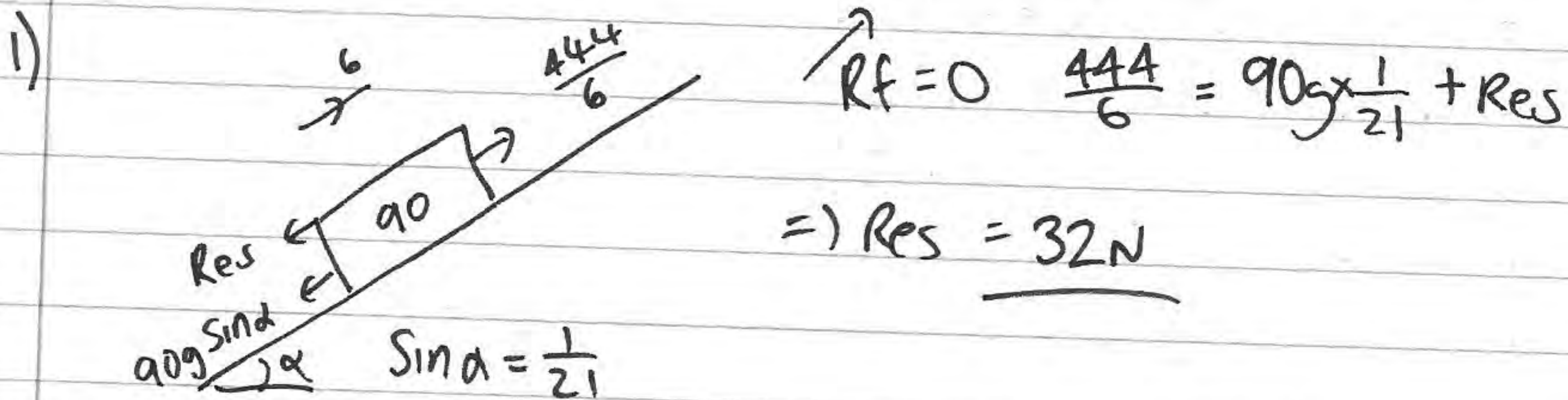


M2 JUNE 07



2) $V = 3t^2 i + (1 - 4t) j$

$a = \frac{dV}{dt} = 6t i - 4 j$

b) $t = 2 \Rightarrow a = 12i - 4j \Rightarrow f = 0.5(12i - 4j) = 6i - 2j$

$|F| = \sqrt{6^2 + 2^2} = \sqrt{40} = \underline{2\sqrt{10} N}$

3) $M = a^2 k$
 $g_1 \left(\frac{3}{2}a, \frac{3}{2}a \right)$

\uparrow $a^2 g_1 \times \frac{3}{2}a + 3a^2 k g_1 \bar{x} = 4a^2 k g_1 \times 0$

$\Rightarrow \frac{3}{2}a^3 + 3a^2 \bar{x} = 4a^3$

$3a^2 \bar{x} = \frac{5}{2}a^3$

$\bar{x} = \frac{5}{6}a \quad \bar{y} = \frac{5}{6}a$

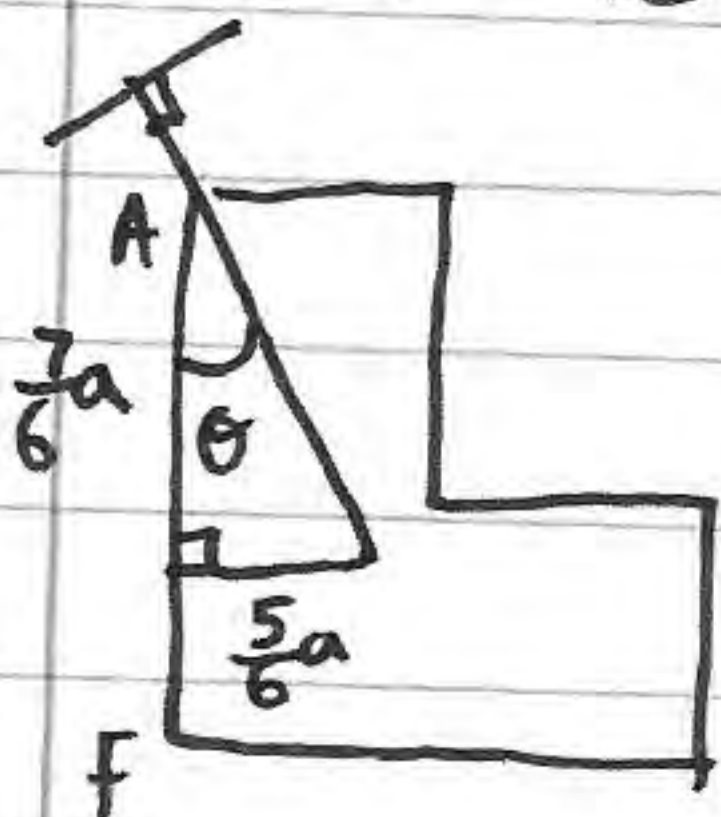
$g_2 \left(\frac{5}{6}a, \frac{5}{6}a \right)$

