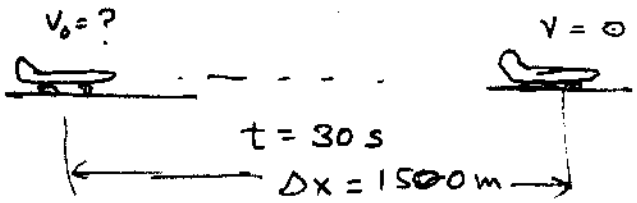
FINAL EXAM - 022

(Q1)



$V_0 = ?$ ✓

$V = 0$ ✓

$\Delta x = 1500\,m$ ✓

$a = ?$

$t = 30\,s$ ✓

what is V_0?

a is not needed (missing)

$$\Delta x = \frac{1}{2}(\overset{0}{V} + V_0)\,t$$

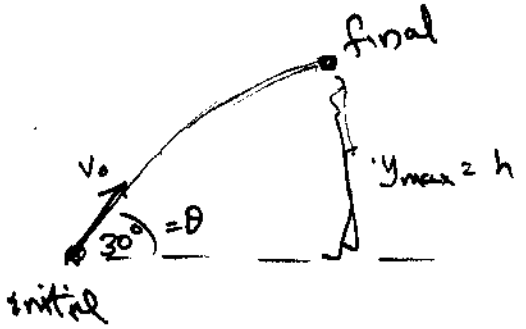
$$\Rightarrow 2\Delta x = (\overset{0}{V} + V_0)\,t$$

~~$V_0 t = 2\Delta x$~~

$$\Rightarrow \frac{\overset{100}{\cancel{3000}}}{\cancel{30}} = \overset{0}{V} + V_0$$

$$V_0 = 100 - \overset{0}{V} = \underline{100\ m/s}$$

(Q2)



x	y
$\Delta x = ?$	$\Delta y = ?$
✓ $V_{x0} = V_0 \cos\theta$	✓ $V_{y0} = V_0 \sin\theta$
✓ $a_x = 0$	✓ $a_y = -9.8\ m/s^2$
$V_x = ?$	✓ $V_y = 0$
? t	t ?

We know three quantities for in the y-dir^n

we need t, Δy (missing)

$$\Rightarrow V_y = V_{y0} + a_y t$$

$V_0 = 49\ m/s$

$$0 = V_0 \sin\theta + (-9.8)\,t$$

$$t = \frac{V_0 \sin\theta}{9} = \frac{\cancel{(49)}\sin 30}{\cancel{9.8}\ \cancel{10}.2} = \frac{1}{\cancel{0}.2} = \underline{2.5\,(s)}$$

(Q3) $M_e = 5.98 \times 10^{24}$ kg

$m = 40\ u = 40\ u \dfrac{1.66 \times 10^{-27}\ kg}{1\ u}$

$m = 6.64 \times 10^{-26}$ kg

$N = \dfrac{M_e}{m} = \dfrac{5.98 \times 10^{24}}{6.64 \times 10^{-26}}$

$N = 9.0 \times 10^{49}$ atoms

(Q4) $\hat{j}$ is the unit vector in the y-direction

let us put $\vec{r} = 2.50\hat{j} + 4.33\hat{k}$

$\therefore \quad \vec{r} \cdot \hat{j} = r(1)\cos\theta$

where θ is the angle between $\vec{r}$ & y-axis ($\hat{j}$)

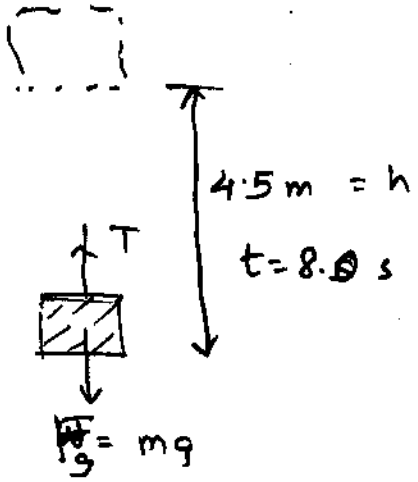
$\Rightarrow \quad \cos\theta = \dfrac{\vec{r} \cdot \hat{j}}{r} \qquad r = |\vec{r}| = \sqrt{0^2 + (2.5)^2 + (4.33)^2}$

