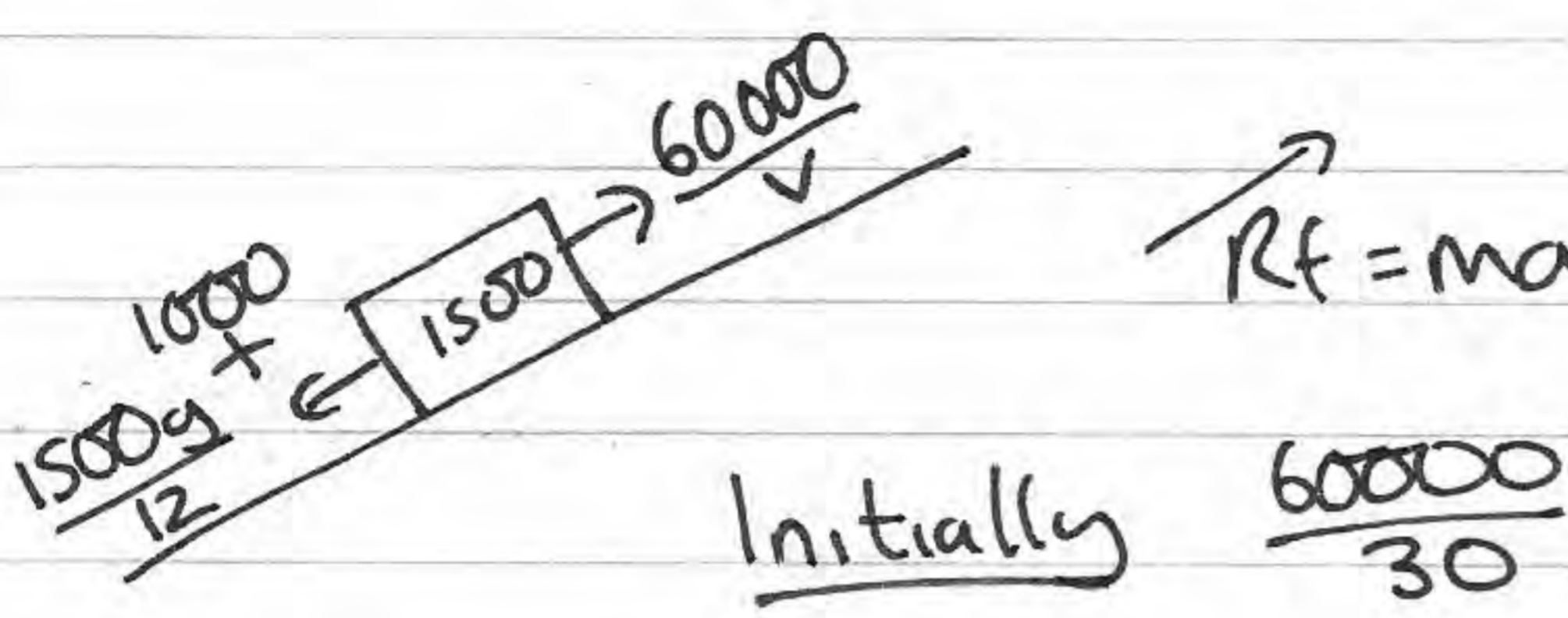


## JAN02 M2

1)  $KE_{lost} = Wd \text{ against Res} \Rightarrow \frac{1}{2}(4)25^2 = R \times 200$   
 $\Rightarrow R = \underline{6.25 N}$

2)   
Initially  $\frac{60000}{30} - 1000 - \frac{1500g}{12} = 1500a$   
 $\Rightarrow \text{Initial acc} = \underline{\underline{\frac{-3}{20} \text{ ms}^{-2}}}$

b)  $R_f \uparrow = 0 \quad \frac{80000}{v} = 1000 + \frac{1500g}{12} \Rightarrow v = \frac{80000}{22.25}$   
 $\Rightarrow v = \underline{36 \text{ ms}^{-1}} \text{ (2sf)}$

c) Resistance is likely to increase as the speed increases.

