ECET - PHYSICS solutions

CIVIL - 2024

51) → $N\,kg^{-1}$ is the unit of ——— [2]

$N\,kg^{-1} \longrightarrow kg \times \frac{m}{sec^2} \times \frac{1}{kg} \longrightarrow \frac{m}{sec^2}$ → 'a' → acceleration

52) → $F \propto d^x v^y A^z$

Take dimensions → $[M^1L^1T^{-2}] = [M^1L^{-3}]^x \times [L^1T^{-1}]^y \times [L^2]^z$ &

$[M^1L^1T^{-2}] = [M^xL^{-3x}] \times [L^yT^{-y}] \times L^{2z}$

$[M^1L^1T^{-2}] = [M^x L^{-3x+y+2z} T^{-y}]$

$-2 = -y \Rightarrow \underline{y=2}$

$\Rightarrow \underline{x=1}$, $-3x+y+2z=1$

$-3(1)+2+2z=1$

$2z=2 \Rightarrow \underline{z=1}$ [1]

$\therefore$ Force $F \propto d^1 v^2 A^1$ [3]

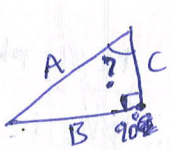
53) → $A=5, B=4, C=3$

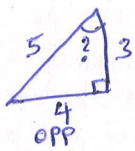
$|A| = |B+C|$

$A^2 = B^2 + C^2 + 2BC\cos\theta$

$25 = 16 + 9 + 24\cos\theta$

$\cos\theta = 0 \longrightarrow \theta = 90^\circ$





$\Rightarrow$ Angle $\cos\alpha = \frac{3}{5}$

$\alpha = \cos^{-1}(3/5)$ [4]

54) → $\hat{A} + \hat{B} = \hat{C}$

$\hat{A} - \hat{B} = ?$

$|A| = |B| = |C| = 1$

$|\hat{A} + \hat{B}| = |\hat{C}|$

$\sqrt{A^2+B^2+2AB\cos\theta} = C$

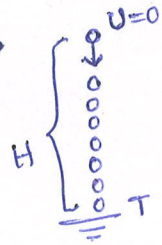
$\sqrt{1+1+2\cos\theta} = 1 \Rightarrow 2+2\cos\theta = 1$

$\Rightarrow \cos\theta = -\frac{1}{2} \longrightarrow \theta = 120^\circ$

Now $|\hat{A} - \hat{B}| = \sqrt{A^2+B^2-2AB\cos\theta}$

$= \sqrt{1+1-2(1)(1)(-\frac{1}{2})} = \sqrt{2+1} = \sqrt{3}$ [1]

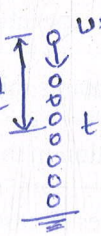
57) →



$S = ut + \frac{1}{2}gt^2$

$H = 0(t) + \frac{1}{2}gT^2$

$H = \frac{1}{2}gT^2$



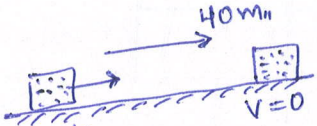
$\frac{H}{2} = 0(t) + \frac{1}{2}gt^2$

$H = gt^2$

$\frac{1}{2}gT^2 = gt^2$

$\therefore t^2 = \frac{T^2}{2} \Rightarrow \underline{t = \frac{T}{\sqrt{2}} = 70\%\,T}$ [1]

58) →



$v^2 - u^2 = 2(-a)s$

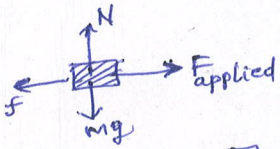
$0 - 8^2 = -2a \times 40$

$a = \frac{64}{80} = \frac{8}{10} = 0.8$

$\mu = \frac{f}{N}$ Horizontal surface

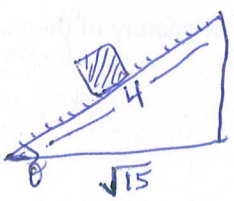
$= \frac{F}{mg} = \frac{ma}{mg}$

$\mu = \frac{a}{g} = \frac{0.8}{10} = 0.08$



[3]

