

M2 JUNE 03

1) $v = 6t - 2t^2$ $v = 0 \Rightarrow 6t = 2t^2$ $t = 3 \text{ sec.}$

$$S = \int v dt = 3t^2 - \frac{2}{3}t^3 + C$$

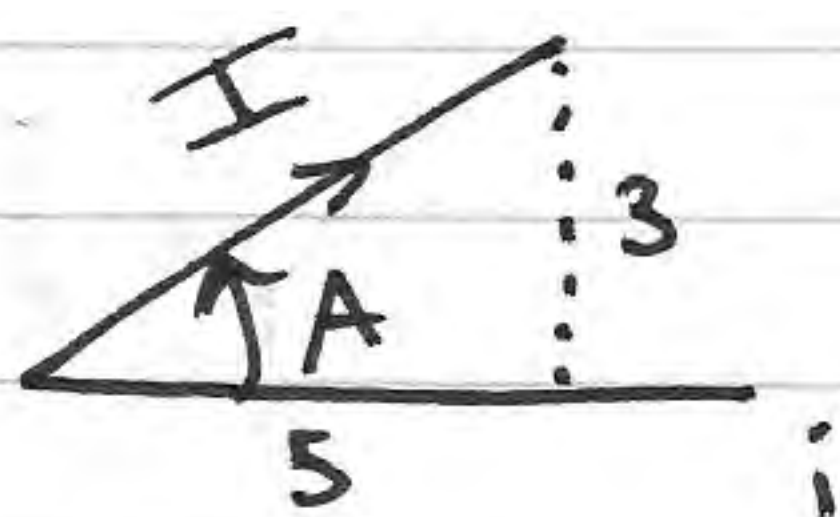
$$t = 0, S = 0 \Rightarrow C = 0 \quad S = 3(3)^2 - \frac{2}{3}(3)^3 = \underline{9 \text{ m}}$$

2) Momentum before = $0.2(-10\mathbf{i}) = -2\mathbf{i}$
Momentum after = $0.2(15\mathbf{i} + 15\mathbf{j}) = 3\mathbf{i} + 3\mathbf{j}$

$$\text{Impulse} = \text{Change in Momentum} = 5\mathbf{i} + 3\mathbf{j}$$

$$\text{Magnitude} = \sqrt{5^2 + 3^2} = \underline{\sqrt{34} \text{ Ns}}$$

b)

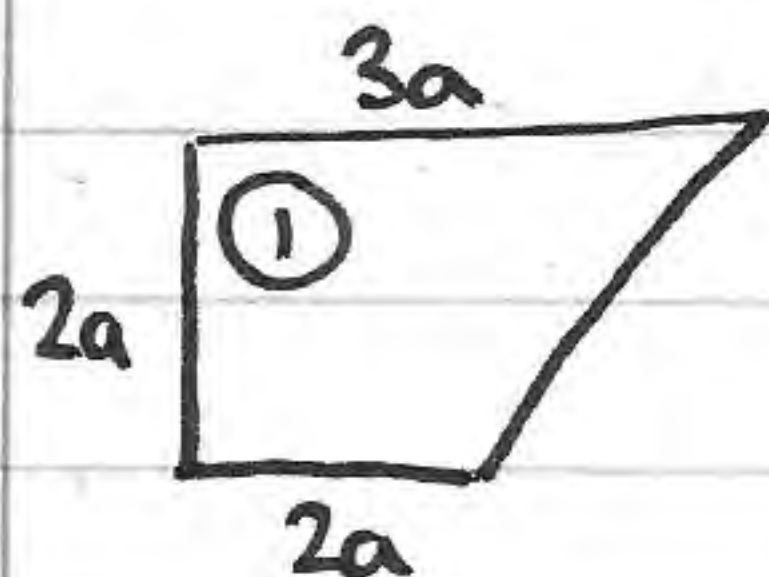


$$A = \tan^{-1}\left(\frac{3}{5}\right) = \underline{31^\circ}$$

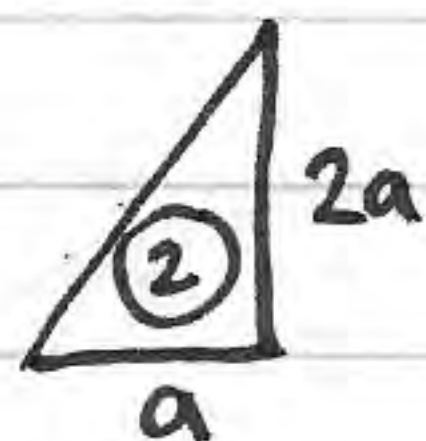
c) KE before = $\frac{1}{2}(0.2)(\sqrt{10^2})^2 = 10 \text{ J}$
KE after = $\frac{1}{2}(0.2)(\sqrt{15^2 + 15^2})^2 = 45 \text{ J.}$

$$\therefore \text{KE gain} = \underline{35 \text{ J.}}$$

3)