3)  $v = 3t^2 i + (6t - 4) j \quad a = \frac{dv}{dt} = 6ti + 6j$   
 $t = 2 \quad a = 12i + 6j \Rightarrow |a| = \sqrt{12^2 + 6^2} = 6\sqrt{5}$

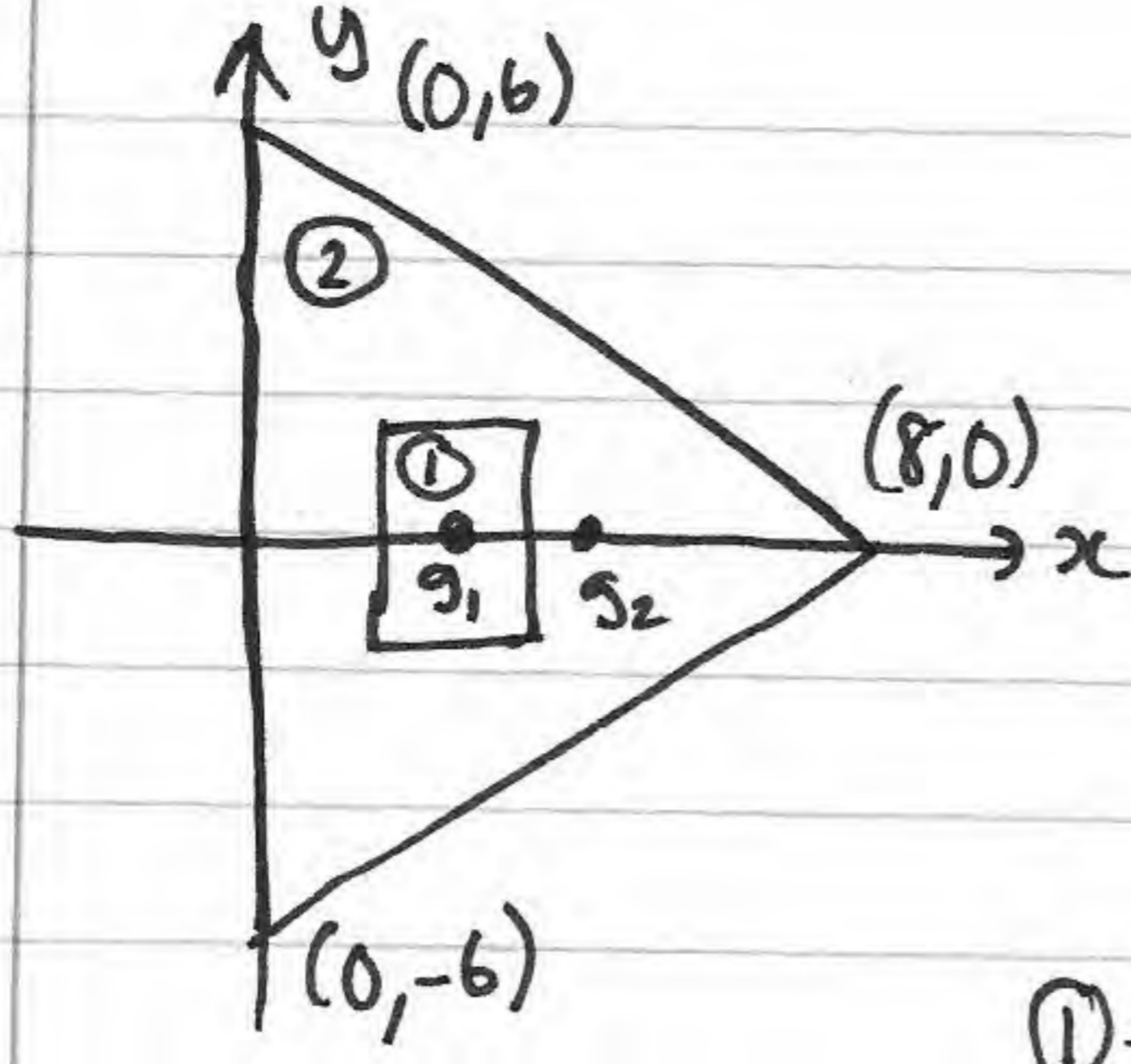
$f = ma \Rightarrow |f| = 0.3 \times 6\sqrt{5} = \underline{4.02 N} \text{ (3sf)}$

