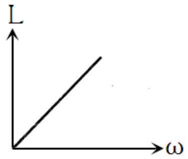
Studentpad

JEE-MAIN Physics 2022-23

Time : 120 Min	Phy : Full Portion Paper	Marks : 120

Hints and Solutions



01) Ans: **C)**

Sol: As we know, $L = I\omega$, $\therefore L \propto \omega$ (IF I = constant)
Therefore from above relation, graph between L and ω will be straight line with constant slope.

02) Ans: **C)** $15.6\,\Omega$

Sol: Given, $l_1 = l + \frac{25}{100} l = \frac{5l}{4}$. Since volume of wire remains unchanged on increasing length,
hence $Al = A_1 \times 5l \times 4$ or $A_1 = 4A/5$

Given, $R = 10 = \rho l / A$, and $R_1 = \frac{\rho l_1}{A_1} = \frac{\rho 5l/4}{4A/5}$

$= \frac{25}{16}\frac{\rho l}{A}$ or $R_1 = \frac{25}{16} \times 10 = \frac{250}{16} = 15.6\Omega$

03) Ans: **D)** 0.016 amp

Sol: Here, current $i = \frac{V}{\sqrt{R^2 + \omega^2 L^2}}$

$\Rightarrow i = \frac{120}{\sqrt{100 + 4\pi^2 \times 60^2 \times 20^2}} = 0.016$ A

04) Ans: **C)** $2(m_1 + m_2)gt_0$

Sol: Here, the momentum of the two-particle system, at t = 0 is $\vec{P}_i = m_1\vec{v}_1 + m_2\vec{v}_2$
Collision between the two does not affect the total momentum of the system.
A constant external force $(m_1 + m_2)g$ acts on the system.
The impulse given by this force, in time t = 0 to $t = 2t_0$ is $(m_1 + m_2)g \times 2t_0$
$\therefore$ Change in momentum in this interval
$= |m_1\vec{v}'_1 + m_2\vec{v}'_2 - (m_1\vec{v}_1 + m_2\vec{v}_2)| = 2(m_1 + m_2)gt_0$

05) Ans: **B)** Y-axis.

Sol: The electron reverses it's direction. It may be done by covering semi-circular path in x-z or x-y plane.

06) Ans: **B)** equal to T minutes

Sol: According to Newton's law of cooling

$\frac{\theta_1 - \theta_2}{t} \propto \left[\frac{\theta_1 + \theta_2}{2} - \theta\right]$

For the first condition

$\frac{62 - 61}{T} \propto \left[\frac{62 + 61}{2} - 30\right] \ldots(i)$

and for the second condition

$\frac{46 - 45.5}{t} \propto \left[\frac{46 + 45.5}{2} - 30\right] \ldots(ii)$

By solving Eqs. (i) and (ii), we get t = T minutes.

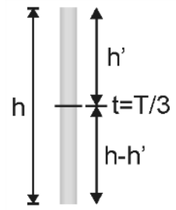
07) Ans: **D)** $4\pi T(nr^2 - R^2)$

Sol: Energy needed = Increment in surface energy = (surface energy of n small drops) - (surface energy of one big drop)
$= n\,4\pi r^2 T - 4\pi R^2 T \Rightarrow = 4\pi T(nr^2 - R^2)$

08) Ans: **A)** (8h)/9 metre from the ground

Sol: $h = ut + \frac{1}{2}gt^2 \Rightarrow h = \frac{1}{2}gT^2$

After $\frac{T}{3}$ seconds, the position of ball from top,



$h' = 0 + \frac{1}{2}g(\frac{T}{3})^2 = \frac{1}{2} \times \frac{g}{9} \times T^2 = \frac{h}{9}$

Therefore, position of ball from ground

$= h - \frac{h}{9} = \frac{8h}{9}$ m

09) Ans: **B)** (3.45 ± 0.3) m/s

Sol: Here, $S = (13.8 \pm 0.2)$ m
and $t = (4.0 \pm 0.3)$ s
Showing it in percentage error, we have,

$S = 13.8 \pm \frac{0.2}{13.8} \times 100\% = 13.8 \pm 1.4\%$

and $t = 4.0 \pm \frac{0.3}{4} \times 100\% = 4 \pm 7.5\%$

$\therefore V = \frac{s}{t} = \frac{13.8 \pm 1.4}{4 \pm 7.5} = (3.45 \pm 0.3)$ m/s

