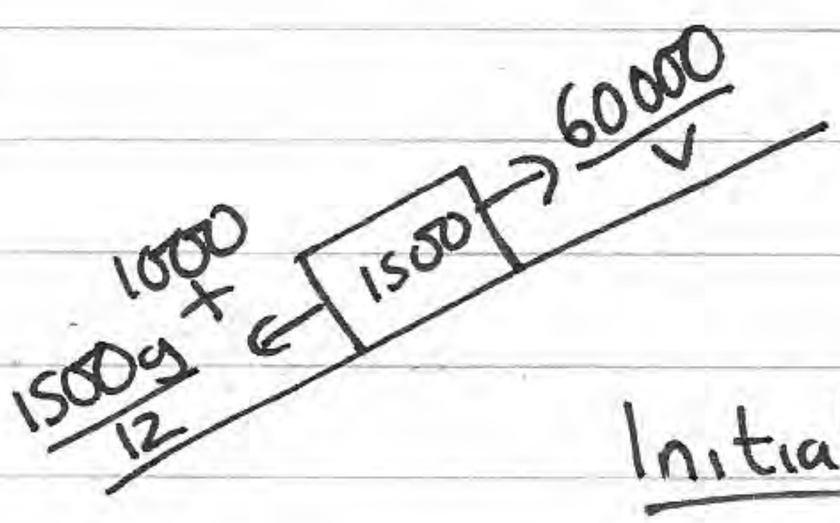
JAN02 M2

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

$\Rightarrow R = \underline{6.25N}$

2)



$\overrightarrow{Rf} = ma$

Initially $\frac{60000}{30} - 1000 - \frac{1500g}{12} = 1500a$

$\Rightarrow$ Initial acc $= \underline{\frac{-3}{20} ms^{-2}}$

b) $Rf \nearrow = 0$ $\frac{80000}{v} = 1000 + \frac{1500g}{12} \Rightarrow v = \frac{80000}{225}$

$\Rightarrow v = \underline{36 ms^{-1} (2sf)}$

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

3) $v = 3t^2 i + (6t-4)j$ $a = \frac{dv}{dt} = 6ti + 6j$

$t = 2$ $a = 12i + 6j$ $\Rightarrow |a| = \sqrt{12^2 + 6^2} = 6\sqrt{5}$

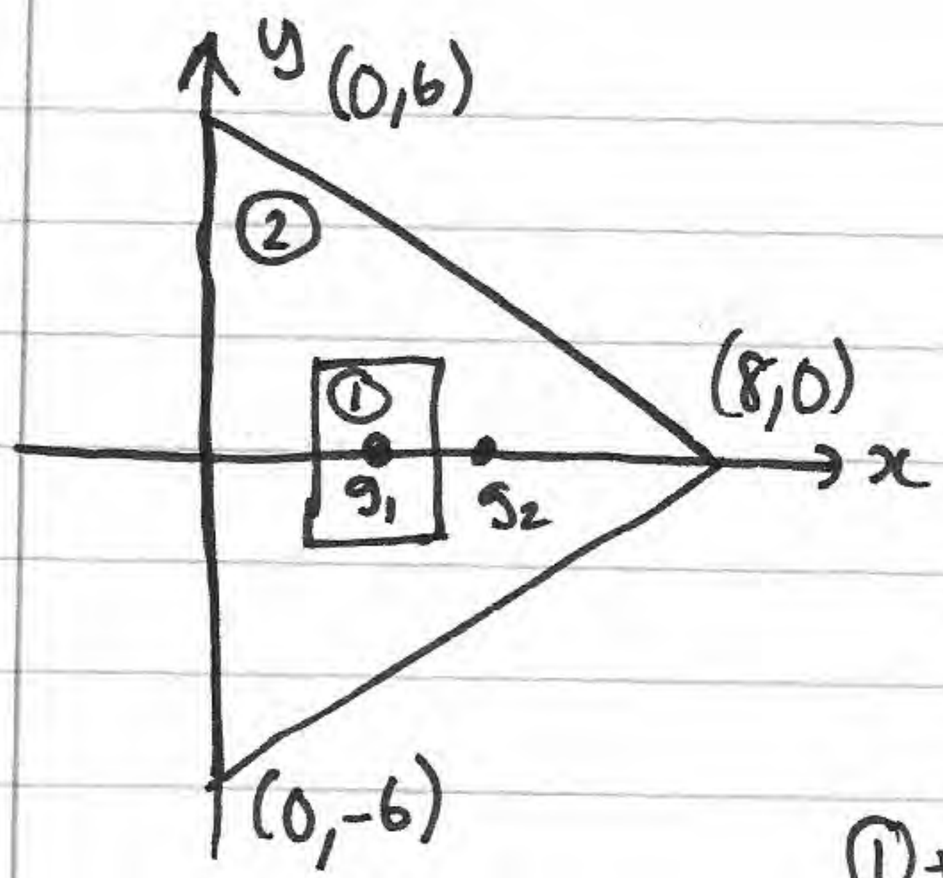
$f = ma \Rightarrow |f| = 0.3 \times 6\sqrt{5} = \underline{4.02N} (3sf)$