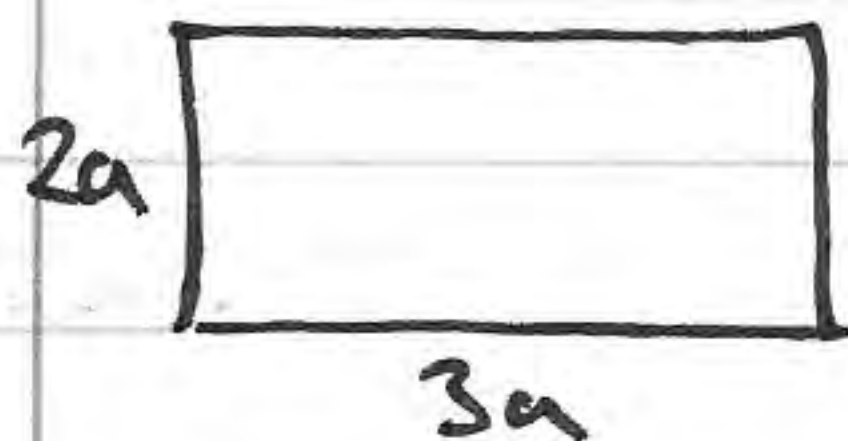
$$M = \frac{(3a + 2a)2a}{2} \rho = 5a^2 \rho \quad g_1(x_1, y_1)$$



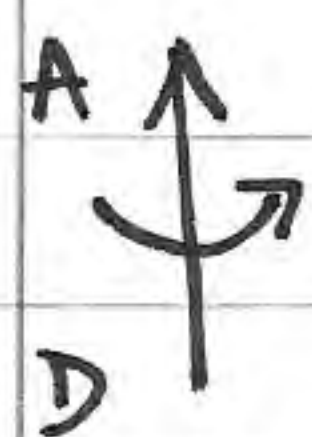
$$M = \frac{a \times 2a}{2} \rho = a^2 \rho$$