10) Ans: **B)** $2.4\,\pi \times 10^{-4}$H

Sol: $M = \mu_0 n_1 n_2 \pi r_1^2 l.$

From $\phi_2 = \pi r_1^2(\mu_0 ni)n_{2l}$

$\Rightarrow A = \pi r_1^2 = 10\text{ cm}^2, l = 20\text{ cm}, \Rightarrow N_1 = 300, N_2 = 400$

$M = \frac{\mu_0 N_1 N_2 A}{l} = \frac{4\pi \times 10^{-7} \times 300 \times 400 \times 10 \times 10^{-4}}{0.20}$

$= 2.4\,\pi \times 10^{-4}$H

11) Ans: **B)** 0.05 N

Sol: Force, $F = \frac{CV^2}{2d} = \frac{Q \times E}{2} = \frac{10^{-6} \times 10^5}{2} = 0.05\,N$

12) Ans: **C)** 5 cm

Sol: Here, Lateral displacement of fringes

$= \frac{\beta}{\lambda}(\mu - 1)\,t \quad = \frac{1 \times 10^{-3}}{600 \times 10^{-9}}(1.5 - 1) \times 0.06 \times 10^{-3}$

$= \frac{1}{20}\,m \quad = 5\,cm.$

13) Ans: **C)** $\frac{mv^2}{r} \le \mu mg$

Sol: The value of frictional force should be equal or more than required centripetal force.

$\therefore \quad \mu mg \ge \frac{mv^2}{r}$

14) Ans: **B)** 417 N

Sol: Here, given that,

$u = 100\ m/s,\ v = 0,\ s = 0.06\ m$

$\text{Retardation} = a = \frac{u^2}{2s} = \frac{(100)^2}{2 \times 0.06} = \frac{1 \times 10^6}{12}$

$\text{Thus, Force} = ma = \frac{5 \times 10^{-3} \times 1 \times 10^6}{12} = \frac{5000}{12} = 417\ N$

15) Ans: **A)** $7.1 \times 10^{-4}\ m^2$

Sol: Young's modulus, $Y = \frac{F/A}{strain} \Rightarrow A = \frac{F}{Y \times strain}$

$\Rightarrow \quad = \frac{10^4}{7 \times 10^9 \times 0.002} = \frac{1}{14} \times 10^{-2} \quad = 7.1 \times 10^{-4} m^2$

16) Ans: **B)** 150 W

Sol: Here, $P_c = P_t\left[\frac{2}{2 + m^2}\right] = 900\left[\frac{2}{2+1}\right] = 600\,W$

Now, $P_{LSB} = \frac{m^2}{4} \times P_c = \frac{1}{4} \times 600 = 150\ W$

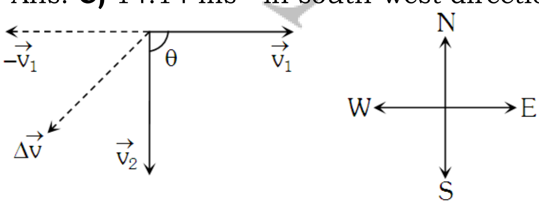
17) Ans: **C)** 127°C

Sol: Since, $P \propto T$,

$\therefore \frac{P_1}{P_2} = \frac{T_1}{T_2} \Rightarrow \frac{P}{P + \frac{0.5}{100}P} = \frac{T}{T+2} \Rightarrow \frac{200}{201} = \frac{T}{T+2}$

$\Rightarrow T = 400\ K = 127°C$

18) Ans: **C)** 14.14 ms^{-1} in south-west direction.



Sol:

The magnitude of vector remains the same, only direction changes by θ therefore

$\overrightarrow{\Delta\upsilon} = \overrightarrow{\upsilon_2} - \overrightarrow{\upsilon_1},\ \overrightarrow{\Delta\upsilon} = \overrightarrow{\upsilon_2} + \overrightarrow{(-\upsilon_1)}$. Magnitude of change in vector $|\overrightarrow{\Delta\upsilon}| = 2\upsilon \sin(\frac{\theta}{2})$

$|\overrightarrow{\Delta\upsilon}| = 2 \times 10 \times \sin(\frac{90^\circ}{2}) = 10\sqrt{2} = 14.14\ m/s$ and

Direction is south-west as shown in figure.

19) Ans: **B)** $v = \frac{c}{\sqrt{\mu_r K}}$

Sol: Speed of light of vacuum is given by

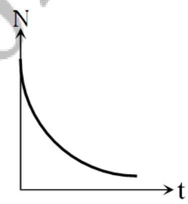
$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ and that of in another medium is

$v = \frac{1}{\sqrt{\mu\varepsilon}}$.