$M = 3a^2 k$
 $g_2 (\bar{x}, \bar{y})$
 $\bar{x} = \bar{y}$

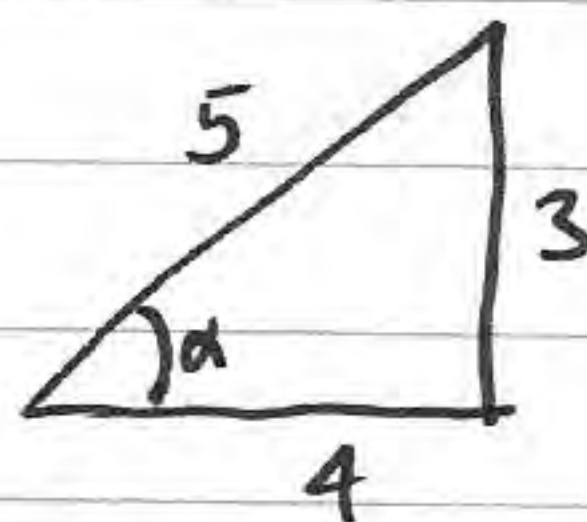
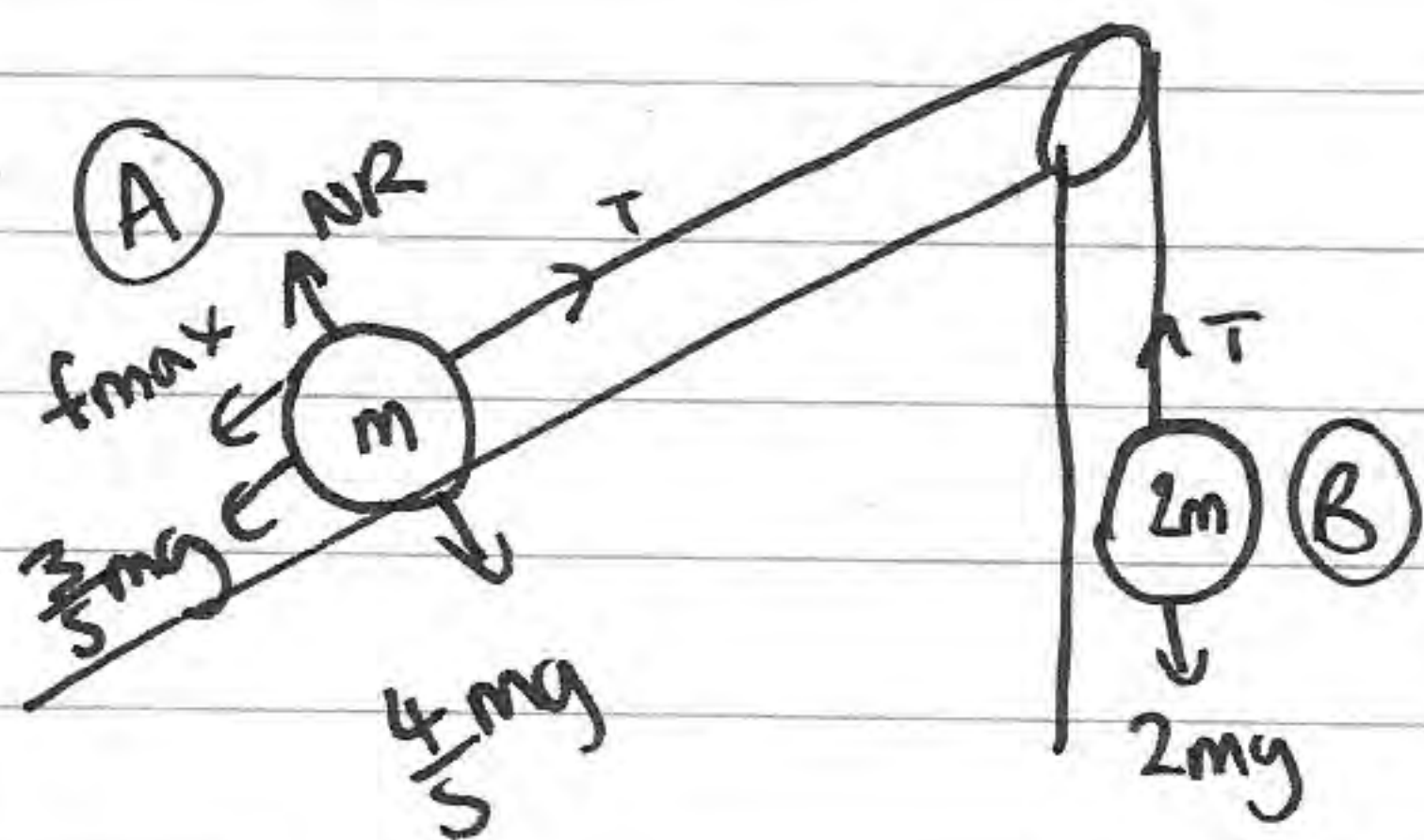
$M = 4a^2 k$
 $G (a, a)$