b)  $s = \int v dt = (t^3 + C_1)i + (3t^2 - 4t + C_2)j$

$t = 0 \quad s = 3i - 4j \Rightarrow C_1 = 3, C_2 = -4$

$t = 4 \quad s = (64 + 3)i + (3 \times 4^2 - 4^2 + -4)j = \underline{67i + 28j} \text{ m}$

4)



mass per unit area =  $u$

①  $M = 4a^2u$   $g_1(2a, 0)$

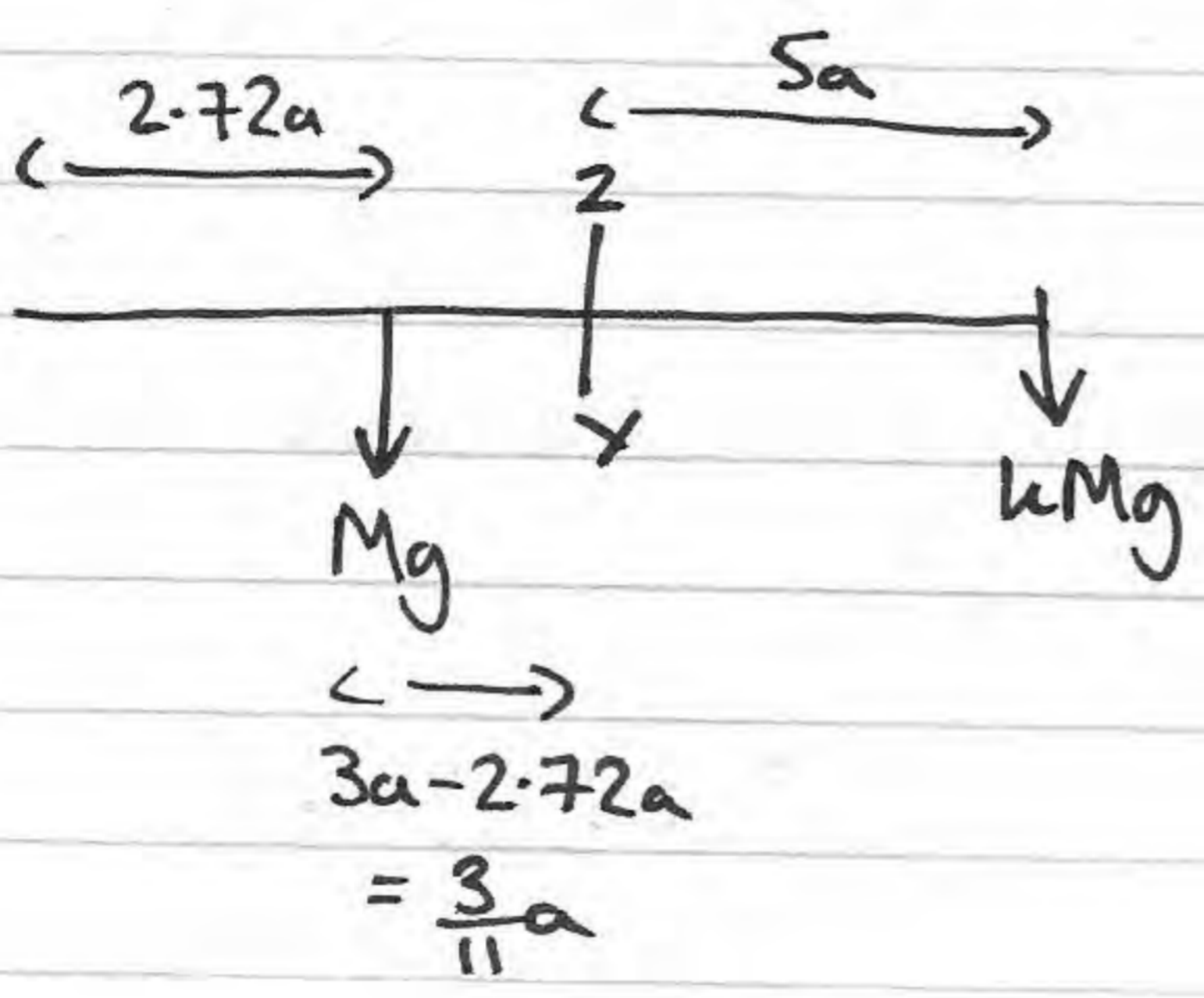
②  $M = 44a^2u$   $g_2(\bar{x}, 0)$