$$g_2\left(\frac{2a + 3a + 3a}{3}, y_2\right)$$

$$g_2\left(\frac{8}{3}a, y_2\right)$$



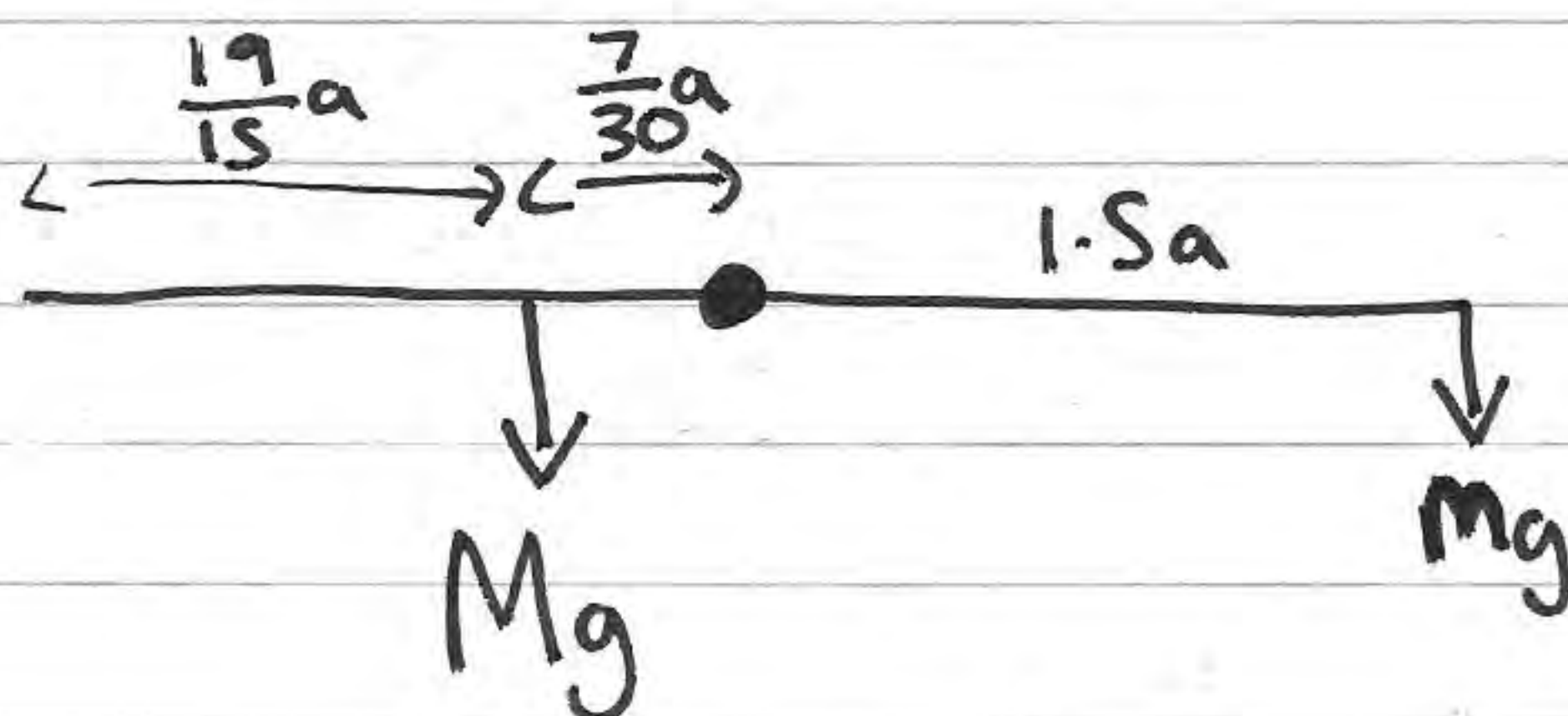
$$M = 6a^2 \rho \quad G(1.5a, a)$$



$$5a^2 \cancel{kg} \times x_1 + a^2 \cancel{kg} \times \frac{8}{3}a = 6a^2 \cancel{kg} \times 1.5a$$

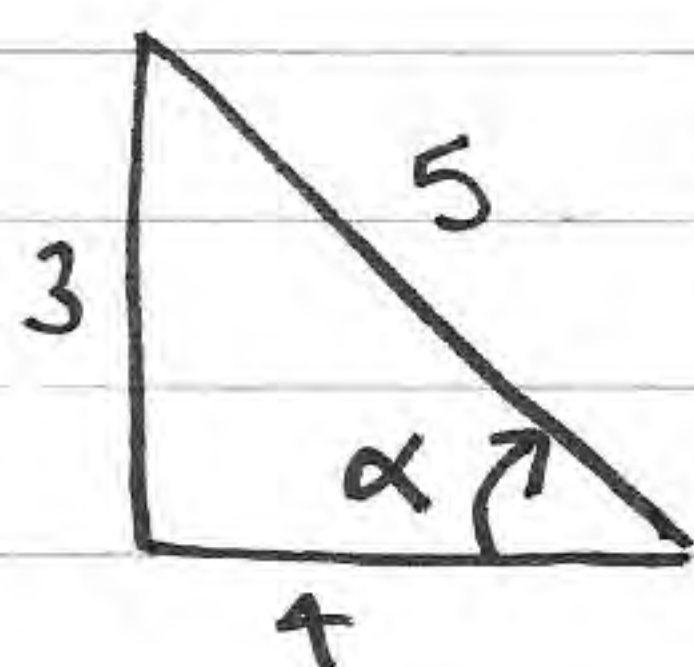
$$\Rightarrow 5x_1 + \frac{8}{3}a = 9a \Rightarrow x_1 = \underline{\underline{\frac{19}{15}a}}$$

b)