$\theta = \tan^{-1} \left(\frac{\frac{5}{6}a}{\frac{5}{6}a} \right) = \tan^{-1} \left(\frac{5}{5} \right)$

$\theta = \underline{35.5^\circ}$



4)



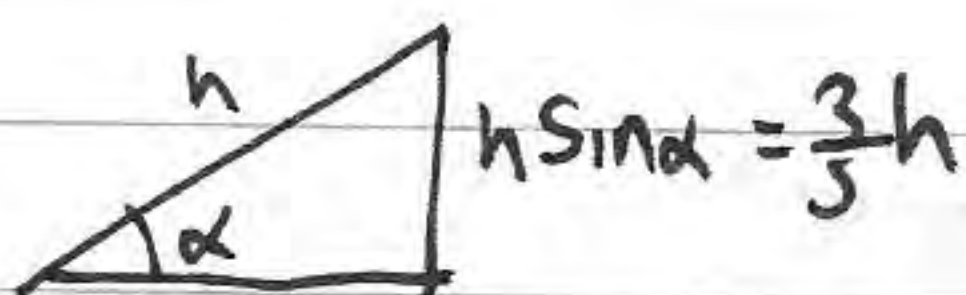
$$\tan \alpha = \frac{3}{4}$$

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

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

$$\mu = \frac{5}{8}$$

a)



$$PE \text{ gained in A} = mg \left(\frac{3}{5}h \right) = \frac{3}{5}mgh$$

$$PE \text{ lost in B} = (2m)gh = 2mgh$$

$$\therefore PE \text{ lost in system} = \underline{\underline{\frac{7}{5}mgh}}$$