$= \dfrac{(2.5\hat{j} + 4.33) \cdot (1\hat{j})}{\sqrt{(2.5)^2 + (4.33)^2}}$

$\cos\theta = \dfrac{2.5}{5.0} = \dfrac{1}{2} = 0.50$

$\theta = 60^\circ$

(95)



The force from the motor is the tension T.

∴ The work done by motor is the work done by the force T.

$$P_{avg} = \frac{W_T}{\Delta t} = \frac{T(h)}{\Delta t}$$

but what is T? — OR — what is W_T?

$\Sigma F_y = m a_y$

$a_y = 0$ because const velocity

$T - F_g = 0$

$T = mg$

$W_{net} = \Delta K$

$W_T + W_g = 0$

$W_T = W_g$

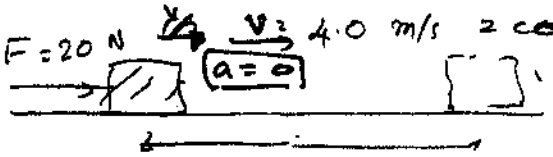
$W_T = -(-mgh)$

$= +mgh$

$$\Rightarrow P_{avg} = \frac{mgh}{\Delta t} = \frac{(3900)(9.8)(4.5)}{8.0}$$

$$P_{avg} = 2.1 \times 10^4 \text{ W}$$

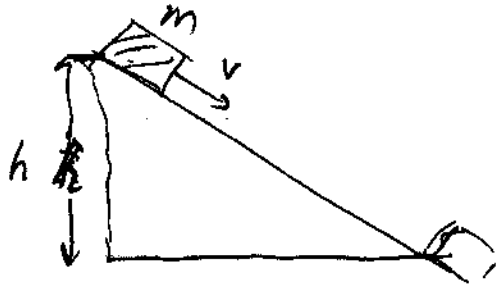
(96)



$W_{net} = \Delta K = K_f - K_i$

$= 0 \quad \because K_f = K_i$ constant velocity

(97)



Consider the system = block + incline + earth

no external forces. ∴ the system $W_{ex} = 0$

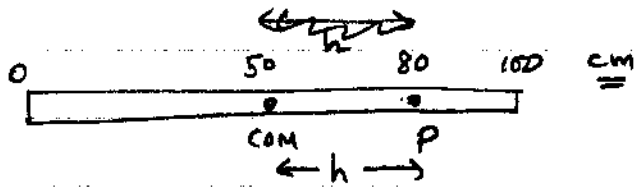
$W_{ex} = \Delta K + \Delta U + \Delta E_{th}$

$0 = 0 + mgh + \Delta E_{th}$

↓ constant speed

$\Rightarrow \quad \Delta E_{th} = mgh$

(98)



L = 100 cm

L = 1.00 m

M = 0.56 kg

h = 80 − 50 = 30 cm

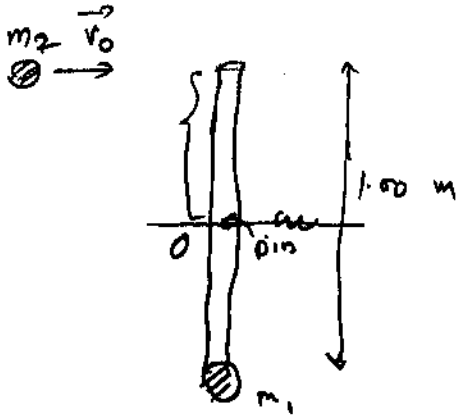
For this rod $I_{com} = \frac{1}{12} ML^2$

$I_P = I_{com} + Mh^2$ (parallel axes theorem)