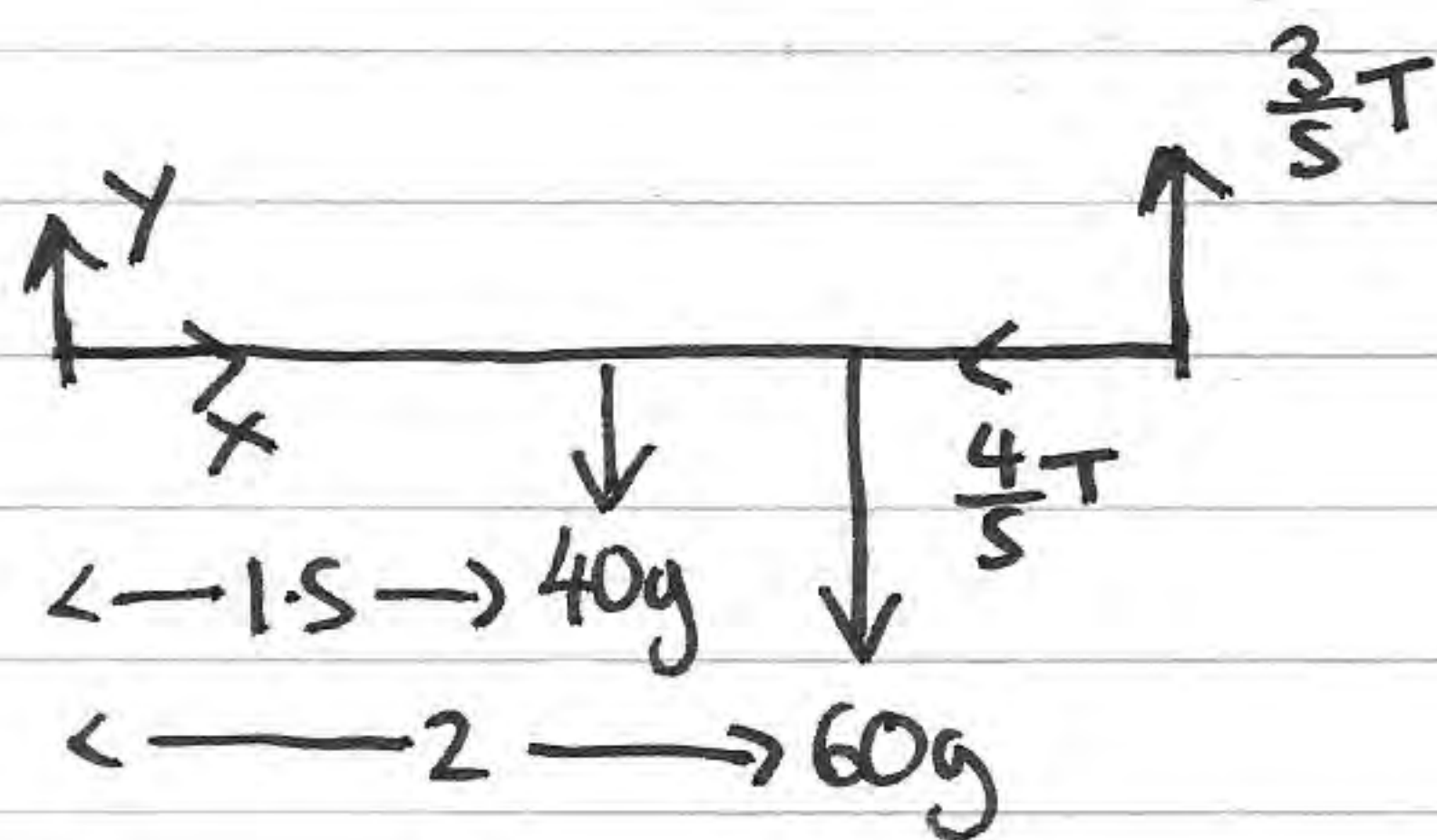
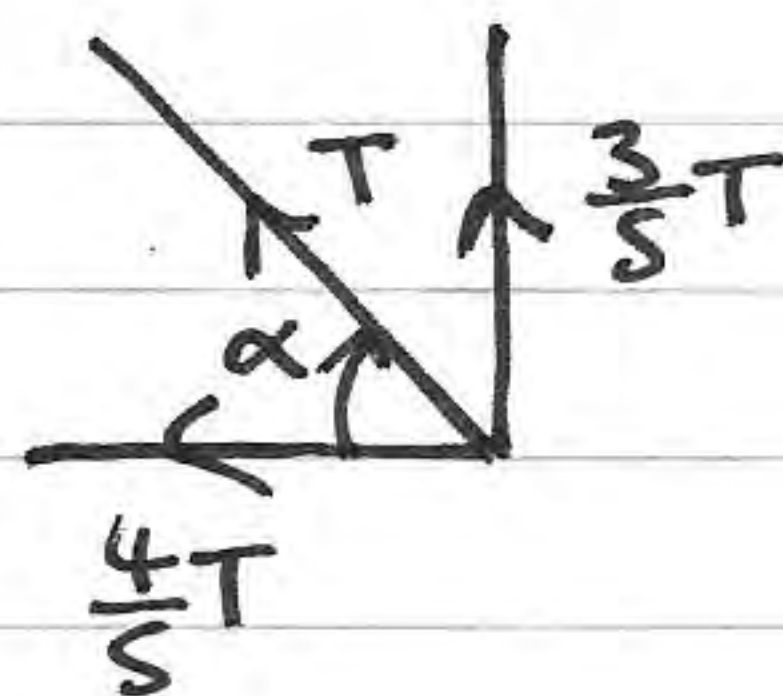
$$Mg \times \frac{7}{30}a = mg \times \frac{3}{2}a \Rightarrow m = \frac{7}{45}M$$

4)