$$PE \text{ lost} = KE \text{ gain} + Wd \text{ against friction}$$

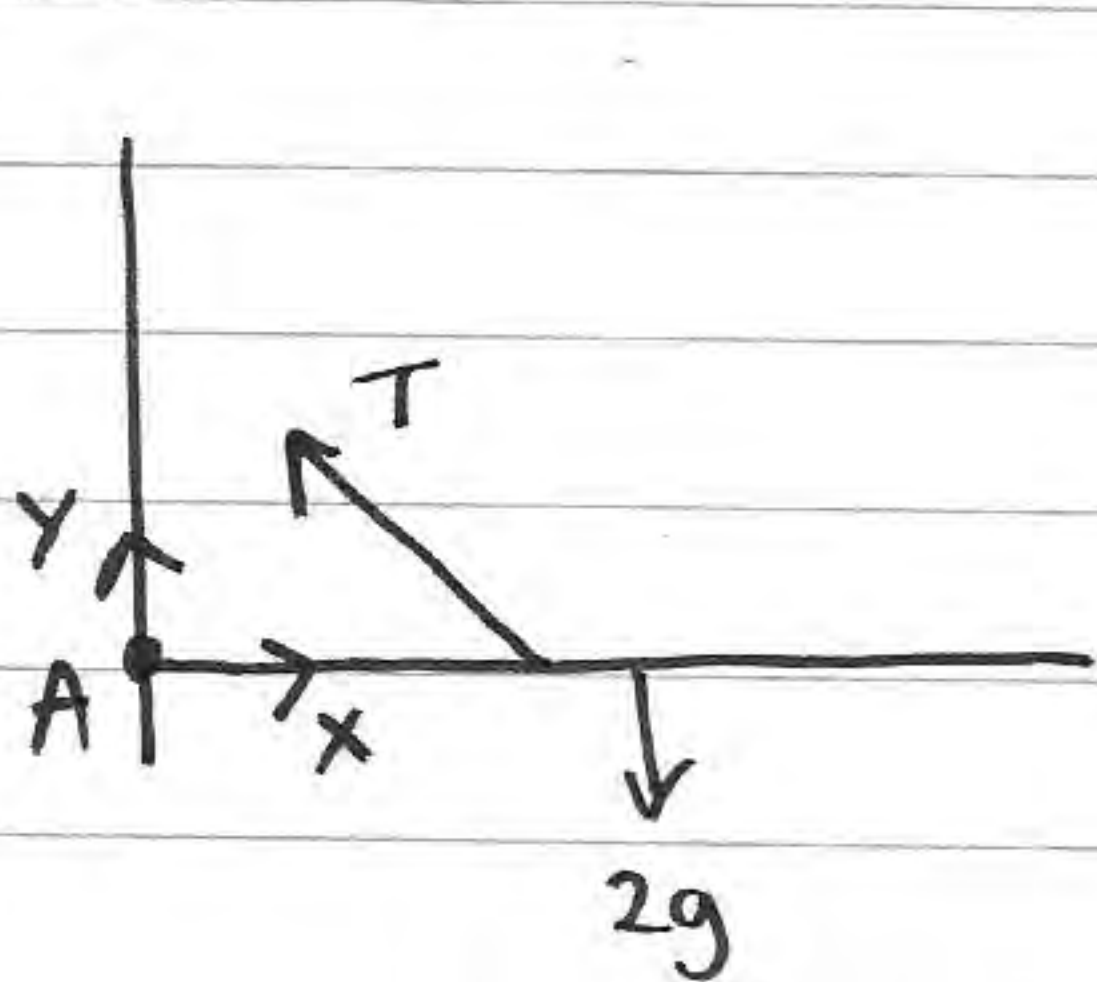
$$\frac{7}{5}mgh = \frac{1}{2}mv^2 + \frac{1}{2}(2m)v^2 + f_{\max} \times h \quad f_{\max} = \frac{5}{8} \times \frac{4}{5}mg$$

$$\Rightarrow \frac{7}{5}mgh = \frac{3}{2}mv^2 + \frac{1}{2}mgh$$

$$\textcircled{\times 10} \Rightarrow 14gh = 15v^2 + 5gh \Rightarrow 15v^2 = 9gh \Rightarrow v^2 = \underline{\underline{\frac{9}{15}gh}}$$

$$\therefore v^2 = \underline{\underline{\frac{3}{5}gh}}$$

5)



$$\vec{R}_f = 0 \quad X = \frac{\sqrt{3}}{2}T$$

$$R_f \uparrow = 0 \quad \frac{1}{2}T + Y \cdot 2 = 2g$$

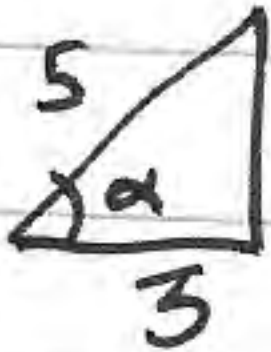
$$A2 \quad 2g \times \left(\frac{1}{2}AB \right) = \frac{1}{2}T \times 0.14 \quad T = 63$$

$$\Rightarrow AB = \frac{4.41}{9} = \underline{\underline{0.49m}} \text{ (2sf)}$$

$$X = \frac{63\sqrt{3}}{2} \quad Y = 2g - 31.5$$

$$Res = \sqrt{\left(\frac{63\sqrt{3}}{2} \right)^2 + (2g - 31.5)^2} = \underline{\underline{55.8N}} \text{ (3sf)}$$

