ECET- EEE -2024 – solutions

51) → $N\,kg^{-1} \longrightarrow kg \times \frac{m}{sec^2} \times \frac{1}{kg} \longrightarrow \frac{m}{s^2}$ → acceleration [2]

52) → Force $F \propto D^x V^y A^z$

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

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

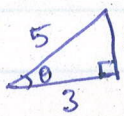
$x=1$, $-3x+y+2z=1$, $-2=-y \Rightarrow y=2$.

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

$2z=2 \rightarrow z=1$. $\Rightarrow F = D^1 V^2 A^1$ [1]

53) → $A=5, B=4, C=3$

$\bar{A} = \bar{B} + \bar{C}$ → clearly it is → Right angle triangle. [3]



$\cos\theta = \frac{3}{5} \rightarrow \theta = \cos^{-1}\left(\frac{3}{5}\right)$ [4]

54) → $\hat{A} + \hat{B} = \hat{C} \longrightarrow |\hat{A}+\hat{B}| = |\hat{C}|$

$|\hat{A}| = |\hat{B}| = |\hat{C}| = 1$

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

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

$1+1+2(1)(1)\cos\theta = 1$

$2+2\cos\theta = 1 \rightarrow \cos\theta = -\frac{1}{2} \rightarrow \theta = 120^\circ$

$\therefore |\hat{A}-\hat{B}| = \sqrt{A^2+B^2-2AB\cos\theta} = \sqrt{1+1-2(1)(1)\left(-\frac{1}{2}\right)}$

$= \sqrt{1+1+1} = \sqrt{3}$ //.

55) → U=0, a, V, s

average velocity $= \frac{V+U}{2} = \frac{V}{2}$

$= \frac{\sqrt{2as}}{2}$

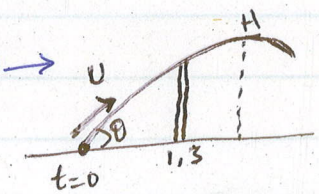
$V_{ave} = \sqrt{\frac{as}{2}}$

$\because V^2-U^2 = 2as$

$V^2-0 = 2as$

$V = \sqrt{2as}$ [1]

56) → [2]



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

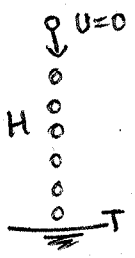
$t=1 \rightarrow y = U\sin\theta - \frac{g}{2}$

$t=3 \rightarrow y = 3U\sin\theta - \frac{9}{2}g$ } equal heights.

$U\sin\theta - \frac{g}{2} = 3U\sin\theta - \frac{9}{2}g \Rightarrow 2U\sin\theta = 4g$

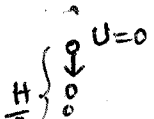
$\Rightarrow U\sin\theta = 2g$

$\therefore H_{max} = \frac{U^2\sin^2\theta}{2g} = \frac{(2g)^2}{2g} = 2g = 2\times10 = 20m$.

57) → 

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

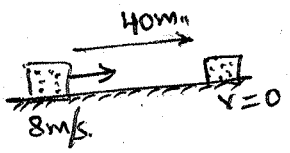
$H = 0 + \frac{1}{2}gt^2$

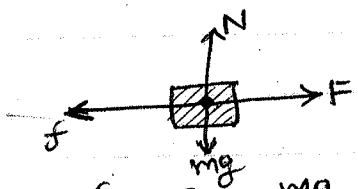


$\frac{H}{2} = 0 + \frac{1}{2}gt^2$

$\frac{1}{4}gT^2 = \frac{1}{2}gt^2$

$t^2 = \frac{T^2}{2} \longrightarrow t = \frac{T}{\sqrt{2}}$ [1]

58) → 

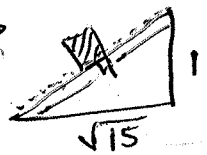


Horizontal surface. [3]

$\mu = \frac{f}{N} = \frac{F}{mg} = \frac{ma}{mg} = \frac{a}{g}$

$V^2 - U^2 = 2aS$

$a = \frac{64}{2\times40} \longrightarrow \mu = \frac{64}{2\times40\times10} = \frac{32}{400} = \frac{8}{100} = 0.08$

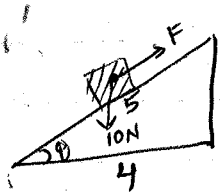
59) → 

$H^2 = Adj^2 + 1^2$

$Adj = \sqrt{15}$

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

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

60) 

