ECET - MECH - 2024

51) Angular Momentum $L = V^x A^y F^z$ $V \to$ velocity, $A \to$ Acceleration, $F \to$ Force. [4]

Taking Dimensions on bothsides,

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

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

By comparing powers $\to$ $\underline{z=1}$, $x+y+z=2$, $-x-2y-2z=-1$

$x-2+1=2$ $x+2y+2z=1$

$\underline{x=3}$. $2+y+z=1$

$y+z=-1$

$y+1=-1$

$\underline{y=-2}$.

$\therefore L = V^3 A^{-2} F^1$

52) velocity $v = At^2 + Bt + C$ [3]

From Homogeneity, all terms having same units.

velocity $= At^2 \to A = \frac{\text{velocity}}{\text{time}^2} \to \frac{L^1T^{-1}}{T^2} \to L^1T^{-3}$

$A \to m/sec^3$

53) $|A| + |B| = |C|$ and $\overline{A} + \overline{B} = \overline{C}$ [3]

$(A+B)^2 = C^2$. $|\overline{A}+\overline{B}| = |\overline{C}|$

$C^2 = A^2 + B^2 + 2AB \to (1)$, $A^2 + B^2 + 2AB\cos\theta = C^2 \to (2)$

from (1), (2) $\to \cos\theta = 1 \to \theta = 0^\circ$

54) Triangle Area $= \frac{1}{2}|\overline{A} \times \overline{B}| = \frac{1}{2}\begin{vmatrix} i & j & k \\ 2 & 3 & 0 \\ 1 & 4 & 0 \end{vmatrix} = \frac{1}{2}|(8-3)\hat{k}|$ [3]

$= \frac{1}{2}(5)|\hat{k}| = 2.5(1) = 2.5$ units.

55) from $V = U + at$ $\to$ After t_1 secs, velocity is doubled [1]

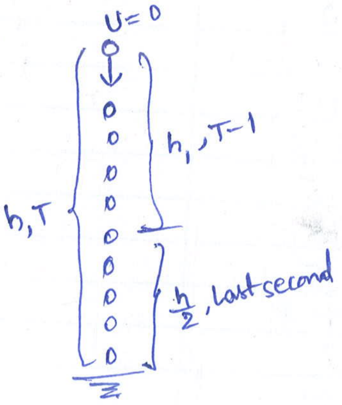
that is $2U = U + at_1 \to U = at_1 \to (1)$

$\to$ After t_2 secs, velocity is tripled

that is $3U = U + at_2 \to 2U = at_2 \to (2)$

$\therefore 2U = at_2 \Rightarrow 2at_1 = at_2 \Rightarrow t_2 = 2t_1$

56) [1]



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

$h = (0)T + \frac{1}{2}gT^2$

$h = \frac{1}{2}gT^2 \to (1)$ Total time

distance travelled in T-1 secs,

$h_1 = 0 + \frac{1}{2}g(T-1)^2 \to (2)$

distance travelled in Last second is

$\frac{h}{2} = h - h_1 \to h_1 = \frac{h}{2}$

$\to \frac{g(T-1)^2}{2} = \frac{gT^2}{4} \Rightarrow 2(T-1)^2 = T^2$

$\Rightarrow 2T^2 - 4T + 2 = T^2$

$\Rightarrow T^2 - 4T + 2 = 0 \to T = 2 + \sqrt{2}$

from eq (1) height $h = \frac{1}{2} \times 9.8 \times (2+\sqrt{2})^2 \to h = 57.18\ m$.

$\left(T = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}\right)$

57) $\theta = 45^\circ$
$H = 30$
$R = ?$

$H = \frac{U^2 \sin^2\theta}{2g} = 30$

$\frac{U^2 \sin^2 45^\circ}{2g} = 30$

$\frac{U^2}{g} = \frac{60}{1/2} = 120,$

$\therefore R = \frac{U^2 \sin 2\theta}{g}$

$= 120 \times \sin 2(45^\circ)$

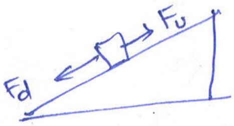
$= 120 \times 1$

$R = 120\ m$

[2]

58) μ is independent of Area of contact $\longrightarrow \mu = 0.2$ for Any cube [1]

59)



$F_U = 2F_d$, $\mu = \frac{1}{\sqrt{3}}$, $\theta = ?$ [4]

$mg(\sin\theta + \mu\cos\theta) = 2\,mg(\sin\theta - \mu\cos\theta)$

$\sin\theta + \mu\cos\theta = 2\sin\theta - 2\mu\cos\theta$

$\sin\theta = 3\mu\cos\theta \longrightarrow \tan\theta = 3\mu = \frac{3}{\sqrt{3}} = \sqrt{3}$