6) $\textcircled{V \uparrow}$ $\uparrow u = 35 \sin \alpha = 28$
 $\uparrow v = 0$
 $\uparrow a = -9.8$

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

$0 = 28^2 - 19.6s \Rightarrow s = \underline{40\text{m}}$ above A

b) $\textcircled{\vec{M}}$ $\vec{u} = 35 \cos \alpha = 21$
 $x = 168$

$168 = 21t \Rightarrow t = 8\text{sec}$

$\textcircled{V \uparrow}$ $u = 28$
 $a = -9.8$
 $t = 8$

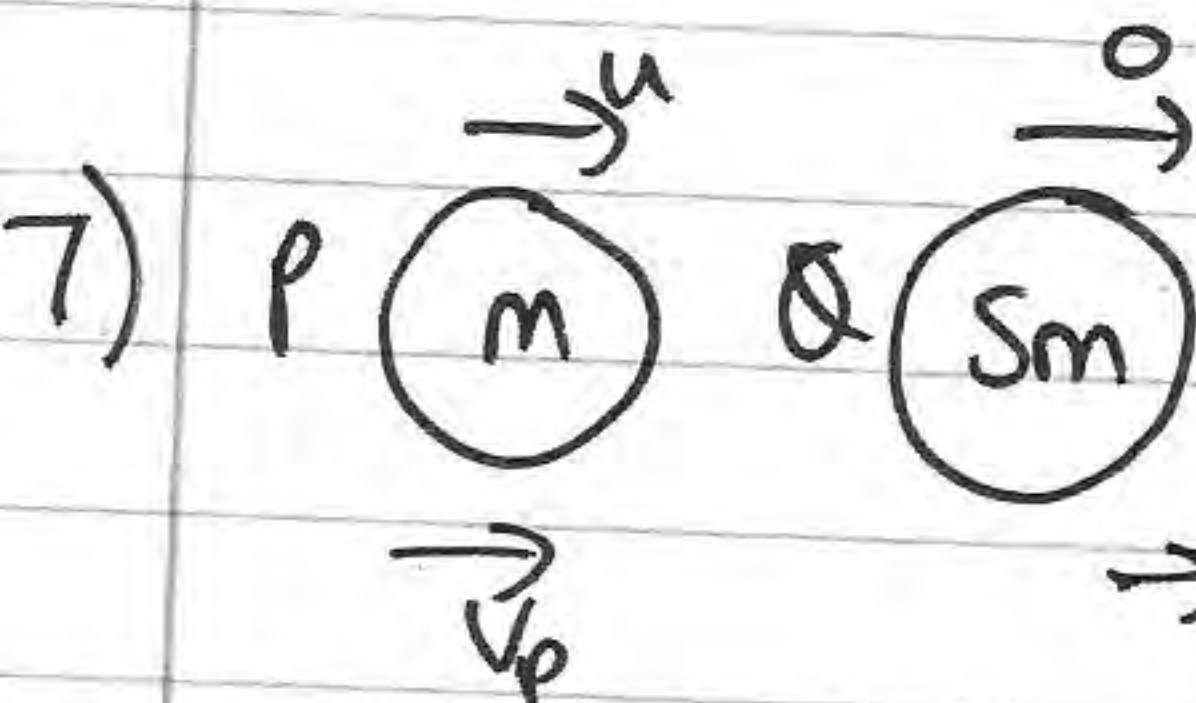
$s = 28 \times 8 - 4.9 \times 8^2 = -89.6\text{m}$

A is 89.6m above the ground

c) gain in KE = loss in PE

$\frac{1}{2}m(35)^2 + mg(89.6) = \frac{1}{2}mv^2 \Rightarrow v^2 = \frac{74529}{25}$

