Studentpad

MHT-CET-X1 PHYSICS(FULL PORTION) 2022-23

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

Hints and Solutions

01) Ans: **C)** $R^{\left(\frac{n+1}{2}\right)}$

Sol: We know that, $m\omega^2 R \propto \frac{1}{R^n}$

$$\Rightarrow m\left(\frac{4\pi^2}{T^2}\right)R \propto \frac{1}{R^n} \Rightarrow T^2 \propto R^{n+1} \qquad \therefore T \propto R^{\left(\frac{n+1}{2}\right)}$$

02) Ans: **D)** 198 years

Sol: Charge given out in one second=ne

$=10^9 \times 1.6 \times 10^{-19} = 1.6 \times 10^{-10}C$

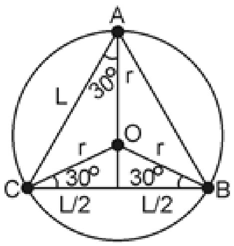
Time required to get a charge of $1.6 \times 10^{-10}C$ is 1 second.

$$\frac{1}{1.6 \times 10^{-10}} = 6.25 \times 10^9 S$$

$$= \frac{6.25 \times 10^9}{365 \times 24 \times 3600} = 198 \text{ years}$$

03) Ans: **A)** sky waves.

04) Ans: **B)** $\sqrt{\frac{GM}{L}}$



Sol:

$$\frac{L}{2} = r\cos 30^0 = \frac{\sqrt{3}}{2}.r \qquad \Rightarrow r = \frac{L}{\sqrt{3}}$$

The force of attraction on A is due to B and C,

$$F_A = 2\left[\frac{GM^2}{L^2}\right]\cos 30^0 = \left[\frac{GM^2}{L^2}\sqrt{3}\right]$$

$$\frac{Mv^2}{r} = \frac{GM^2}{L^2}.\sqrt{3} \text{ or } \frac{Mv^2\sqrt{3}}{L} = \frac{GM^2\sqrt{3}}{L^2}$$

$$\therefore v = \sqrt{\frac{GM}{L}}$$

05) Ans: **C)** $F_2 = 3F_1$

Sol: The force F_1 required to prevent the block from sliding down is

$F_1 = mg\sin\theta - \mu mg\cos\theta$ ....(i)

The force F_2 required to make the block move up the plane is

$F_2 = mg\sin\theta + \mu mg\cos\theta$ ....(ii)

Adding (i) and (ii), we get $F_2 + F_1 = 2\,mg\sin\theta$

Subtracting (i) from (ii), we get $F_2 - F_1 = 2\mu mg\cos\theta$

$$\Rightarrow \frac{F_2 + F_1}{F_2 - F_1} = \frac{2mg\sin\theta}{2\mu mg\cos\theta} = \frac{\tan\theta}{\mu} = \frac{\tan 30^0}{1/2\sqrt{3}} = 2$$

or $F_2 + F_1 = 2F_2 - 2F_1$ or $3F_1 = F_2$ or $F_2 = 3F_1$

06) Ans: **B)** a fraction of mm/s

Sol: In metals, the free electrons are the charge carriers under normal condition, their velocity is of the order of a fraction of mm/s.

Before applying a P.D. to a conductor [or before setting up an electric field in conductor] the average velocity of the electrons is zero.

But after applying the P.D., the electrons acquired a small drift velocity which is of the order of 10^{-3} m/s.

07) Ans: **B)** 0.72 J

Sol: Potential at centre of P,

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

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.

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

08) Ans: **C)** is greatest when it is closest to the earth.

09) Ans: **D)** 20 mm

Sol: $\lambda = ?\ v = 340\,m/s$

As maximum audible frequency = 20000 Hz

Therefore, the minimum audible wavelength

$$\lambda = \frac{v}{n} = \frac{340}{20000}m = \frac{340\times1000}{20000}mm$$

$$= 17mm \cong 20\,mm.$$

10) Ans: **B)** To get final image erect

11) Ans: **B)** $4.8\times10^4 N$

Sol: $F = \frac{q_1q_2}{4\pi\upsilon_0}\left[\frac{1}{r_1^2} + \frac{1}{r_2^2} + ...\right] = 9\times10^9\times4\times10^{-6}$

$$\left[\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{4^2} + ...\right] = 36\times10^3\left[\frac{1}{1-\frac{1}{4}}\right]$$

$= 36 \times 10^3 \times \frac{4}{3} = 4.8 \times 10^4$ N

12) Ans: **D)** $90^0, 0^0$

Sol: As angle of dip at a place is defined as the angle δ, which is the direction of total intensity of earth's magnetic field B makes with a horizontal line in magnetic meridian,

At poles $B = B_V$ and $B_V = B \sin\delta$

$\Rightarrow \sin\delta = 1 \Rightarrow \delta = 90^0$

At equator $B = B_H$ and $B_H = B\cos\delta$

$\therefore \cos\delta = 1 \Rightarrow \delta = 0^0$.