①+②  $M = 48a^2u$   $g_{1+2}(\frac{8}{3}a, 0)$

$4a^2ug \times 2a + 44a^2ug \times \bar{x} = 48a^2ug \times \frac{8}{3}a$

$\Rightarrow 8a + 44\bar{x} = 128a \Rightarrow 44\bar{x} = 120a \Rightarrow \bar{x} = \underline{2.72a}$

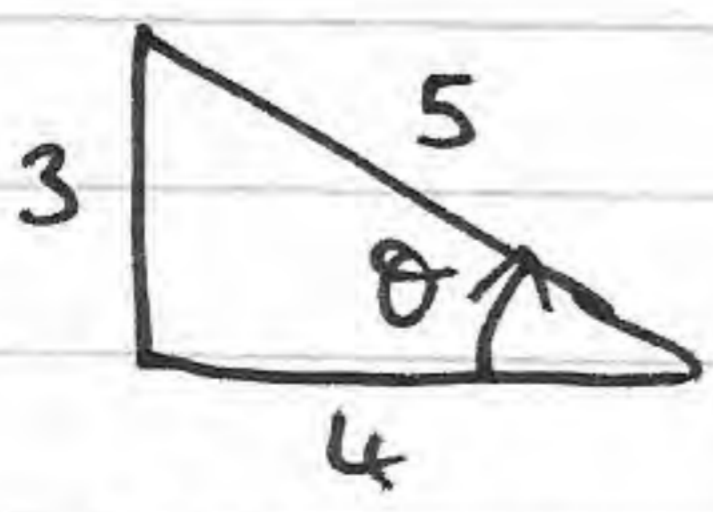
b)



$uMg \times 5a = Mg \times \frac{3}{11}a$   
 $= 5u = \frac{3}{11} \Rightarrow u = \frac{3}{55}$

