SAMPLE HINTS AND SOLUTIONS

INSTITUTE NAME & LOGO

JEE-MAIN EXAM YEAR		
Time : 60 Min	**Phy : Full Portion Paper**	**Marks : 100**
Hints and Solutions		

01) Ans: **3)** 1 : 8
Sol: From the Young's modulus,

$$l = \frac{FL}{AY} \Rightarrow l \propto \frac{L}{d^2} \Rightarrow \frac{l_1}{l_2} = \frac{L_1}{L_2} \times \left(\frac{d_2}{d_1}\right)^2$$

$$\therefore = \frac{1}{2} \times \left(\frac{1}{2}\right)^2 = \frac{1}{8}$$

02) Ans: **2)** 8 TL
Sol: Here, Force on each side $= 2\,TL$. It is because of two surfaces are there.
$\therefore$ Force on the frame $= 4\,(2\,TL) = 8\,TL$

03) Ans: **2)** - 249.7°C
Sol: Speed of sound in gases is

$$v = \sqrt{\frac{\gamma RT}{M}},$$

$\therefore T \propto M$ (As v, γ - constant).

$$\therefore \frac{T_{H_2}}{T_{O_2}} = \frac{M_{H_2}}{M_{O_2}} \Rightarrow \frac{T_{H_2}}{(273+100)} = \frac{2}{32}$$

$$\Rightarrow T_{H_2} = 23.2\,K = -249.7^{\circ}C$$

04) Ans: **3)** 0.8 mA

Sol: We know, $i = \frac{Q}{T} = Qv$

$$\Rightarrow i = 1.6 \times 10^{-19} \times 5 \times 10^{15} = 0.8\text{ mA}$$

05) Ans: **1)** 4/3
Sol: If two liquid of equal masses with different densities are mixed together, then density of mixture is given by

$$\rho = \frac{2\rho_1\rho_2}{\rho_1+\rho_2} = \frac{2 \times 1 \times 2}{1+2} = \frac{4}{3}$$

06) Ans: **4)** $\frac{5}{6}$ J

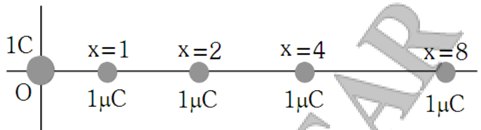
Sol: Work done,

$$W = Fs = F \times \frac{1}{2}at^2 \quad \left[\text{from } s = ut + \frac{1}{2}at^2\right]$$

$$\Rightarrow W = F\left[\frac{1}{2}\left(\frac{F}{m}\right)t^2\right]$$

$$= \frac{F^2t^2}{2m} = \frac{25 \times (1)^2}{2 \times 15} = \frac{25}{30} = \frac{5}{6}\text{ J}$$

07) Ans: **3)** 12000 N
Sol: The schematic diagram of distribution of charges on x-axis is shown in the following figure.



Total force acting on 1 C charge is given by

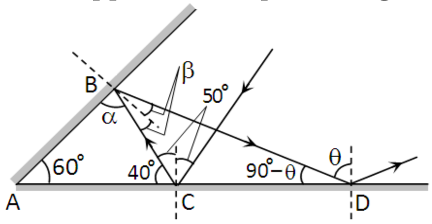
$$F = \frac{1}{4\pi\varepsilon_0}\left[\frac{1 \times 1 \times 10^{-6}}{(1)^2} + \frac{1 \times 1 \times 10^{-6}}{(2)^2} + \frac{1 \times 1 \times 10^{-6}}{(4)^2} + \frac{1 \times 1 \times 10^{-6}}{(8)^2} + \ldots\infty\right]$$

$$\Rightarrow F = \frac{10^{-6}}{4\pi\varepsilon_0}\left(\frac{1}{1} + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \ldots\infty\right)$$

$$= 9 \times 10^9 \times 10^{-6}\left(\frac{1}{1 - \frac{1}{4}}\right)$$

$$\Rightarrow F = 9 \times 10^9 \times 10^{-6} \times \frac{4}{3} \Rightarrow F = 9 \times 10^3 \times \frac{4}{3} = 12000\text{ N}$$

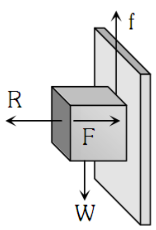
08) Ans: **2)** 70°
Sol: Suppose the required angle be θ.