$$\tan \alpha = \frac{3}{4} \Rightarrow \sin \alpha = \frac{3}{5}$$

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



$$\text{A2 } 40g \times 1.5 + 60g \times 2 = \frac{3}{5}T \times 3$$

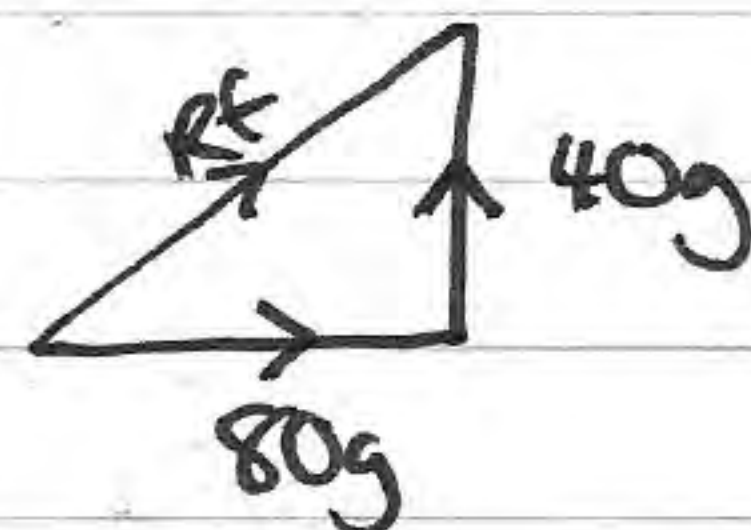
$$180g = \frac{9}{5}T$$

$$T = \underline{\underline{100g \text{ N (980 N)}}} \#$$

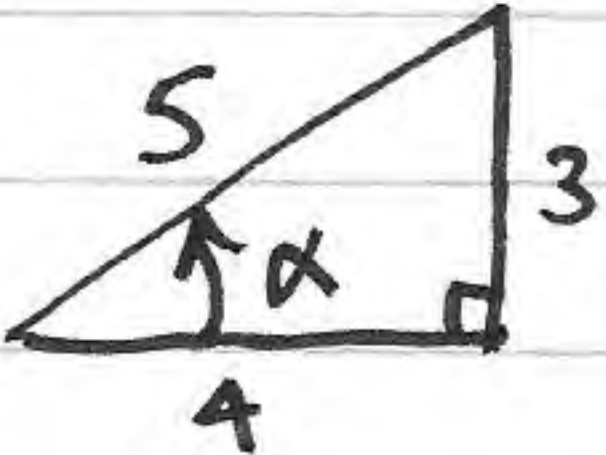
$$\text{b) } \vec{R}_F = 0 \Rightarrow X = \frac{4}{5}T = 80g$$

$$R_{F\uparrow} = 0 \Rightarrow Y = 100g - \frac{3}{5}(100g) = 40g$$

$$R_F = \sqrt{(80g)^2 + (40g)^2} = \underline{\underline{40\sqrt{5}g \text{ N}}}$$