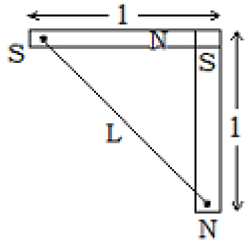
13) Ans: **C)** 4

Sol: If the number is less than 1, the zero's on the right of decimal point are significant but to the left of the first non-zero digit are not significant.

Thus 0.0006312 has 4 significant figures.

14) Ans: **D)** $\sqrt{2}$ ml

Sol: The resultant magnetic dipole moment will be



From fig, $M = mL$

$L^2 = l^2 + l^2$, $\therefore L = \sqrt{2l^2} = \sqrt{2}l \Rightarrow M = \sqrt{2}ml$

15) Ans: **D)** 0.0031^0C^{-1}

Sol: The coefficient of volume expansion of the gas at constant pressure,

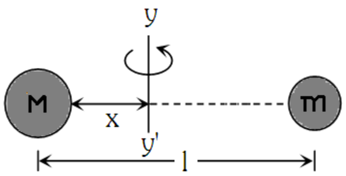
$$\gamma_P = \frac{V_2 - V_1}{V_1(T_2 - T_1)} = \frac{125 - 100}{100(100 - 20)} = \frac{25}{100 \times 80} = \frac{1}{320}$$

$\Rightarrow \gamma_P = 0.0031/°C$

16) Ans: **B)** $\frac{ml}{M + m}$

Sol: As mentioned, if the both masses are revolving about the axis yy' and tension in both the threads are equal then, $M\omega^2 x = m\omega^2(l - x)$

$\Rightarrow Mx = m(l - x) \Rightarrow x = \frac{ml}{M + m}$



17) Ans: **A)** $\tan^{-1}\left(\sqrt{3}/2\right)$

Sol: Let the actual angle of dip (in the magnetic meridian) be θ.

If B_H and B_V be the horizontal and vertical components of earth's magnetic field respectively, then $\tan\theta = (B_V / B_H)$

In the plane situated at 30^0 with the magnetic meridian, the horizontal component of earth's magnetic field will be $B_H \cos 30^0$ while the vertical component will be B_V.

The angle of dip in the plane is

$$\tan 45^0 = \frac{B_V}{B_H \cos 30^0}$$

$$\Rightarrow \frac{\tan\theta}{\tan 45^0} = \cos 30^0 \text{ or } \theta = \tan^{-1}\left(\sqrt{3}/2\right)$$

18) Ans: **A)** 5 N

Sol: Minimum force required to move the block $= \mu_s\, mg = 0.5 \times 2 \times 9.8 = 9.8$ N

As the force applied is only 5N, the block fails to move.

Therefore, frictional force = applied force = 5 N

19) Ans: **A)** $-\hat{j}$

Sol: $-\hat{j}$

20) Ans: **A)** 1.018×10^{-2}dyne

Sol: Here, $r = 0.3mm = 0.03cm$,

$v = 1ms^{-1} = 100\ cms^{-1}$, $\eta = 18 \times 10^{-5}$ poise

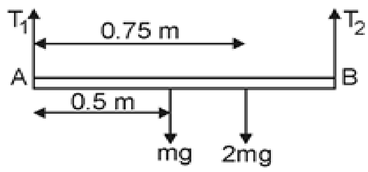
According to stoke's law, force of viscosity on an rain drop is

$F = 6\pi\eta rv = 6 \times 3.142 \times 18 \times 10^{-5} \times 0.03 \times 100$dyne

$= 1.081 \times 10^{-2}$dyne.