From the geometry of figure,
In ΔABC, α = 180° - (60° + 40°) = 80°
$\Rightarrow \beta$ = 90° - 80° = 10°
In ΔABD, $\angle A$ = 60°, $\angle B = (\alpha + 2\beta)$
$\Rightarrow \angle B$ = (80 + 2 × 10) = 100° and $\angle D$ = (90° - θ)
As $\angle A + \angle B + \angle D$ = 180°
$\Rightarrow$ 60° + 100° + (90° - θ) = 180° $\Rightarrow \theta$ = 70°

09) Ans: **2)** greater than W.
Sol: In this problem, applied horizontal force F acts as normal reaction.
For holding the block
Force of friction = Weight of block

$$f = W \Rightarrow \mu R = W \Rightarrow \mu F = W \Rightarrow F = \frac{W}{\mu}$$



As $\mu < 1 \therefore F > W$

10) Ans: **4)** 654 Joule
Sol: As $J\Delta Q = \Delta U + \Delta W, \quad \therefore \Delta U = J\Delta Q - \Delta W$

$\Rightarrow \Delta U = 4.18 \times 300 - 600 = 654$ Joule

11) Ans: **3)** 0.4 A
Sol: Magnetic field at the center of circular loop is given by

$B = \frac{\mu_0}{4\pi}\frac{2\pi i}{r} \Rightarrow 0.5 \times 10^{-5} = \frac{10^{-7} 2 \times 3.14 \times i}{5 \times 10^{-2}}$

$\Rightarrow i = 0.4$ A

12) Ans: **2)** current leads the voltage by 60^o.
Sol: Phase difference, $\Delta\phi = \phi_2 - \phi_1$

$\Rightarrow \Delta\phi = \frac{\pi}{6} - \left(\frac{-\pi}{6}\right) = \frac{\pi}{3}$

13) Ans: **1)** G shows deflection to the left and right but the amplitude steadily decreases.

14) Ans: **2)** 112° C
Sol: Given that, Initial volume $V_1 = 47.5$ units
Final volume of $V_2 = 67$ units
and Temperature of ice cold water $T_1 = 0^\circ C = 273\,K$

By Charl's law, we have $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (where temperature T_2 is the boiling point)

or $T_2 = \frac{V_2}{V_1} \times T_1 = \frac{67 \times 273}{47.5} = 385\,K = 112^\circ C$

15) Ans: **3)** 12 cm/s
Sol: Here, acceleration, $A = \omega^2 y$

$\Rightarrow \omega = \sqrt{A/y} = \sqrt{\frac{8}{2}} = 2\,rad/s$

Now $v_{max} = a\omega = 6 \times 2 = 12\,cm/s$

16) Ans: **2)** R^4
Sol: Here, $F = \frac{G \times m \times m}{(2R)^2}$

$\Rightarrow = \frac{G \times \left(\frac{4}{3}\pi R^3 \rho\right)^2}{4R^2} = \frac{4}{9}\pi^2\rho^2 R^4 \quad \therefore \quad F \propto R^4$

17) Ans: **3)** 6×10^{-8} T
Sol: By using, $c = \frac{E}{B} \Rightarrow B = \frac{E}{c}$

$= \frac{18}{3 \times 10^8} = 6 \times 10^{-8} T$

18) Ans: **2)** $5\hat{i} + \frac{25}{7}\hat{j}$
Sol: Here, velocity of centre of mass,

$\vec{v}_{cm} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2} = \frac{200 \times 10\hat{i} + 500 \times (3\hat{i} + 5\hat{j})}{200 + 500}$

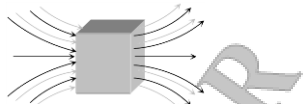
$\Rightarrow \vec{v}_{cm} = 5\hat{i} + \frac{25}{7}\hat{j}$

19) Ans: **1)** 1.0 g
Sol: We have, $PV = mrT$.