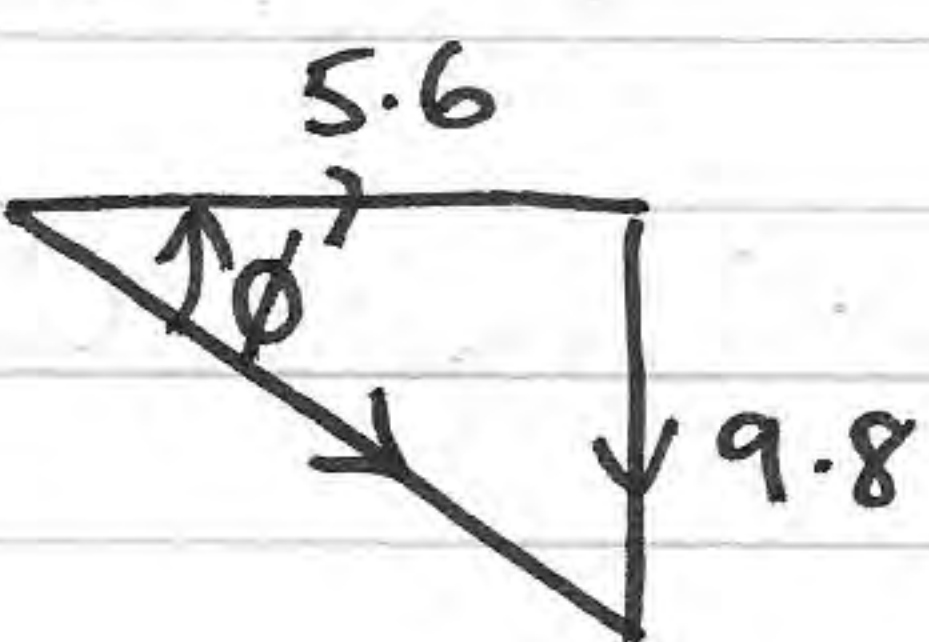


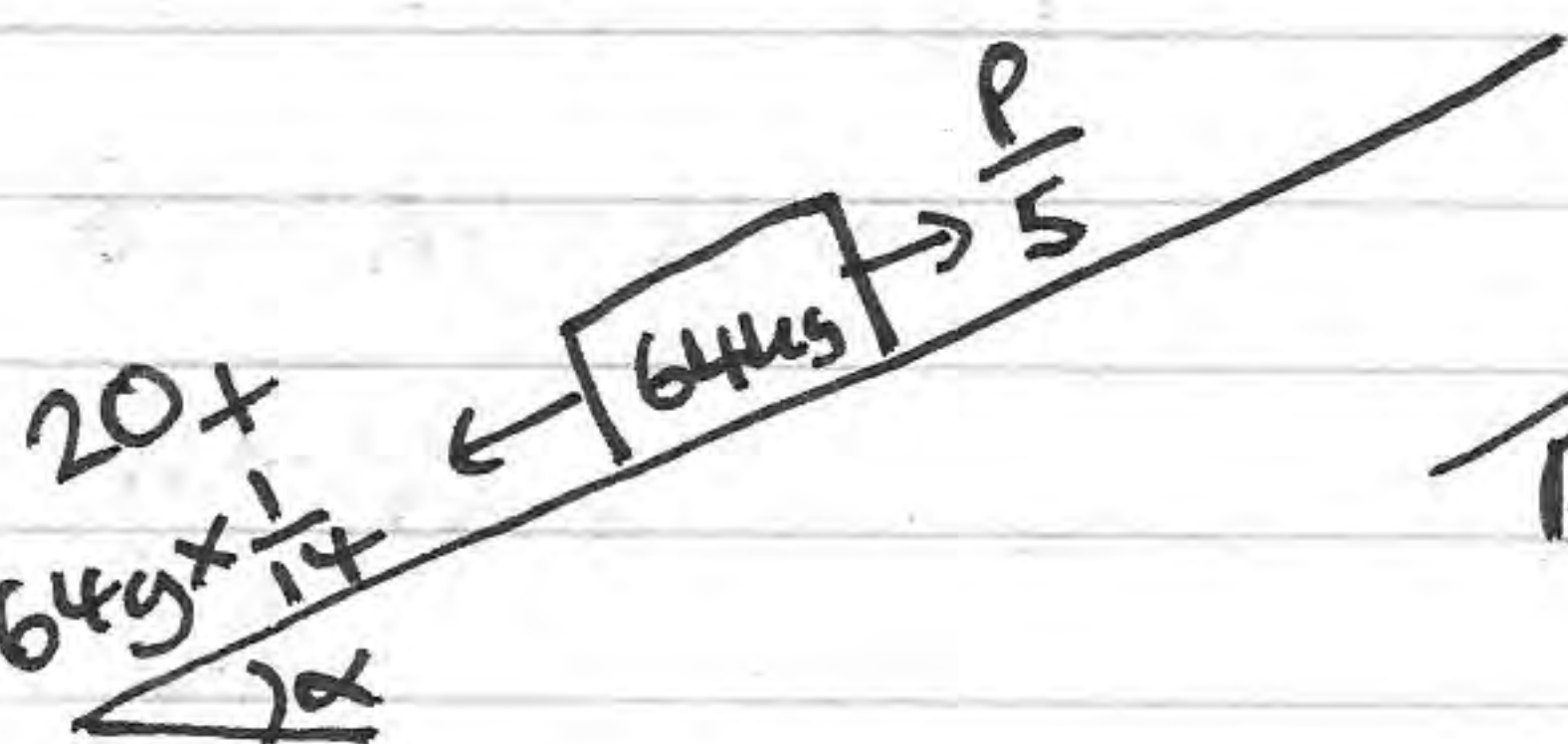
c) Same tension, no additional weight added to system.

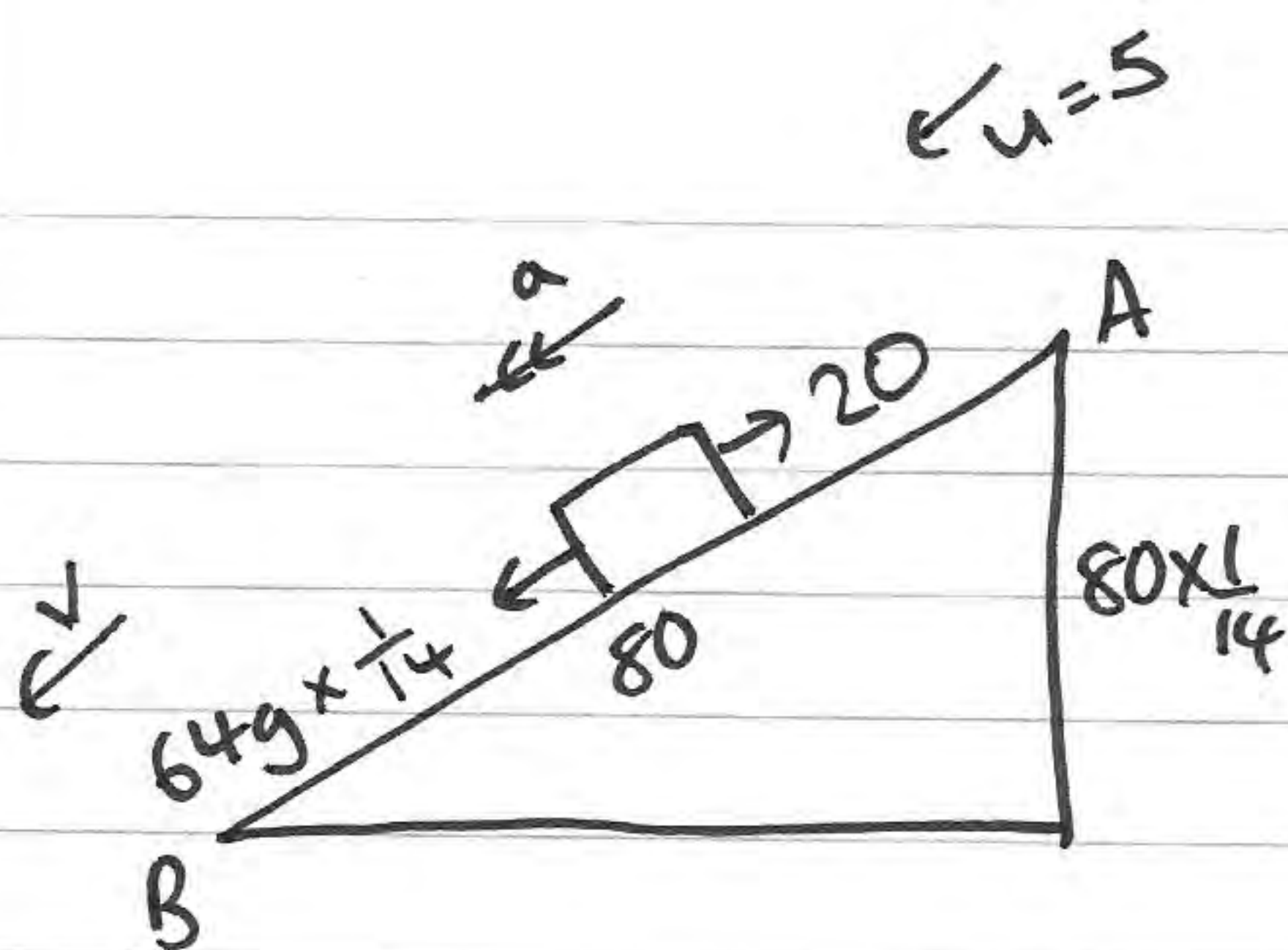
5)  $\tan \alpha = \frac{3}{4}$ $\cos \alpha = \frac{4}{5}$ $\sin \alpha = \frac{3}{5}$