21) Ans: **B)** $m^2:n^2$

22) Ans: **D)** 1 : 2



Sol:

$T_1 + T_2 = 3\ mg$

Taking torques about A, we get

$0.5\ mg + 0.75 \times 2\ mg = 1 \times T_2 \quad \Rightarrow T_2 = 2\ mg$,

Similarly, taking torques about B, we get $T_1 = mg$

$\therefore \frac{T_1}{T_2} = \frac{1}{2}$

23) Ans: **D)** it is reverse biased

24) Ans: **B)** $R / \left(\frac{2gR}{V^2} - 1\right)$

Sol: Here,

$$\Delta K.E. = \Delta U \Rightarrow \frac{1}{2}MV^2 = GM_eM\left(\frac{1}{R} - \frac{1}{R + h}\right) \quad \ldots(i)$$

Also we have $g = \frac{GM_e}{R^2} \quad \ldots(ii)$

By solving equations (i) and (ii), we get,

$$h = \frac{R}{\left(\frac{2gR}{V^2} - 1\right)}$$

25) Ans: **B)** 12 cm
Sol: Here, n=500 Hz, v=360 m/s.
$\Delta x = ?\, \Delta x = ?\, \phi = 60^0$
$\therefore \lambda = \frac{v}{n} = \frac{360}{500} = \frac{18}{25} m$
$\therefore \Delta x = \frac{\lambda}{2\pi} \times \Delta\phi \quad = \frac{18}{25} \times \frac{60}{360^0} = \frac{3}{25} m = 12cm$

26) Ans: **D)** 60°
Sol: $i + e = A + \Delta \quad \therefore 55 + 45 = A + 40 \;\therefore A = 60°$

27) Ans: **D)** 17.2 m/s
Sol: The maximum velocity for a banked road with friction, $v^2 = gr\left(\frac{\mu + \tan\theta}{1 - \mu\tan\theta}\right)$
$\Rightarrow v^2 = 9.8 \times 100 \times \left(\frac{0.5 + 1}{1 - 0.5 \times 1}\right)$ (As $\mu = 0.5$)
$\Rightarrow v = 17.2\, m/s$

28) Ans: **C)** $7.2 \times 10^{10} N/m^2$
Sol: For longitudinal waves in a rod the velocity of sound is $v = \sqrt{\frac{Y}{\rho}}$ where Y is Young's modulus and ρ density.
Also for a clamped rod in the middle, the frequency of fundamental note is $n = \frac{v}{2\ell}$ Comparing we get
$2n\ell = \sqrt{\frac{Y}{\rho}}$ or $Y = 4n^2\ell^2\rho$
Substituting the data from question
$Y = 4 \times \left(10^3\right)^2 \times (1.5)^2 \times 8 \times 10^3$
$= 7.2 \times 10^{10}\, N/m^2$

29) Ans: **C)** 720 N and 480 N
Sol: Given, $m = 60$ kg, $g = 10\, m\, s^{-2}$, $a = 2\, m\, s^{-2}$
When the lift is accelerating upwards with constant acceleration a, the weight of the man is
$W' = m(g + a) = 60\,(10 + 2) = 720\, N$
When the lift is accelerating downwards with same acceleration a, the weight of the man is
$W'' = m(g - a) = 60\,(10 - 2) = 480\, N$

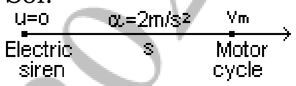
30) Ans: **A)** 6
Sol: $\vec{A} \cdot \vec{B} = A_xB_x + A_yB_y + A_zB_z$
$\vec{A} \cdot \vec{B} = 2a - 3a + 6 = -a + 6$
As $\vec{A}$ and $\vec{B}$ are perpendicular to each other
$\vec{A} \cdot \vec{B} = 0$
$\therefore -a + 6 = 0 \;\therefore a = 6$

31) Ans: **A)** $\frac{ev}{2\pi r}$
Sol: Here, $I = \frac{e}{t}$, $v = r\,\omega = r2\pi f$, $t = \frac{2\pi r}{v}$, $\therefore I = \frac{ev}{2\pi r}$

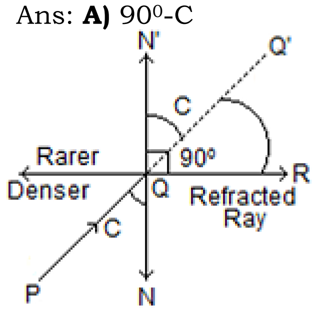
32) Ans: **C)** 15.43 m
Sol: Given, $u = 11\, m\, s^{-1}$, $\mu = 0.4$
Force of friction , $f = \mu mg$
Retardation due to friction = $\frac{f}{m} = \frac{\mu mg}{m}$
$= \mu g = 0.4 \times 9.8 = 3.92\, m\, s^{-2}$
Using $v^2 - u^2 = 2as$
$\Rightarrow (0)^2 - (11)^2 = 2(-3.92)s$ or $s = 15.43\, m$

33) Ans: **C)** modulator.

