Studentpad

MHT-CET-XII PHYSICS 2022-23

Time : 150 Min	Phy : Full Portion Paper	Marks : 50

Hints and Solutions

01) Ans: **D)** 2:1

Sol: $u = 20$ m/s and $\theta = 30°$

The time of flight (T)

$$= \frac{2u\sin\theta}{g} = \frac{2\times 20\times \sin 30°}{10} = 2s$$

If 't' is the total time taken by the ball to hit the ground

$s = ut + \frac{1}{2}at^2$ we get

where h=40m, u=v sinθ, a=g

$$40 = -(u\sin\theta)\times t + \frac{1}{2}\times 10\times t^2$$

$$= (-20\times\frac{1}{2}\times t) + 5t^2 = 5t^2 - 10t$$

$\therefore 5t^2 - 10t - 40 = 0$ $\therefore t^2 - 2t - 8 = 0$

$\therefore (t-4)(t+2) = 0$

t=4s because t=-2 is not possible.

$$\Rightarrow \frac{t}{T} = \frac{4}{2} = \frac{2}{1}$$

02) Ans: **A)** 4

Sol: Here, $n\beta_1 = (n+1)\beta_2$

$$\frac{n\times 650\times 10^{-19}D}{d} = \frac{(n+1)\times 520\times 10^{-19}\times D}{d} \Rightarrow n = 4$$

03) Ans: **D)** $0.3^0 C/s$

Sol: $\frac{dT_1}{dt} = -K(T - T_0)$; $0.6 = -K(40)$ ...(i)

$\Rightarrow \frac{dT_2}{dt} = -K(20)$ ...(ii)

Dividing equation (i)by (ii) we get,

$$\frac{0.6}{\left(\frac{dT_2}{dt}\right)} = \frac{40}{20} = 2$$

$$\therefore \frac{dT_2}{dt} = \frac{0.6}{2} = 0.3^0 C/s$$

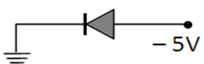
04) Ans: **B)** Smaller than eyepiece

05) Ans: **A)** lorentz's force

06) Ans: **D)** $0.022\ Wbm^{-2}$

Sol: Magnetic induction, $B = \frac{\mu_0 Ni}{2r}$

$$\Rightarrow B = \frac{4\pi\times 10^{-7}\times 100\times 2\times\sqrt{\pi}}{2\times 10^{-2}} = 0.022\ wb/m^2$$

07) Ans: **D)** 

Sol: Since P-side is more negative than N-side.

08) Ans: **B)** 0.45 m

Sol: For no deflection in mutually perpendicular electric and magnetic field,

$$v = \frac{E}{B} = \frac{3.2\times 10^5}{2\times 10^{-3}} = 1.6\times 10^8\ m/s.$$

Now, if electric field is removed, then due to only magnetic field radius of the path described by electron will be $r = \frac{mv}{qB}$

$$\Rightarrow r = \frac{9.1\times 10^{-31}\times 1.6\times 10^8}{1.6\times 10^{-19}\times 2\times 10^{-3}} = 0.45\ m$$

09) Ans: **D)** -3.0 eV

Sol: Total energy $= \frac{e^2}{8\pi\varepsilon_0 r} = \frac{1}{2}\frac{e^2}{4\pi\varepsilon_0 r}$

Therefore, total energy $= \frac{1}{2}\times$ P.E.

P.E. = 2(total energy) = -3 eV

10) Ans: **B)** 22.5 cm

Sol: Light travels from denser to rarer.

$\therefore \frac{1}{\mu} = \frac{R.D}{A.D}$ $\therefore R.D. = \frac{A.D}{\mu} = \frac{30\times 3}{4} = 22.5$ cm

11) Ans: **A)** n = 2

Sol: As, $r \propto n^2$, $\therefore \frac{r_f}{r_i} = \left(\frac{n_f}{n_i}\right)^2$

$$\Rightarrow \frac{21.2\times 10^{-11}}{5.3\times 10^{-11}} = \left(\frac{n}{1}\right)^2 \Rightarrow n^2 = 4 \Rightarrow n = 2$$

12) Ans: **C)** 0.34 MeV

Sol: Given that, $m_0c^2 = 0.51$ MeV and v = 0.8 c and K. E. of the electron = $mc^2 - m_0c^2$

$$\text{But, } m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{m_0}{\sqrt{1 - \left(\frac{0.8\,c}{c}\right)^2}}$$

$$\Rightarrow m = \frac{m_0}{\sqrt{0.36}} = \frac{m_0}{0.6}$$

Now, $mc^2 = \frac{0.51}{0.6}$ M eV = 0.85 M eV

$\therefore$ K. E. = (0.85 - 0.51)M eV = 0.34 M eV.