(H) $v_{el} = \frac{4}{5}u$ $s = 8$ $8 = \frac{4}{5}ut \Rightarrow 40 = 4ut$
 $\Rightarrow 10 = ut$

(V) $u = \frac{3}{5}u$ $s = ut + \frac{1}{2}at^2$
 $a = -9.8$ $-4 = \frac{3}{5}ut - 4.9t^2$
 $s = -4$ $-4 = \frac{3}{5}(10) - 4.9t^2 \Rightarrow 4.9t^2 = 10$
 $\Rightarrow t = \sqrt{\frac{10}{4.9}}$
 $u = \frac{10}{t} = \frac{10}{\sqrt{\frac{10}{4.9}}} = 7 \text{ ms}^{-1}$

c)  $v_h = \frac{4}{5}u = 5.6$ $v_v \uparrow = u + at$
 $v_v = \frac{3}{5}(7) - 9.8\left(\sqrt{\frac{10}{4.9}}\right) = -9.8$
 $\Rightarrow v_v \downarrow = 9.8$
 $\tan \phi = \frac{9.8}{5.6} = \frac{7}{4}$

6)  $\sin \alpha = \frac{1}{14}$
 $R_t = 0 \Rightarrow \frac{P}{5} = 20 + \frac{64g}{14}$
 $\Rightarrow P = 324 \text{ w}$



$$KE_A + PE_A - W_{\text{against } R_{\text{es}}} = KE_B + PE_B (=0)$$

$$\frac{1}{2}(64)(5)^2 + 64g \times 80 \times \frac{1}{14} - 20 \times 80 = \frac{1}{2}(64)v$$

$$\Rightarrow v = \sqrt{87} = \underline{9.3 \text{ ms}^{-1}} \text{ (2sf)}$$

$$c) R \propto v \Rightarrow R = kv$$

$$20 = k \times 5 \Rightarrow k = 4$$

$$R_{\text{es}} = 4 \times 8 \Rightarrow \underline{R = 32 \text{ N}}$$

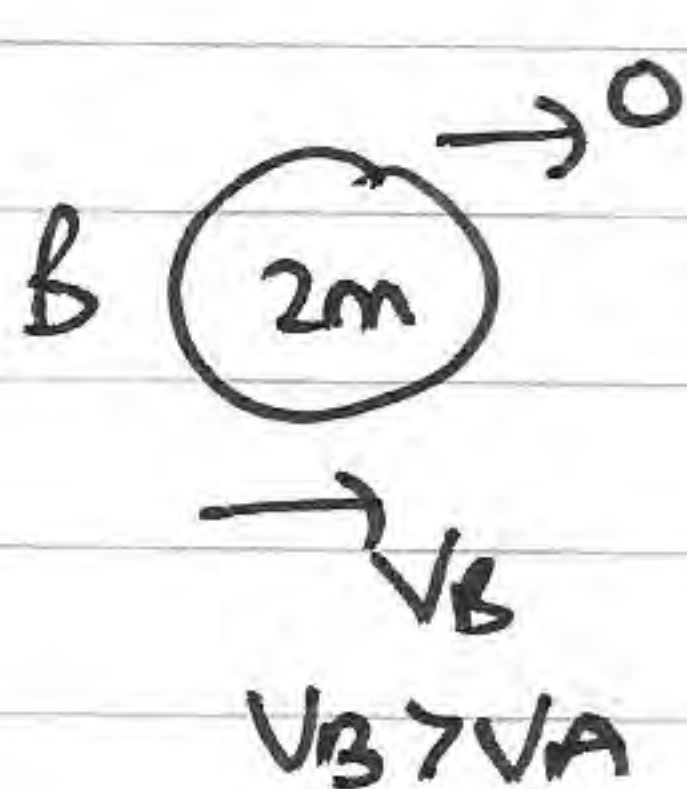
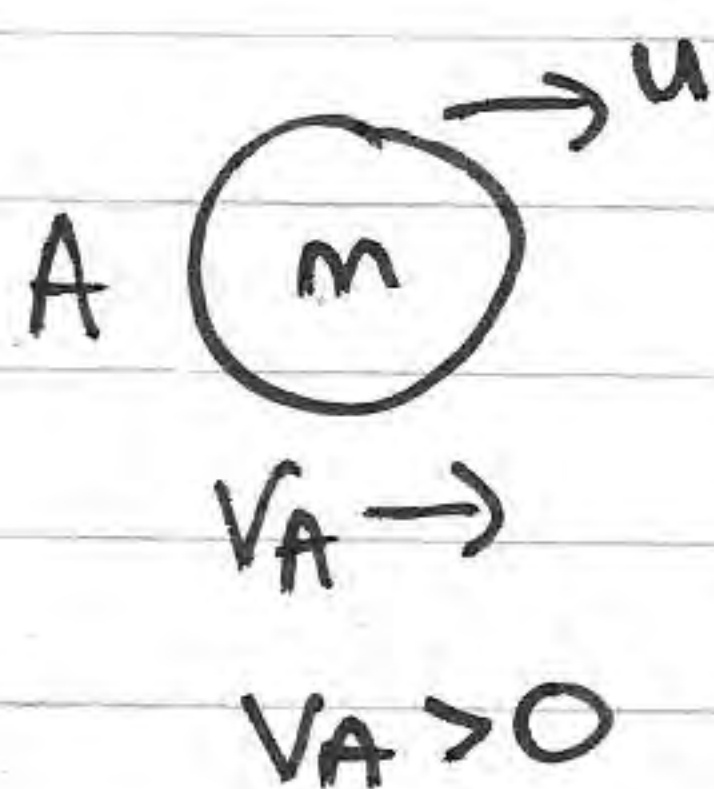
d)