34) Ans: **D)** It is limited by the external circuit resistance

35) Ans: **B)** 98 m
Sol:


$v_m^2 - u^2 = 2as$
$\therefore v_m^2 = 2 \times 2 \times s \quad \therefore v_m = 2\sqrt{s}$
According to Doppler's effect
$v' = v\left[\frac{v - v_m}{v}\right] \quad \Rightarrow 0.94v = v\left[\frac{330 - 2\sqrt{s}}{330}\right]$
$\Rightarrow s = 98.01m$

36) Ans: **A)** 90^0-C


Sol:
From the figure we find that when i=C, $r = 90°$ and the refracted ray $\overrightarrow{QR}$ is parallel to the surface.
The incident ray $\overrightarrow{PQ}$ is deviated through an angle Q'QR in the rarer medium and for the critical angle, the deviation is maximum.
$\therefore Q'QR = \Delta = 90° - C \quad \therefore \Delta = 90° - C$

37) Ans: **C)** mass

38) Ans: **D)** $\frac{1}{\sqrt{3}}$ oersted
Sol: Here, vertical component of earth's magnetic field, $B_V = 0.5$ oersted,Angle of dip, $\delta = 60^0$
Earth's magnetic field , B =?

As $\sin\delta = \frac{B_V}{B}$

$$\Rightarrow B = \frac{B_V}{\sin\delta} = \frac{0.5}{\sin 60^0} = \frac{0.5}{\left(\frac{\sqrt{3}}{2}\right)} = \frac{1}{\sqrt{3}} \text{ oersted}$$

39) Ans: **A)** Charge

40) Ans: **B)** $\cos^{-1}\left(\frac{n^2-1}{n^2+1}\right)$

Sol: Let θ be an angle between vectors $\vec{A}$ and $\vec{B}$.

$\left|\vec{A}+\vec{B}\right| = n\left|\vec{A}-\vec{B}\right|$ (Given)

$\therefore \left|\vec{A}+\vec{B}\right|^2 = n^2\left|\vec{A}-\vec{B}\right|^2$

$A^2 + B^2 + 2\,AB\cos\theta = n^2\left[A^2 + B^2 - 2\,AB\cos\theta\right]$

$A^2 + A^2 + 2A^2\cos\theta = n^2\left[A^2 + A^2 - 2A^2\cos\theta\right]$

$\left[\because \left|\vec{A}\right| = \left|\vec{B}\right|\right]$

$2A^2 + 2A^2\cos\theta = n^2\left[2A^2 - 2A^2\cos\theta\right]$,

$\left(n^2+1\right)\cos\theta = \left(n^2-1\right)$

$\Rightarrow \cos\theta = \left(\frac{n^2-1}{n^2+1}\right)$ or $\theta = \cos^{-1}\left(\frac{n^2-1}{n^2+1}\right)$

41) Ans: **D)** 400 km

42) Ans: **B)** $40\,\Omega$

Sol: $\because R\ \alpha\ \frac{1}{A}$

$\therefore \frac{R_1}{R_2} = \frac{A_2}{A_1} = \frac{1}{3}$ [$\because \rho$ and L are the same]

If $R_1 = 10\,\Omega, R_2 30\,\Omega \Rightarrow R_s = 10+30 = 40\,\Omega$

43) Ans: **B)** $8\times10^5\ m/s^2$

Sol: We know, $a = \omega^2 r = 4\pi^2 n^2 r = 4\pi^2 \times 1^2 \times 20\times10^3$

$\therefore\ a = 8\times10^5\ m/s^2$

44) Ans: **D)** 9.45×10^{12}

Sol: One ly = distance covered by light in one year.

1 ly = velocity $\times$ time

= $3\times10^8\times365\times24\times60\times60$

= $3\times10^8\times365\times86400 = 3\times10^8\times3.15\times10^7$

= 9.45×10^{15} m = $9.45\times10^{15}\times10^{-3}$ km

= 9.45×10^{12} km

45) Ans: **D)** Conduction

Sol: In conduction, heat is transferred by molecular collisions. The molecules does not migrate.

46) Ans: **D)** all of these

47) Ans: **C)** reverse bias exceeds a certain value

48) Ans: **D)** -2 mv

Sol: Change in momentum

= Final momentum - Initial momentum

= - mv - mv = -2 mv

49) Ans: **B)** 100.15 cm

Sol: $\ell_2 - \ell_1 = \ell_1\alpha(t_2 - t_1) = 100\times2.5\times10^{-5}\times(80-20)$

$= 100\times2.5\times10^{-5}\times60 = 15000\times10^{-5} = 0.15$ cm

$\therefore \ell_2 = 100 + 0.15 = 100.15$ cm

50) Ans: **A)** Of the scattering of light