13) Ans: **B)** $\frac{\mu_0 I}{6a}$

Sol: Magnetic field at the centre of a semicircular current carrying conductor is given by

$B = \frac{\mu_0 I\pi}{4\pi a} = \frac{\mu_0 I}{4a}$ where a is the radius of the first semicircle.

The current in all the semicircles is the same but its sense is alternately opposite (i.e. anticlockwise in I[st] semicircle and clockwise in II[nd] semicircle and so on) and the radii are in the proportion 1 : 2 : 4 : 8 : 16 : ..... .
Net magnetic field at the point O is

$$B=\frac{\mu_0 I}{4a}\left[1-\frac{1}{2}+\frac{1}{4}-\frac{1}{8}+\frac{1}{16}-\frac{1}{32}+\ldots\right]$$

$$=\frac{\mu_0 I}{4a}\left[\left(1+\frac{1}{4}+\frac{1}{16}+\ldots.\right)-\left(\frac{1}{2}+\frac{1}{8}+\frac{1}{32}+\ldots..\right)\right]$$

$$=\frac{\mu_0 I}{4a}\left[\left(1+\frac{1}{2^2}+\frac{1}{2^4}+\ldots..\right)-\left(\frac{1}{2}+\frac{1}{2^3}+\frac{1}{2^5}+\ldots...\right)\right]$$

$$=\frac{\mu_0 I}{4a}\left[\left(\frac{1}{1-\frac{1}{4}}\right)-\left(\frac{1/2}{1-\frac{1}{4}}\right)\right]$$ (By using geometric progression formula)

$$=\frac{\mu_0 I}{4a}\left[\left(\frac{4}{3}\right)-\left(\frac{2}{3}\right)\right]=\frac{\mu_0 I}{4a}\left(\frac{2}{3}\right)=\frac{\mu_0 I}{6a}$$

14) Ans: **D)** $\frac{30\,E}{100}$

Sol: According to the principle of potentiometer, $V \propto l$.

$\Rightarrow \frac{V}{E}=\frac{l}{L}$; where V = e. m. f. of battery, E = e. m. f. of standard cell, L = Length of potentiometer wire

$\therefore V=\frac{El}{L}=\frac{30\,E}{100}$

15) Ans: **C)** 4F

Sol: Centripetal force, $F=m\omega^2R$

$\therefore\ F \propto \omega^2$ (Here, m and R are constant.)

From the above relation, if angular velocity is doubled, force will becomes four times.

16) Ans: **B)** π

Sol: From the given snapshot at $t=0$,

$y=0$ at $x=0$

and $y=-ve$ when x increases from zero.

Standard expression of any progressive wave is given by $y=A\sin(kx-\omega t+\phi)$

Here, ϕ is the phase difference, we need to get at $t=0$ $y=A\sin(kx+\phi)$

Clearly $\phi=\pi$, so that

$y=A\sin(kx+\pi)\ \therefore y=-A\sin(kx)\ \Rightarrow y=0$ at $x=0$

and $y=-ve$ at $x>0$

17) Ans: **D)** only if the frequency of the incident radiation is above a certain threshold value

Sol: From the concept of threshold frequency.

18) Ans: **A)** Convex upward

19) Ans: **B)** 3 : 1

Sol: Consider r be radius of each small drop and R be the radius of a big drop.

$C=\frac{A\varepsilon_0 k}{d}$

Capacity of small drop $=\frac{4\pi r^2\varepsilon_0}{r}=4\pi\varepsilon_0 r$ ... (1)

Capacity of big drop $C'=4\pi\varepsilon_0 R$ ... (2)

Volume of a big drop

$=27\times$ Volume of small drop

$\therefore \frac{4}{3}\pi R^3=27\left(\frac{4}{3}\pi r^3\right)\ \Rightarrow R^3=27r^3\ \Rightarrow R^3=(3r)^3$

$\therefore R=3r$ ... (3)

So, from equations (1), (2) and (3), $\frac{C'}{C}=\frac{R}{r}=\frac{3r}{r}=\frac{3}{1}$

20) Ans: **B)** $\pi/2$

Sol: Time interval between two consecutive beats

$T=\frac{1}{n_1-n_2}=\frac{1}{260-256}=\frac{1}{4}$ s $\quad\therefore t=\frac{1}{16}=\frac{T}{4}$ s