59) →

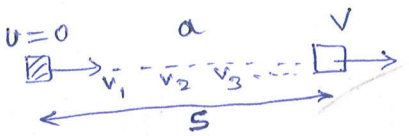


$4^2 = Adj^2 + 1^2$

$Adj^2 = \sqrt{15}$

$\therefore \theta = \tan^{-1}(\mu)$

$\mu = \tan\theta = \frac{1}{\sqrt{15}}$ [4]

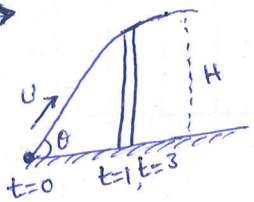
55) → 

$v^2 - u^2 = 2as$

$v^2 - 0 = 2as \longrightarrow v = \sqrt{2as}$ [1]

Average velocity $= \frac{u+v}{2} = \frac{0+\sqrt{2as}}{2} = \sqrt{\frac{as}{2}}$

56) → [2]



$y = (u\sin\theta)t - \frac{1}{2}gt^2$

$t=1 \rightarrow y = u\sin\theta - \frac{g}{2}$

$t=3 \rightarrow y = 3u\sin\theta - \frac{9}{2}g$

both heights are equal

$u\sin\theta - \frac{g}{2} = 3u\sin\theta - \frac{9}{2}g$

$2u\sin\theta = \frac{8}{2}g$

$u\sin\theta = 2g = 2\times10 = 20$

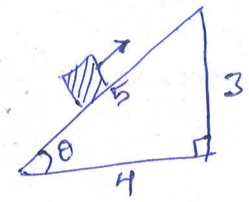
Max height $H = \frac{u^2\sin^2\theta}{2g}$

$\therefore H = \frac{(20)^2}{2\times10}$

$= \frac{400}{20}$

$H = 20$ metre.

60) → [3]



weight $mg = 10$ N

$\sin\theta = \frac{3}{5}$

$\cos\theta = \frac{4}{5}$

$\mu = 0.6$

$F = ?$

$F = ma$

$= mg[\sin\theta + \mu\cos\theta]$

$= 10\left[\frac{3}{5} + 0.6\times\frac{4}{5}\right]$

$F = \frac{10}{5}[3 + 2.4] = 2\times5.4 = 10.8$ N

61) → [2]

$m = 7200$ kg

$h = 100$ m

$g = 10\ ms^{-2}$

Power = 50% gain

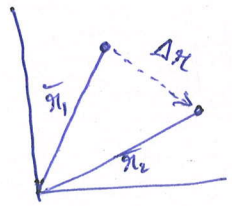
$t = 1$ hour $= 3600$ sec

$P = \frac{W}{t} = \frac{P.E}{t} = \frac{mgh}{t}$

$50\%\ P = \frac{7200\times10\times100}{3600} \Rightarrow P = \frac{2\times1000\times100}{50}$

$P = 4000$ watt $= 4$ KW.

62) → [2]



$\Delta r = r_1$ to r_2

$= \bar{r}_2 - \bar{r}_1$

$= (\hat{i} - \hat{j} + 2\hat{k}) - (\hat{i} + \hat{j} + \hat{k})$

$\Delta r = 0\hat{i} - 2\hat{j} + \hat{k}$

Force $\bar{F} = \hat{i} + 2\hat{j} + 3\hat{k}$

Work $W = \bar{F}\cdot\Delta\bar{r} = \bar{F}\cdot\bar{S}$

$W = (1,2,3)\cdot(0,-2,1)$

$W = (1\times0) + (2\times-2) + (3\times1)$

$= 0 - 4 + 3$

$W = -1$ Joule

63) → $K.E = \frac{1}{2}mv^2$, mass m = constant

$\therefore K.E \propto v^2 \longrightarrow \frac{K.E_1}{K.E_2} = \left(\frac{V_1}{V_2}\right)^2 \Rightarrow \frac{30}{K.E_2} = \left(\frac{10}{30}\right)^2 = \frac{1}{9}$ [4]