$$\frac{64g}{14} + \frac{R}{v}$$

$$R + \frac{1}{v} = ma \Rightarrow \frac{64g}{14} + \frac{200}{8} = 32 = 64a$$

$$\Rightarrow a = \underline{0.59 \text{ ms}^{-2}} \text{ (2sf)}$$

7)



$$CLM \Rightarrow m u = m v_A + 2m v_B$$

$$\Rightarrow u = v_A + 2v_B$$

$$e = \frac{Sep}{app} = \frac{v_B - v_A}{u}$$

$$eu = v_B - v_A \Rightarrow v_B = eu + v_A$$

$$\therefore u = v_A + 2eu + 2v_A \Rightarrow 3v_A = u - 2eu \Rightarrow v_A = \underline{\frac{1}{3}u(1-2e)}$$

$$V_B = eu + \frac{1}{3}u(1-2e) = eu + \frac{1}{3}u - \frac{2}{3}ue = \frac{1}{3}eu + \frac{1}{3}u$$

$$V_B = \frac{1}{3}u(1+e)$$

$$b) V_B > V_A \Rightarrow \frac{1}{3}u(1+e) > \frac{1}{3}u(1-2e)$$

$$\Rightarrow 1+e > 1-2e \Rightarrow 3e > 0 \Rightarrow e > 0$$

$$V_A > 0 \Rightarrow \frac{1}{3}u(1-2e) > 0 \Rightarrow 2e < 1 \Rightarrow e < \frac{1}{2}$$

$$\therefore 0 < e < \frac{1}{2}$$

$$c) \begin{array}{ccc} \frac{1}{3}u(1-2e) & \frac{1}{3}u(1+e) & \rightarrow 0 \\ A \text{ (m)} & B \text{ (2m)} & C \text{ (4m)} \\ \rightarrow & \rightarrow & \rightarrow \\ \frac{1}{3}u(1-2e) & V_B & V_C \end{array}$$

$$e = \frac{\text{sep}}{\text{app}} = \frac{V_C - V_B}{\frac{1}{3}u(1+e)}$$

$$\Rightarrow \frac{1}{3}eu(1+e) = V_C - V_B$$

$$V_C = \frac{1}{3}eu(1+e) + V_B$$

$$\text{CM} \Rightarrow 2m(\frac{1}{3}u(1+e)) = 2mV_B + 4mV_C$$

$$\Rightarrow \frac{2}{3}u(1+e) = 2V_B + \frac{4}{3}eu(1+e) + 4V_B$$

$$\Rightarrow \frac{2}{3}u(1+e) - \frac{4}{3}eu(1+e) = 6V_B$$

$$\Rightarrow \frac{2}{3}u(1+e)(1-2e) = 6V_B \Rightarrow V_B = \frac{1}{9}u(1+e)(1-2e)$$

$$e < \frac{1}{2} \Rightarrow V_B > 0 \quad e > 0 \Rightarrow V_B < \frac{1}{9}u$$

$$V_B = \frac{1}{9}u(1+e)(1-2e) = \frac{1}{3}(1+e) \left[\frac{1}{3}u(1-2e) \right]$$

$$V_B = \frac{1}{3}(1+e)V_A \quad 0 < e < \frac{1}{2} \quad \frac{1}{3}V_A < V_B < \frac{1}{2}V_A$$

$\therefore$ Since $V_B > 0$ and $V_B < V_A$ they must collide again