Using, time difference = $\frac{T}{2\pi}\times$ Phase difference

$\Rightarrow \frac{T}{4}=\frac{T}{2\pi}\times\phi \Rightarrow \phi=\frac{\pi}{2}$

21) Ans: **B)** 0.72 J

Sol: Potential at centre of P,

$V_p=\frac{1}{4\pi\epsilon_0}.\left[\frac{2\times10^{-6}}{10^{-1}}+\frac{4\times10^{-6}}{5\times10^{-1}}\right]\Rightarrow V_P=\frac{126}{5}\times10^4$ V

Similarly,

$V_Q=9\times10^9\left[\frac{4\times10^{-6}}{10^{-1}}+\frac{2\times10^{-6}}{5\times10^{-1}}\right]=\frac{198}{5}\times10^4 V$

$P.D.=\frac{72}{5}\times10^4 V$

work done=charge x P.D.

$=5\times10^{-6}\times\frac{72}{5}\times10^4=0.72$ J

22) Ans: **B)** 5 Hz

Sol: Here, for the body to remain in contact,

$a_{max}=g$

$\therefore \omega^2A=g\Rightarrow 4\pi^2n^2\ A=g$

$\Rightarrow n^2=\frac{g}{4\pi^2A}=\frac{10}{4(3.14)^2 0.01}=25\Rightarrow n=5$ Hz

23) Ans: **D)** cross sectional area

24) Ans: **B)** $\frac{18d}{11}$

Sol: Here,

$\rho_{mix}=\frac{3m}{V_1+V_2+V_3}=\frac{3m}{\frac{m}{d}+\frac{m}{2d}+\frac{m}{3d}}=\frac{3\times6}{11}d=\frac{18}{11}d$

25) Ans: **C)** 8 V

26) Ans: **B)** 4 L

Sol: Angular momentum,

$L=mvr=m\sqrt{\frac{GM}{r}}r=m\sqrt{GMr}\qquad\therefore\ L\propto\sqrt{r}$

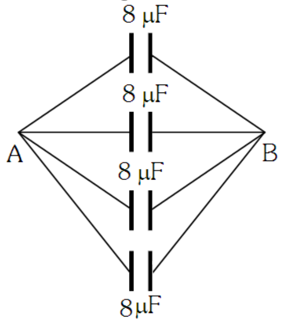
27) Ans: **A)** 0^0

Sol: $\angle i = \angle r = 0^0$

28) Ans: **D)** both the position and direction of motion of the particle at time t.

29) Ans: **D)** $32\,\mu F$

Sol: The given circuit can be redrawn as



$\therefore$ Equivalent capacitance = 4 x 8 = 32 μ F.

30) Ans: **A)** 1728×10^{10} J

Sol: The energy generated is

$$\frac{\text{Energy}}{\text{Day}} = 200 \times 10^6 \times 24 \times 3600$$

$$\Rightarrow \frac{\text{Energy}}{\text{Day}} = 2 \times 2.4 \times 3.6 \times 10^{12} = 1728 \times 10^{10} \text{ J}$$

31) Ans: **D)** Zero

32) Ans: **D)** $250\mu T$

Sol: Field along axis of coil, $B = \dfrac{\mu_0 I R^2}{2\left(R^2 + x^2\right)^{3/2}}$

At the centre of coil, $B' = \dfrac{\mu_0 I}{2R}$

$$\therefore \frac{B'}{B} = \frac{\mu_0 I}{2R} \times \frac{2\left(R^2 + x^2\right)}{\mu_0 I R^2} = \frac{\left(R^2 + x^2\right)^{3/2}}{R^3}$$

$$\Rightarrow B' = \frac{B \times \left(R^2 + x^2\right)^{3/2}}{R^3} = \frac{54 \times \left[(3)^2 + (4)^2\right]^{3/2}}{(3)^3}$$

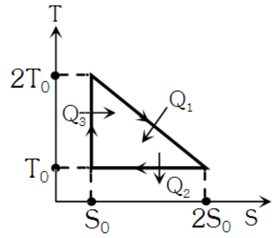
$$= \frac{54 \times 125}{27} \quad \text{or } B' = 250\mu T$$

33) Ans: **C)** 3 cm

Sol: Force, $F = kx \Rightarrow mg = kx \Rightarrow m \propto kx$

$$\therefore \frac{m_1}{m_2} = \frac{k_1}{k_2} \times \frac{x_1}{x_2} \Rightarrow \frac{4}{6} = \frac{k}{k/2} \times \frac{1}{x_2} \quad \Rightarrow x_2 = 3 \text{ cm}$$