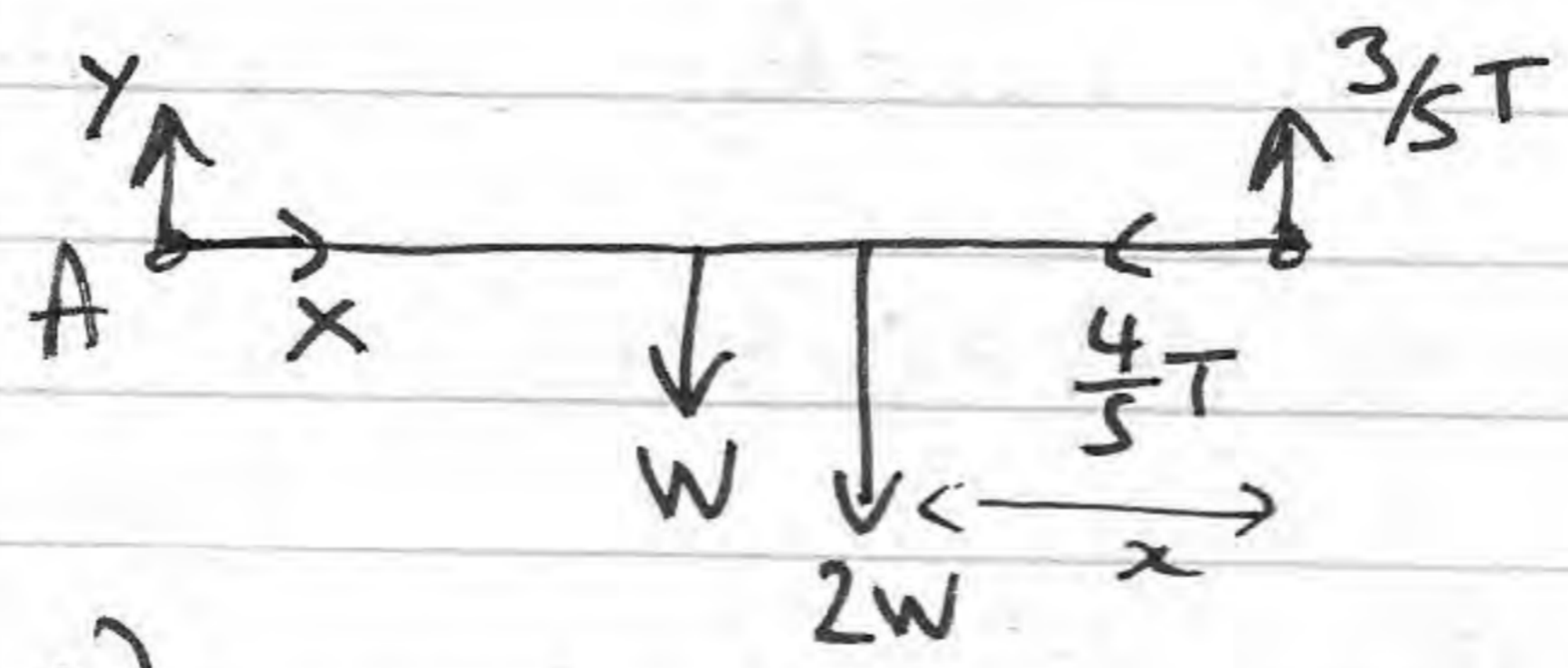
5)

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



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

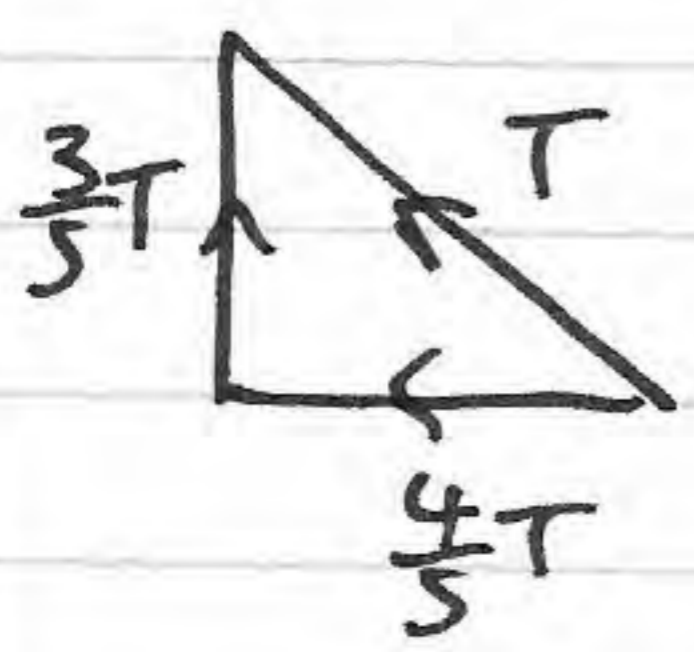
$\tan \theta = \frac{3}{4}$



$W \times a + 2W \times (2a - x) = \frac{3}{5}T \times 2a$

$\Rightarrow 5W(a + (2a - x) \times 2) = 6a \times T$

$\Rightarrow \frac{5W(5a - 2x)}{6a} = T \quad \#$



$$R_{f\uparrow} = 0 \Rightarrow Y + \frac{3}{5}T = 3W \Rightarrow \frac{3}{5}T = 3W - \frac{7}{6}W$$