$mg = 10$

$\mu = 0.6$

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

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

$F = mg(\sin\theta + \mu\cos\theta)$

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

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

61) → $50\%\ P = \frac{W}{t} = \frac{mgh}{t}$

$\frac{P}{2} = \frac{7200\times10\times100}{3600} \longrightarrow P = 4000\ Watt \longrightarrow 4KW$ [2]

62) → $\bar{F} = \hat{i} + 2\hat{j} + 3\hat{k}$

$\Delta\bar{r} = \bar{r}_2 - \bar{r}_1 = 0\hat{i} - 2\hat{j} + 1\hat{k}$

$W = ?$

$W = \bar{F}\cdot\bar{S}$

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

$W = 0 - 4 + 3 = -1$ Joule. [2]

63) $K.E_1 = \frac{1}{2}mv_1^2$

$K.E_2 = \frac{1}{2}mv_2^2$

$\longrightarrow \frac{K.E_1}{K.E_2} = \left(\frac{V_1}{V_2}\right)^2$

$\longrightarrow \frac{30}{K.E_2} = \left(\frac{10}{30}\right)^2 = \frac{1}{9} \Rightarrow K.E_2 = 30\times9 = 270\ J$ [4]

64) $V = r\omega = 1$

$a = r\omega^2 = 1.57$

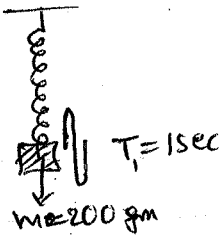
$T = ?$

$\longrightarrow \frac{r\omega^2}{r\omega} = \frac{1.57}{1} \Rightarrow \omega = 1.57$

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

$\Rightarrow T = \frac{2\times3.14}{1.57} = \frac{6.28}{1.57}$

$T = 4$ sec. [1]

66) 

$T_1 = 1$ sec, $m_1 = 200$ gm, $T_2 = 0.5$ sec, $m_1 - m_2 = ?$

$T = 2\pi\sqrt{\frac{m}{K}}$ [3]

$T \propto \sqrt{m}$

$\frac{T_1}{T_2} = \sqrt{\frac{m_1}{m_2}} \Rightarrow \frac{1}{0.5} = \sqrt{\frac{200}{m_2}}$

$\Rightarrow m_2 = 50$ gm.

$m_1 - m_2 = 200 - 50 = 150$ gm to be removed

68) $x_1 = A\sin(320\pi t) \longrightarrow \omega_1 = 320\pi \rightarrow 2\pi\nu_1 = 320\pi$ [4]

$\nu_1 = 160$ Hz

$x_2 = A\sin(326\pi t) \longrightarrow \omega_2 = 326\pi \rightarrow \nu_2 = 163$ Hz

$\Delta\nu = \nu_2 - \nu_1 = 3$ Hz

[4]

70) $m = 5$ gm, O_2 (oxygen) $= M = 32$ $\longrightarrow PV = nRT$

$n = \frac{m}{M} = \frac{5}{32} \rightarrow PV = \frac{5}{32}RT$

[3]

71) $P = 10^3$ N/m^2, $dV = 0.25$ m^3, $dW = ?$

$dW = P\,dV$

$= 10^3 \times 0.25 = 250$ J.

[3]

72) $PV^\gamma = $ constant $\Rightarrow V^\gamma dP + P\gamma V^{\gamma-1} dV = 0$

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

$\Rightarrow \frac{dP}{P} = -\gamma\frac{dV}{V}$

[2]

74) $i_c = 30^\circ$, $V = ?$

$\mu = \frac{c}{V}$, $\mu = \frac{1}{\sin i_c} = \frac{1}{\sin 30^\circ}$

$\mu = \frac{3\times10^8}{V}$, $\mu = \frac{1}{2}$

$\mu = \frac{1}{2} = \frac{3\times10^8}{V} \Rightarrow V = \frac{3\times10^8}{2} = 1.5\times10^8$ m/s

75) $\lambda = 4.36\times10^{-7}$ m, $h\nu_0 = ?$, $W = 1.24$ eV

[1]

$h\nu = h\nu_0 + W$

$\frac{hc}{\lambda} = h\nu_0 + 1.24$

$\frac{6.624\times10^{-34}\times3\times10^8}{1.6\times10^{-19}\times4.36\times10^{-7}} = h\nu_0 + 1.24$

2.84 eV $= h\nu_0 + 1.24$ eV

$h\nu_0 = 1.60$ eV