$\Rightarrow v = \underline{54.6\text{ms}^{-1}}$ (3sf)



before

$e = \frac{v_q - v_p}{u}$

$\Rightarrow v_q - v_p = eu$

$v_q = v_p + eu$

after

$$CLM \Rightarrow mu = mV_p + 5mV_q \quad V_q = V_p + eu$$

$$\Rightarrow u = V_p + 5V_p + 5eu$$

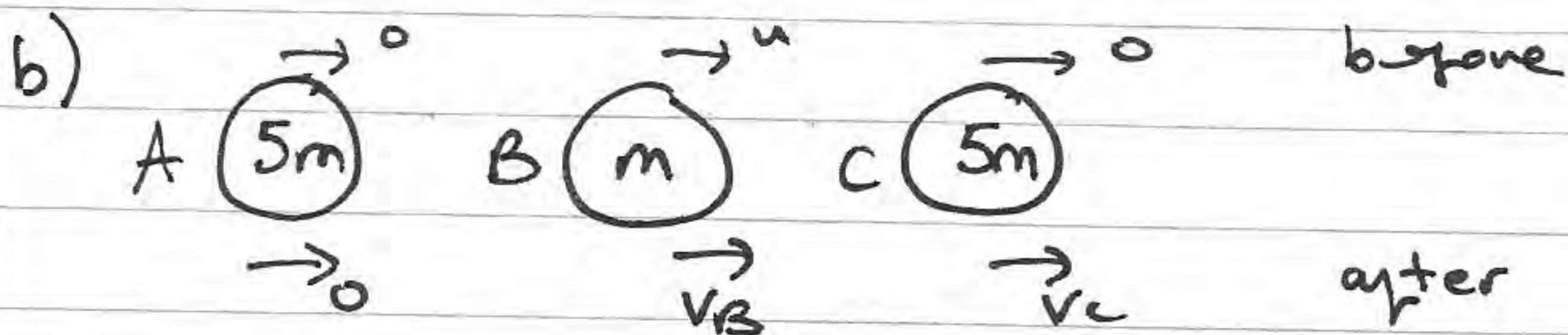
$$\Rightarrow 6V_p = u - 5eu$$

$$\Rightarrow V_p = \frac{1}{6}u(1 - 5e) \Rightarrow V_p = -\frac{1}{6}u(5e - 1)$$

$$\therefore \text{Speed} = \frac{1}{6}u(5e - 1)$$

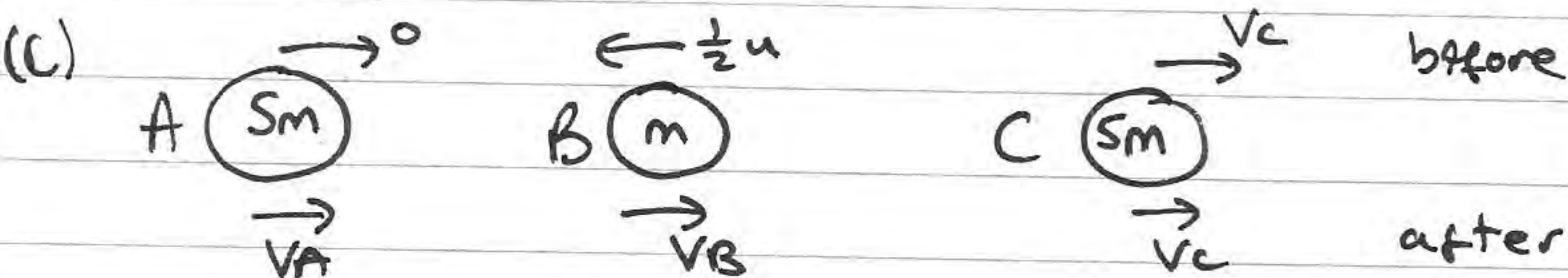
$$ii) V_q = V_p + eu = -\frac{1}{6}u(5e - 1) + eu = -\frac{5}{6}eu + eu + \frac{1}{6}u$$

$$V_q = \frac{1}{6}eu + \frac{1}{6}u \Rightarrow V_q = \frac{1}{6}u(e + 1) \quad \lambda = \frac{e + 1}{6}$$



$$\text{from (a)} \quad v_B = -\frac{1}{6}u(5e - 1) \quad e = \frac{4}{5} \quad v_B = -\frac{3}{6}u = -\frac{1}{2}u$$

$$v_B = \leftarrow \frac{1}{2}u \quad \text{so it will collide with A}$$



$$e_{AB} = \frac{V_B - V_A}{\frac{1}{2}u} = \frac{4}{5} \Rightarrow 5V_B - 5V_A = 2u$$