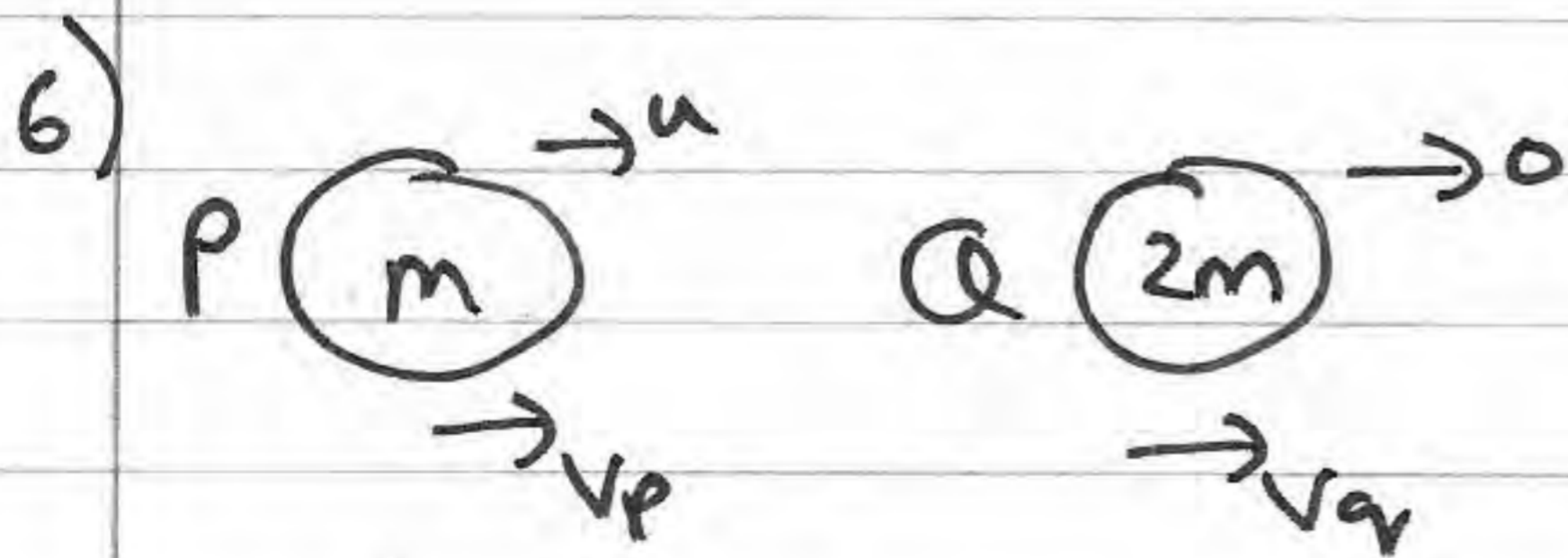
$$\Rightarrow \frac{3}{5}T = \frac{11}{6}W \Rightarrow T = \frac{55}{18}W$$

$$\therefore \frac{55}{18}W = \frac{5W(Sa - 2x)}{6a} \Rightarrow \frac{11}{18} \times 6a = Sa - 2x$$

$$\Rightarrow \frac{11}{3}a = 5a - 2x \Rightarrow 2x = \frac{4}{3}a \Rightarrow x = \frac{2}{3}a$$

$$c) \vec{R}_f = 0 \quad X = \frac{4}{5}T = \frac{4}{5} \left( \frac{55}{18}W \right) \Rightarrow X = \frac{44}{18}W$$

$$X = \frac{22}{9}W$$



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

$$v_p = v_q - eu$$

$$CLM \Rightarrow m\cancel{u} = m\cancel{v_p} + 2m\cancel{v_q} \Rightarrow u = v_q - eu + 2v_q$$

$$\Rightarrow u + eu = 3v_q \Rightarrow v_q = \frac{1}{3}u(1+e)$$

$$b) v_p = \frac{1}{3}u(1+e) - eu \frac{x_3}{x_3} = \frac{1}{3}u(1+e-3e)$$

$$\therefore v_p = \frac{1}{3}u(1-2e)$$

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

$$\Rightarrow 1 > 2e \Rightarrow \underline{e < \frac{1}{2}} \quad (0 < e < \frac{1}{2})$$