$\longrightarrow \theta = 60^\circ$

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

$0 - u^2 = -2\mu g s$

$s = \frac{u^2}{2\mu g} = \frac{16}{2 \times 0.1 \times 9.8}$

$s = 8.163\ m$

here work on ice creates heat. , L = Latent heat $= 334000$ [2]

$W = Q \Rightarrow f \times s = m_1 L$

$\Rightarrow \mu mgs = m_1 L$

$\Rightarrow m_1 = \frac{\mu mgs}{L} = \frac{0.1 \times 42 \times 9.8 \times 8.163}{334000}$

$m_1 = 0.001\ kg = 1\ gm$

[2]

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

$v = \sqrt{2as}$

$F = ma$

$a = \frac{F}{m} = \frac{5 \times 10^4}{3 \times 10^7} = \frac{5}{3} \times 10^{-3}$

$\therefore v = \sqrt{2as} = \sqrt{2 \times \frac{5}{3} \times 10^{-3} \times 3} = \sqrt{10^{-2}} = 0.1\ m/sec.$

[4]

62) $W = \bar{F}.\bar{S} = (2\hat{i} + 4\hat{j} + 5\hat{k}) \cdot (3\hat{i} + 2\hat{j} + \hat{k})$

$= (2 \times 3) + (4 \times 2) + (5 \times 1) = 6 + 8 + 5 = 19$ Joule. [1]

63) Power $P = 45 \times 746$ Watt.
$v = 15\ m/sec$
$F = ?$

$P = F \times v \longrightarrow F = \frac{45 \times 746}{15}$

$F = 3 \times 746 = 2238$ Newton.

[3]

64) $K_1 = m\omega_1^2$
$K_2 = m\omega_2^2$

Max velocity $v = r\omega$
both velocities equal $\longrightarrow r_1\omega_1 = r_2\omega_2$

$\frac{r_1}{r_2}$ or $\frac{A}{B} = \frac{\omega_2}{\omega_1} = \frac{\sqrt{K_2/m}}{\sqrt{K_1/m}} = \sqrt{\frac{K_2}{K_1}}$

[1]

65) $T = 1\ sec$
$g = 10\ m/s^2$

$T = 2\pi\sqrt{\frac{l}{g}} \longrightarrow 1 = \frac{2\pi}{\sqrt{10}} . \sqrt{l} \Rightarrow \sqrt{l} = \frac{\sqrt{10}}{2\pi}$

$\longrightarrow l = \frac{10}{4\pi^2} = \frac{5}{2\pi^2}$

$\longrightarrow l = \frac{5}{2(3.14)^2} = 0.2535\ m$

[4]

66) freefall $g = 0 \longrightarrow T = 2\pi\sqrt{\frac{l}{g}} \longrightarrow T = \infty$

[1]

67) $n' = \left(\frac{v}{v - v_s}\right) n$

$= \left(\frac{v}{v - \frac{v}{10}}\right) \times 90 = \frac{10v}{9v} \times 90 = 10 \times 10 = 100\ Hz.$

68) $V = 100 \times 30 \times 10 \ m^3$
$V = 30000 \ m^3$
$T = 1.5$ sec
$A = ?$

$T = \frac{0.17V}{A}$

$A = \frac{0.17 \times 30000}{1.5} = 3400$ [2]

69) vapour condense into liquid at below their boiling points, and it does not follow ideal gas laws, [2]
That is vapour is not perfect gas.

70) $PV = nRT$, $n = \frac{m}{M} = \frac{14}{28} = \frac{1}{2} \rightarrow PV = \frac{1}{2}RT$ [2]
$\searrow N_2$

71) $P_1 = 80$ cm of Hg.
$m_1 = 1$
here $2/5$th part Leaked
$m_2 = \frac{3}{5}$ remains.
$P_2 = ?$

$PV = \frac{m}{M}RT$ [3]

$P \propto m \rightarrow \frac{P_1}{P_2} = \frac{m_1}{m_2} \rightarrow \frac{80}{P_2} = \frac{1}{3/5}$

$\rightarrow P_2 = 80 \times \frac{3}{5} = 16 \times 3 = 48$ Cm of Hg.

72) $\frac{dU}{dQ} = ?$

$dQ = dU + dW$ two way used. [4]

$\frac{dU}{dQ} = \frac{nC_V dT}{nC_P dT} = \frac{C_V}{C_P} = \frac{5/2 R}{7/2 R} = 5/7$

73) $C_V = \frac{f}{2}R$, f = degrees of Freedom for diatomic gas. [1]
$= 3$ translational $+ 2$ Rotational
$f = 5 \longrightarrow C_V = \frac{5}{2}R$.