$$CLM_{AB} \quad -\frac{1}{2}mu = 5mV_A + 5mV_B$$

$$\Rightarrow -\frac{1}{2}mu =$$

$$e_{AB} = \frac{V_B - V_A}{\frac{1}{2}u} = \frac{4}{5} \Rightarrow 5V_B - 5V_A = 2u$$
$$\Rightarrow 5V_A = 5V_B - 2u$$

$$CLM_{AB} \Rightarrow -\frac{1}{2}mu = 5mV_A + mV_B$$

$$\Rightarrow -\frac{1}{2}u = 5V_B - 2u + V_B$$

$$\Rightarrow \frac{3}{2}u = 6V_B \Rightarrow V_B = \frac{3}{12}u = \frac{1}{4}u$$

$$\text{from (a)} \quad V_C = \frac{1}{6}u(e+1) \quad e = \frac{4}{5} \quad V_C = \frac{1}{6}u\left(\frac{9}{5}\right)$$
$$\Rightarrow V_C = \frac{3}{10}u$$

$$V_B = \frac{1}{4}u \quad V_C = \frac{3}{10}u$$

Since $\frac{1}{4}u < \frac{3}{10}u$ B and C will not collide again.

8) greatest speed when $acc = \frac{dv}{dt} = 0$

$$\frac{dv}{dt} = 8 - 3t^2 = 0 \quad 3t = 8 \quad t = \frac{8}{3}$$

$$v = 8\left(\frac{8}{3}\right) - \frac{3}{2}\left(\frac{8}{3}\right)^2 = \underline{\underline{\frac{32}{3} \text{ ms}^{-1}}}$$

b) $S = \int v dt = 4t^2 - \frac{1}{2}t^3 + C \quad t=0, S=0 \Rightarrow C=0$

$$S = 4t^2 - \frac{1}{2}t^3, \quad t=4 \quad S=32\text{m}$$

c) at rest when $v=0 \Rightarrow t=8$

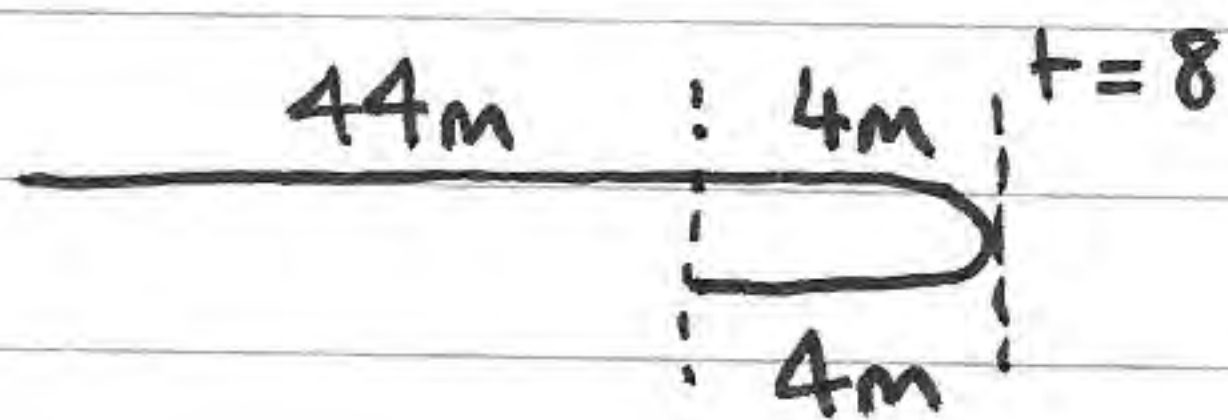
d) $S = \int v dt = 16t - t^2 + C \quad t=4, S=32$

$$\Rightarrow 32 = 64 - 16 + C \Rightarrow C = -16$$

$$S = 16t - t^2 - 16 \quad \text{when } t=10 \quad S=44\text{m}$$

displacement from 0 = 44m but the particle travels towards the origin after 8 sec.

$$t=8 \quad S = 16(8) - 8^2 - 16 = 48\text{m}$$



$$\therefore \text{total distance travelled} = 44 + 4 + 4 = \underline{\underline{52\text{m}}}$$