As P, V, r $\Rightarrow$ remains same. $\therefore m \propto \frac{1}{T}$

$\Rightarrow \frac{m_1}{m_2} = \frac{T_2}{T_1} \Rightarrow \frac{13}{m_2} = \frac{(273+52)}{(273+27)} = \frac{325}{300}$

$\Rightarrow m_2 = 12$ gm
It means mass released = 13 gm - 12 gm = 1 gm.



20) Ans: **3)**
Sol: Permeability of soft iron is maximum, therefore maximum lines of force tries to pass through the soft iron.

21) Ans: **6.5** Sol: $F = 3t^2 - 32 \Rightarrow m\frac{d^2x}{dt^2} = 3t^2 - 32$

$\Rightarrow \frac{d^2x}{dt^2} = \frac{3t^2 - 32}{10} \Rightarrow \frac{dV}{dt} = \frac{3t^2 - 32}{10}$

$\Rightarrow dV = \left(\frac{3t^2 - 32}{10}\right)dt$

By integrating between the given limits

$\int_{10}^{v} dV = \int_0^5 \left(\frac{3t^2 - 32}{10}\right)dt \quad \Rightarrow (V - 10) = \frac{1}{10}\left\{\frac{3t^2}{3} - 32t\right\}_0^5$

$= \frac{1}{10}\left[\frac{3(125)}{3} - (32 \times 5)\right] = \frac{1}{10}[125 - 160] = -3.5$

$\Rightarrow V = 10 - 3.5 = 6.5\,ms^{-1}$.

22) Ans: **500** Sol: 500

23) Ans: **5** Sol: Let $\vec{A} + \vec{B} = \vec{R}$.
Here $A_x = 7$ and $A_y = 6$
Also $R_x = 11$ and $R_y = 9$.
So, $B_x = R_x - A_x = 11 - 7 = 4$
and $B_y = R_y - A_y = 9 - 6 = 3$

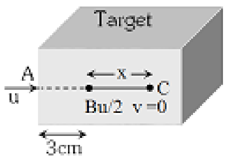
Therefore, $B = \sqrt{B_x^2 + B_y^2} = \sqrt{4^4 + 3^2} = 5$

24) Ans: **1.00** Sol: Assume, initial velocity of the bullet = u

After penetrating 3 cm its velocity becomes $\frac{u}{2}$

We know, $v^2 = u^2 - 2as$

$\Rightarrow (\frac{u}{2})^2 = u^2 - 2a(3) \quad \Rightarrow 6a = \frac{3u^2}{4} \Rightarrow a = \frac{u^2}{8}$

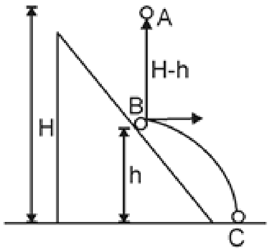


Let, further it will penetrate through distance x and stops at point C.
For distance BC, v = 0, u = u/2, s = x, a = $u^2/8$

Form $v^2 = u^2 - 2as \Rightarrow 0 = (\frac{u}{2})^2 - 2(\frac{u^2}{8}).x \Rightarrow x = 1\,cm$

25) Ans: **0.5** Sol: Consifer t_1 is the time from A to B and t_2 the time from B to C.

Then, $t_1 = \sqrt{\frac{2(H-h)}{g}}$ and $t_2 = \sqrt{\frac{2h}{g}}$



Then, the total time $t = t_1 + t_2 = \sqrt{\frac{2}{g}}\left[\sqrt{H-h} + \sqrt{h}\right]$

For t to be maximum $\frac{dt}{dh} = 0$ or

$\sqrt{\frac{2}{g}}\left[\frac{-1}{2\sqrt{H-h}} + \frac{1}{2\sqrt{h}}\right] = 0$ or $\frac{1}{\sqrt{h}} = \frac{1}{\sqrt{H-h}}$ or $2h = H$

$\Rightarrow \frac{h}{H} = \frac{1}{2}$