$= \frac{1}{12} ML^2 + M(0.30)^2$

$I = 9.7 \times 10^{-2}$ kg.m²

Q9



$m_1 = m_2 = 100\ g$

$\ell = 1.00\ m$

$$\vec{L}_i = \vec{L}_f$$

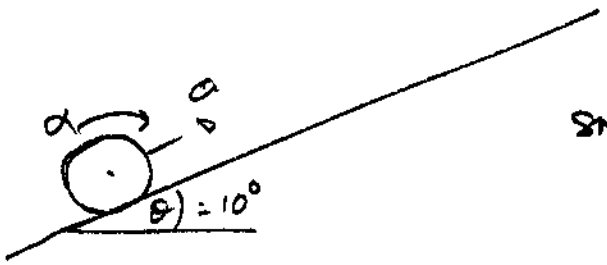
$$(-)\, m_2 \frac{\ell}{2} v_0 + 0 = -\left\{m_2 \left(\frac{\ell}{2}\right)^2\right\}\omega + \left\{m_1 \left(\frac{\ell}{2}\right)^2\right\}\omega$$

$$\frac{\ell}{2} v_0 = \frac{2\omega\, \ell^2}{4}$$

$$v_0 = \ell\omega = (1)(32)$$

$$v_0 = 32\ m/s$$

Q10



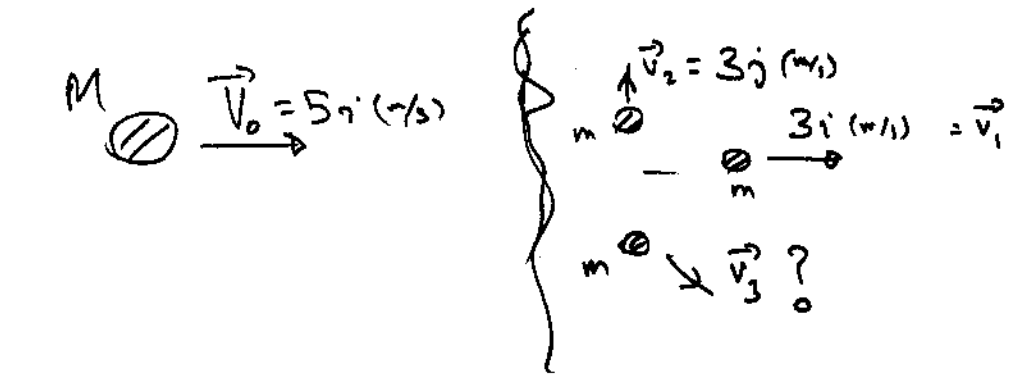
smooth rolling

$$a = \frac{g \sin\theta}{\sqrt{1 + \left(I/mR^2\right)}} = \frac{g}{\frac{7}{5}} \text{ for sphere}$$

$$a = \frac{(9.8)\sin 10}{\sqrt{1 + 2/5}} = 1.2\ m/s^2 \text{ down the ramp}$$

Note the acceleration is down the ramp whether the sphere is rolling up or down

(Q11)



Conservation of momentum (linear) for explosion: $\Sigma \vec{P}_i = \Sigma \vec{P}_f$

$$\Rightarrow M\vec{V}_0 = \frac{M}{3}\vec{v}_1 + \frac{M}{3}\vec{v}_2 + \frac{M}{3}\vec{v}_3$$

$$\vec{V}_0 - \frac{\vec{v}_1}{3} - \frac{\vec{v}_2}{3} = \frac{\vec{v}_3}{3}$$

$$5\hat{i} - \frac{3\hat{i}}{3} - \frac{3\hat{j}}{3} = \frac{\vec{v}_3}{3}$$

$$3\left(5\hat{i} - 1\hat{i} - \hat{j}\right) = \vec{v}_3$$

$$3(4\hat{i} - \hat{j}) = \vec{v}_3$$

$$\underline{12\hat{i} - 3\hat{j}\ (m/s) = \vec{v}_3}$$