$$c) e = \frac{1}{4} \Rightarrow v_p = \frac{1}{3}u(1-2(\frac{1}{4})) = \frac{1}{6}u$$

$$v_q = \frac{1}{3}u(1+2(\frac{1}{4})) = \frac{5}{12}u$$

$$a) KE_{\text{before}} = \frac{1}{2}m(u)^2$$

$$KE_{\text{after}} = \frac{1}{2}m(\frac{1}{6}u)^2 + \frac{1}{2}m(\frac{5}{12}u)^2 = \frac{3}{16}mu^2$$

$$\Rightarrow KE_{\text{lost}} = \underline{\frac{5}{16}mu^2}$$

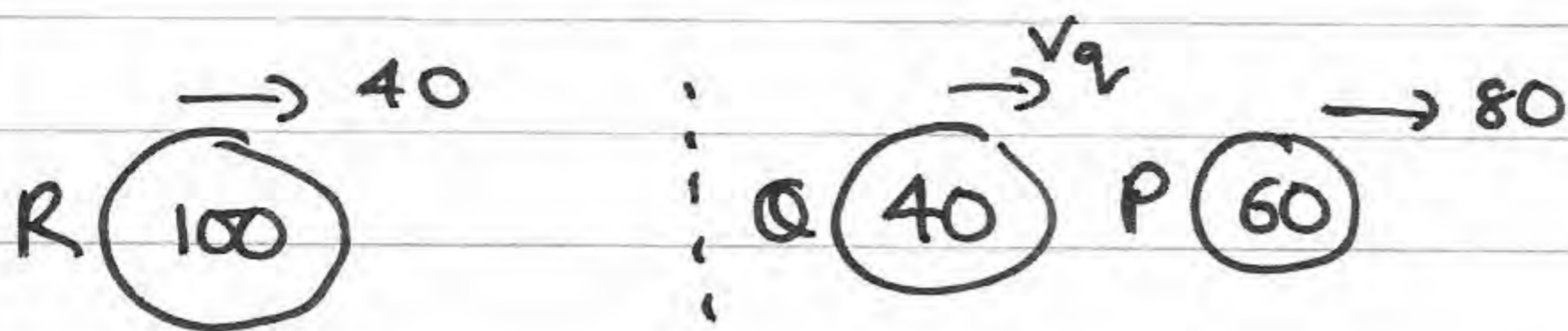
d) Heat, Sound.

$$7) \textcircled{v \uparrow} \uparrow u = 80 \sin 60 \quad a \uparrow = -9.8 \quad v \uparrow = 0$$

$$v^2 = u^2 + 2as \Rightarrow 0 = 4800 - 19.6s \Rightarrow s = 244.9 \Rightarrow \underline{265 \text{ m above ground}}$$

$$b) v \uparrow = u \uparrow + at \Rightarrow 0 = 40\sqrt{3} - 9.8t \Rightarrow t = \underline{7.1 \text{ sec (2sf)}}$$

c)  $\vec{v}_e = 80 \cos 60 = 40$



CLM  $\Rightarrow 100 \times 40 = 40v_q + 60 \times 80$

$\Rightarrow -800 = 40v_q \Rightarrow v_q = -20$

$\Rightarrow$  Speed Q =  $20 \text{ ms}^{-1}$  ←

d) (R)  $\vec{H}$   $v_e = 40, t = 7.1 \dots \Rightarrow \vec{OB} = 282.783 \dots$

(Q)  $u \downarrow = 0$   $S = ut + \frac{1}{2}at^2$   
 $a \downarrow = 9.8$   $265 \dots = 4.9t^2 \Rightarrow t = 7.35 \dots$   
 $S \downarrow = 265 \dots$

←  $u = 20$   $t = 7.35 \Rightarrow BC = 147.052 \dots$

$\therefore \underline{OC = 136 \text{ m}}$