$\therefore \frac{c}{v} = \sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}} = \sqrt{\mu_r K} \qquad \Rightarrow v = \frac{c}{\sqrt{\mu_r K}}$

20) Ans: **A)** 4/3

Sol: If two liquid of equal masses with different densities are mixed together, then density of mixture is given by $\rho = \frac{2\rho_1\rho_2}{\rho_1 + \rho_2} = \frac{2 \times 1 \times 2}{1+2} = \frac{4}{3}$

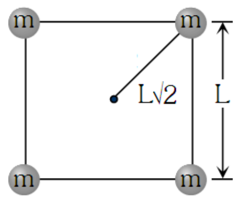


21) Ans: **C)**

Sol: Using, $N = N_0 e^{-\lambda t}$ and $\frac{dN}{dt} = -\lambda N$.

It gives that N decreases exponentially with time.

22) Ans: **B)** $-\sqrt{32}\frac{GM}{L}$



Sol:

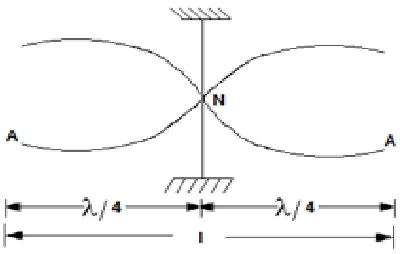
Potential at the centre because of single mass

$= \frac{-GM}{L/\sqrt{2}}$

$\therefore$ Potential at the centre because of all four masses $= -4\frac{GM}{L/\sqrt{2}} \; -4\sqrt{2}\frac{GM}{L} = -\sqrt{32} \times \frac{GM}{L}$.

23) Ans: **A)** 5 km/s

Sol: In fundamental mode, $1 = 2\left(\frac{\lambda}{4}\right) = \frac{\lambda}{2}$



$\Rightarrow \lambda = 2l$

Given $l = 100$ cm, $v = 2.53$ kHz Using. $V = V\lambda$

$\Rightarrow v = 2.53 \times 10^3 \times 2 \times 100 \times 10^{-2} = 5.06 \times 10^3$ m/s

$= 5.06$ km/s

24) Ans: **B)** $U = -\dfrac{KX^2}{2}$

Sol: Force, $F = -kx \Rightarrow dW = Fdx = -kxdx$

$$\Rightarrow \int_0^W dW = \int_0^x -kx\,dx \Rightarrow W = U = -\frac{1}{2}kx^2$$

25) Ans: **A)** $9 \times 10^{13}/s$

Sol: Here, $\dfrac{n}{t} = \dfrac{IA\lambda}{hc}$

$$\Rightarrow \frac{n}{t} = \frac{150 \times 10^{-3} \times 4 \times 10^{-4} \times 3 \times 10^{-7}}{6.6 \times 10^{-34} \times 3 \times 10^{8}} = 9 \times 10^{13}\frac{1}{s}$$

26) Ans: **B)** $\dfrac{1}{L-1}$

Sol: Here, coefficient of friction between the table and the chain is given as

$$\mu = \frac{\text{Length of chain hanging from the table}}{\text{Length of chain lying on the table}} = \frac{1}{L-1}$$

27) Ans: **D)** 40 J

Sol: From given problem, $\Delta Q = \Delta U + \Delta W$

$\Rightarrow \Delta U = \Delta Q - \Delta W = 150 - 110 = 40$ J

28) Ans: **A)** 2×10^{-3} mho

Sol: Since, $\mu = r_p \times g_m$

$\therefore g_m = \dfrac{20}{10 \times 10^3} = 2 \times 10^{-3}$ mho

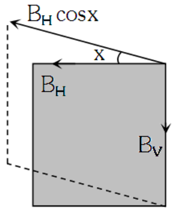
29) Ans: **C)** $\dfrac{1}{\cos x}$

Sol: In first case, $\tan\theta = \dfrac{B_V}{B_H}$ ..... (i)

and in second case, $\tan\theta' = \dfrac{B_V}{B_H \cos x}$ ..... (ii)

From equations (i) and (ii),

$$\frac{\tan\theta'}{\tan\theta} = \frac{1}{\cos x}$$



30) Ans: **B)** less than 41°.

Sol: From the hypothesis, we know that

$i_1 + i_2 = A + \delta \Rightarrow 55^\circ + 46^\circ = 60^\circ + \delta \quad \Rightarrow \delta = 41^\circ$

But $\delta_m < \delta$, therefore $\delta_m < 41^\circ$.