E_0}{c} \right) \sin((\omega t - k\hat{z})) \]

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24. If gravitational potential at some height is \( 5.12 \times 10^7 \) m\(^2\)/s\(^2\) and gravitational acceleration is 6.4 m/s\(^2\), then find the height about earth surface:

(1) 3200 km

(2) 1600 km

(3) 800 km

(4) 800 km

Ans. (2)
Sol. \( V_p = \frac{GM}{R_e + h} \)

\[ g = \frac{GM}{(R_e + h)^2} \]

\[ = 5.12 \times 10^7 \text{ m}^2/\text{s}^2 \]

\[ = 6.4 \text{ m/s}^2 \]

\[ h = (8000 - R_e) \text{ km} \]

\[ h = (8000 - 6400) \text{ km} \]

\[ h = 1600 \text{ km} \]

25. Primary coil has 100 turns. & no. of turns in secondary coil is 10. Then find \( v_o \):

(1) 22 V

(2) 7 V

(3) 15 V

(4) 20 V

Ans. (2)
Sol. \( v_o = \frac{N_2}{N_1} \cdot \frac{V_p}{220} = \frac{10}{100} \]

\( V_o = 22 \text{ volt} \)
26. If a hydrogen electron is excited to an orbit of energy – 0.85 eV in an atom then maximum possible number of transitions to lowest energy levels is 

(1) 6  (2) 3  (3) 5  (4) 2

Ans. (2)

Sol. 
\[
\frac{-13.6e^2}{n^2} = -0.85
\]
\[
\Rightarrow n = 4
\]

For max Transitions : 
4 → 3 → 2 → 1
3 transitions

27. The fundamental frequency of a closed organ pipe is 50 Hz. Now some water is filled then fundamental frequency becomes 110 Hz. If the cross-sectional area of the pipe is 2 cm² then find the amount of water added in grams. Speed of sound in air = 330 m/sec.

(1) 90 grams  (2) 180 grams  (3) 300 grams  (4) 18 grams

Ans. (2)

Sol. 
\[
f_0 = 50 = \frac{v}{4l} = \frac{330}{4l'}
\]
\[
l' = \frac{330}{40} = 8.25 m
\]
\[
f' = 110 = \frac{330}{4r'}
\]
\[
r' = \frac{3}{4} m
\]

Water column height
\[
(\ell - r') = \frac{33}{20} - \frac{3}{4} = \frac{9}{20} = 0.9 m
\]

Volume of water
\[
A (\ell - r') = 2 \times 10^{-4} \times 0.9 = 1.8 \times 10^{-4} m^3
\]

Mass of water = \( \rho A (\ell - r') = 1000 \times 1.8 \times 10^{-4} = 0.18 \) kg = 180 gm
28. If Young's modulus of all strings is $2 \times 10^{11} \text{ N/m}^2$ and cross section area is $0.005 \text{ cm}^2$. Find the elongation in the string connected between blocks A and B, if the length of string AB is 1 m.

(1) 100 cm (2) 1 cm (3) 0.1 cm (4) 0.01 cm

Ans. (4)

Sol. $a = \frac{\text{Net force along string}}{\text{total mass}}$

$\frac{3g}{3} = \frac{g}{3} = \frac{10}{3} \text{ m/s}^2$

Tension in string AB:

\[ T = 3g = 10 \text{ N} \]

Elongation in AB string:

\[ \Delta l = \frac{Tl}{YA} = \frac{10 \times 10^{-1}}{2 \times 10^{-11} \times 5 \times 10^{-7}} \]

\[ \Delta l = 10^7 \text{ m} = 0.01 \text{ cm} \]

29. Two capacitors of capacitance $C$ and $2C$ and potential difference between plates V & 2V respectively are connected together then total energy loss is $\frac{2}{3} E$. Where $E$ is the energy of capacitor of capacitance $C$ and potential V. Then value of 'x' will be –

(1) 2 (2) 4 (3) 1 (4) 3

Ans. (1)
\[ q_1 + q_2 = 5CV \quad \text{(1)} \]

Also,
\[ \frac{q_1}{C} = \frac{q_2}{2C} \]
\[ 2q_1 = q_2 \quad \text{_____ (2)} \]

From (1) and (2) –
\[ q_1 = \frac{5}{3}CV, \quad q_2 = \frac{10}{3}CV \]

Energy loss = \[ \Delta E = \frac{\Delta q_1^2}{2C_1} + \frac{\Delta q_2^2}{2C_2} \]
\[ \Delta E = \frac{\left( CV \frac{5}{3}CV \right)^2}{2C} + \frac{\left( CV \frac{10}{3}CV \right)^2}{2(2C)} \]
\[ = \frac{25CV^2}{18} + \frac{100CV^2}{18} \]
\[ = \frac{2}{3} + \frac{1}{2}CV^2 \]
\[ \frac{1}{2}CV^2 \]
\[ = x = 2 \]