34) Ans: **D)** $1/3$



Sol:

From the figure,

$$Q_1 = T_0 S_0 + \frac{1}{2} T_0 S_0 = \frac{3}{2} T_0 S_0 ,\ Q_2 = T_0 S_0 \ \text{ and } \ Q_3 = 0$$

$$\therefore \text{Efficiency, } \eta = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1} = 1 - \frac{Q_2}{Q_1} = 1 - \frac{2}{3} = \frac{1}{3}$$

35) Ans: **C)** $6P_oV_o$

Sol: Change in internal energy from $A \to B$ is given by $\Delta U = \dfrac{f}{2}\mu R \Delta T = \dfrac{f}{2}(P_f V_f - P_i V_i)$

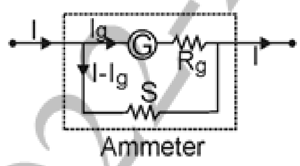
$$= \frac{3}{2}(2P_0 \times 2V_0 - P_0 \times V_0) = \frac{9}{2} P_0 V_0$$

Work done in process $A \to B$ is equal to the Area covered by the graph with volume axis means,

$$W_{A \to B} = \frac{1}{2}(P_0 + 2P_0) \times (2V_0 - V_0) = \frac{3}{2} P_0 V_0$$

Therefore, $\Delta Q = \Delta U + \Delta W = \dfrac{9}{2} P_0 V_0 + \dfrac{3}{2} P_0 V_0 = 6 P_0 V_0$

36) Ans: **A)** $0.05\,\Omega$



Sol:

Let the shunt resistance be S.

Here $I = 10$ A, $I_g = 0.01$ A, $R_g = 50\,\Omega$

From the figure $I_g R_g = \left(I - I_g\right) S$

$$\Rightarrow 0.01 \times 50 = (10 - 0.01) S \quad \text{or } S = \frac{0.5}{9.99} = 0.05\,\Omega$$

37) Ans: **C)** $-\dfrac{n(W_2 - W_1)}{5Rt}$

Sol: We know,

$$i = \frac{e}{R} \Rightarrow i = \frac{-N}{R}\frac{(\phi_2 - \phi_1)}{\Delta t} = \frac{-n(W_2 - W_1)}{5Rt}$$

38) Ans: **A)** solid sphere

Sol: $\dfrac{1}{2} I\omega^2 = \dfrac{4}{10} \times \dfrac{1}{2} mv^2 \qquad \Rightarrow \dfrac{1}{2} mK^2 \times \dfrac{v^2}{r^2} = \dfrac{1}{5} mv^2$

$$\therefore K^2 = \frac{2}{5} r^2$$

Therefore, it is a solid sphere.

39) Ans: **C)** Convection

Sol: Conduction and radiation do not depend upon the gravity. In convection, when we supply heat to the liquid, the heated particles move upwards and other colder particles move downwards. This process depends upon gravity.

40) Ans: **D)** 50 kV

Sol: Using , $\dfrac{1}{2} mv^2 = QV$

$$\Rightarrow \frac{1}{2} \times 2 \times 10^{-3} \times (10)^2 = 2 \times 10^{-6} V \Rightarrow V = 50 kV$$

41) Ans: **D)** In parallel with C and has a magnitude $\dfrac{\left(1 - \omega^2 LC\right)}{\omega^2 L}$

Sol: Power factor of an AC circuit containing L, C and R connected in series is given by,

$$\cos\phi = \frac{R}{\sqrt{R^2 + \left(L\omega - \frac{1}{\omega C}\right)^2}}$$

When an additional capacitance C' is joined in parallel with capacitor C, then it makes power factor of circuit unity

i.e., $\cos\phi = 1 \Rightarrow \dfrac{R}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega(C+C')}\right)^2}} = 1$

$$\Rightarrow \omega L = \frac{1}{\omega(C+C')} \quad \Rightarrow C + C' = \frac{1}{\omega^2 L}$$

$$\Rightarrow C' = \frac{1-\omega^2 LC}{\omega^2 L}$$

Therefore, option (d) is correct.

42) Ans: **A)** 262 Hz

Sol: Suppose n_A = Known frequency = 256Hz, n_B =?

x = 6 bps, which remains the same after loading.

Unknown tuning fork F_2 is loaded thus $n_B\downarrow$.

$\therefore n_A - n_B\downarrow = x$ ... (i) $\rightarrow$ Wrong

$n_B\downarrow - n_A = x$ ... (ii) $\rightarrow$ Correct

$\Rightarrow n_B = n_A + x = 256 + 6 = 262$ Hz.