$\Rightarrow K.E_2 = 30\times9 = 270$ J

64) → $V = r\omega = 1 \longrightarrow r = \frac{1}{\omega}$ [1]

$a = r\omega^2 = 1.57 \longrightarrow \frac{1}{\omega}\cdot\omega^2 = 1.57 \rightarrow \omega = 1.57$

$T = ?$

$\frac{2\pi}{T} = 1.57$

$T = \frac{2\pi}{1.57} = \frac{6.28}{1.57} = 4$ sec.

ber via OTP ----

																	REMARKS

(3)

66) → $m_1 = 200$ gm.
$T_1' = 1$ sec.
$T_2 = 0.5$ sec
$m_2 = ?$

$T = 2\pi\sqrt{\frac{l}{g}} \rightarrow T = 2\pi\sqrt{\frac{ml}{mg}}$

$T \propto \sqrt{m} \rightarrow \frac{T_1}{T_2} = \sqrt{\frac{m_1}{m_2}} \rightarrow \frac{1}{0.5} = \sqrt{\frac{200}{m_2}}$

$\rightarrow 4 = \frac{200}{m_2}$

$\rightarrow m_2 = 50$ gm.

∴ The Reduced mass to be $200 - 50 \rightarrow 150$ gm. [3]

67) → ~~$x_1 = A \sin(320\pi t)$~~
~~$x_2 = A \sin(326\pi t)$~~ [3]

68) → $x_1 = A \sin(320\pi t) \rightarrow \omega_1 = 320\pi \rightarrow n_1 = 160$ Hz
$x_2 = A \sin(326\pi t) \rightarrow \omega_2 = 326\pi \rightarrow n_2 = 163$ Hz. [4]

Beat frequency $\Delta n = |n_1 \sim n_2| = |163 - 160| = 3$ Hz. [4]

69) → Boyle's law $P \propto \frac{1}{V}$, T = constant. [4]

70) → $PV = nRT$, $n = \frac{m}{M}$ moles.

$m \rightarrow$ mass
$M \rightarrow$ molecular weight
5 gm $O_2' \rightarrow m = 5$, $M = 2 \times 16 = 32 \Rightarrow PV = \frac{5}{32} RT$. [3]

71) → Work $W = F \times l$
$= \frac{F}{A} \times l \times A$
$W = P \times V \rightarrow 10^3 \times 0.25 \rightarrow 250$ Joule.

73) → 1st Law of TD → $dq = du + dw$ [4]

heat energy = Internal energy + external workdone

→ Law of conservation of energy.

74) → $i_c = 30^\circ$ $\quad i_c = \sin^{-1}\left(\frac{1}{\mu}\right)$ [2]

$30^\circ = \sin^{-1}\left(\frac{1}{\mu}\right)$

$\frac{1}{\mu} = \sin 30^\circ = \frac{1}{2} \Rightarrow \mu = 2$ $\quad \mu = \frac{c}{v}$

$2 = \frac{3\times10^8}{v}$

$v = 1.5\times10^8 \text{ ms}^{-1}$

75) → $h\nu = h\nu_0 + W$ [1]

$1 eV = 1.6\times10^{-19}$ Joule.

$\frac{hc}{\lambda} = V_0 + 1.24 eV$ (Joule)

$\frac{6.624\times10^{-34}\times3\times10^8}{4.36\times10^{-7}} = V_0 + 1.24$

$\frac{19.872\times10^{-26}}{4.36\times10^{-7}} = V_0 + 1.24$

4.5577×10^{-19} Joule $= V_0 + 1.24$

$\frac{4.5577\times10^{-19}}{1.6\times10^{-19}} eV = V_0 + 1.24 \Rightarrow 2.84 eV = V_0 + 1.24 eV$

$\Rightarrow V_0 = 2.84 - 1.24$

$\Rightarrow V_0 = 1.6 eV.$