43) Ans: **A)** 110 Hz

Sol: Let the frequency of the tuning fork be n Hz.

Then frequency of air column at $15^0C = n+4$

Frequency of air column at $10^0C = n+3$

According to $v = n\lambda$, we have

$v_{15} = (n+4)\lambda$ and $v_{10} = (n+3)\lambda$

$$\therefore \frac{v_{15}}{v_{10}} = \frac{n+4}{n+3}$$

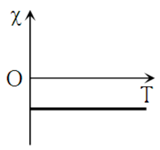
The speed of sound is directly proportional to the square root of the absolute temperature.

$$\therefore \frac{v_{15}}{v_{10}} = \sqrt{\frac{15+273}{10+273}} = \sqrt{\frac{288}{283}}$$

$$\Rightarrow \frac{n+4}{n+3} = \sqrt{\frac{288}{283}} = \left(1+\frac{5}{283}\right)^{1/2}$$

$$\Rightarrow 1 + \frac{1}{n+3} = 1 + 1/2 \times \frac{5}{283} = 1 + \frac{5}{566}$$

$$\Rightarrow \frac{1}{n+3} = \frac{5}{566} \Rightarrow n+3 = 113 \Rightarrow n = 110\text{Hz}$$



44) Ans: **C)**

Sol: χ is small, negative and independent of temperature for a diamagnetic substance.

45) Ans: **B)** 7%

Sol: We know that, $PV^\gamma = K$ or

$P\gamma V^{\gamma-1} dV + dP.V^\gamma = 0$

or $\dfrac{dP}{P} = -\gamma\dfrac{dV}{V}$ or $\dfrac{dP}{P}\times 100 = -\gamma\left(\dfrac{dV}{V}\times 100\right)$

$= -1.4 \times 5 = 7\%$

46) Ans: **C)** 1200 cal

Sol: Here for the mixture, $(C_P)_{mix} = \dfrac{\mu_1 C_{P_1} + \mu_2 C_{P_2}}{\mu_1 + \mu_2}$

$\left(C_{P_1}(He) = \dfrac{5}{2}R \text{ and } C_{P_2}(H_2) = \dfrac{7}{2}R\right)$

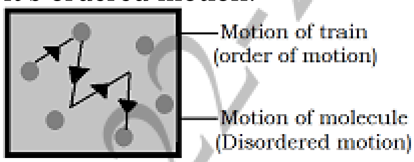
$$\Rightarrow = \frac{1\times\frac{5}{2}R + 1\times\frac{7}{2}R}{1+1} = 3R = 3\times 2 = 6 \text{ cal/mol}^\circ C$$

Thus, the amount of heat needed to raise the temperature from 0°C to 100°C is

$(\Delta Q)_P = \mu C_P \Delta T = 2\times 6\times 100 = 1200$ cal

47) Ans: **B)** will remain the same.

Sol: The temperature of the gas is concerned only with it's disordered motion. It is not concerned with it's ordered motion.



48) Ans: **B)** $T_1 = \dfrac{mg\cos\beta}{\sin(\alpha+\beta)}$, $T_2 = \dfrac{mg\cos\alpha}{\sin(\alpha+\beta)}$

Sol: Applying Lami's theorem, $\dfrac{T_1}{\sin(90^0+\beta)} = \dfrac{T_2}{\sin(90^0+\alpha)}$

$$= \frac{mg}{\sin\left[180^0 - (\alpha+\beta)\right]}$$

$$\text{or } \frac{T_1}{\cos\beta} = \frac{T_2}{\cos\alpha} = \frac{mg}{\sin(\alpha+\beta)}$$

$$\Rightarrow T_1 = \frac{mg\cos\beta}{\sin(\alpha+\beta)}; \quad T_2 = \frac{mg\cos\alpha}{\sin(\alpha+\beta)}$$

49) Ans: **A)** 6 m/s

Sol: K.E. of the rotating body $= \dfrac{1}{2}I\omega^2$

K.E. of the body having translational motion $\dfrac{1}{2}mv^2$

$$\therefore \frac{1}{2}I\omega^2 = \frac{1}{2}mv^2 \Rightarrow \frac{1}{2}\times 5\times 36 = \frac{1}{2}\times 5\times v^2$$

$$\therefore v^2 = 36 \qquad \Rightarrow v = 6 \text{ m/s}$$

50) Ans: **A)** reverse.

Sol: A huge current flows in reverse direction known as avalanche current at a particular reverse voltage in PN-junction.