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

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

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

4)



mass per unit area $= k$

① $M = 4a^2k$ $g_1(2a, 0)$

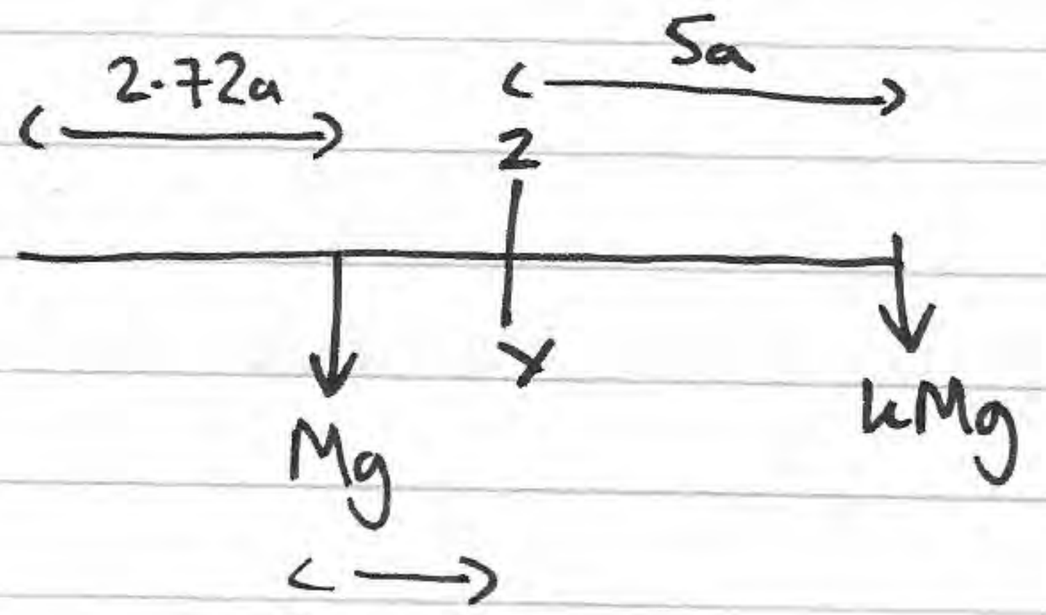
② $M = 44a^2k$ $g_2(\bar{x}, 0)$

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

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

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

b)

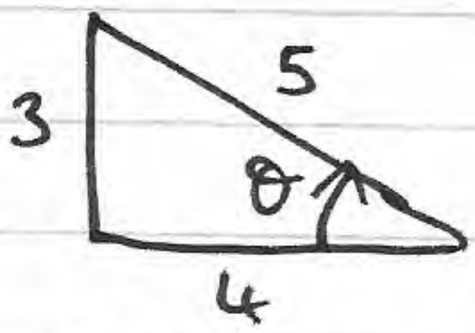


$3a - 2.72a = \frac{3}{11}a$

ZY↻ $kMg \times 5a = Mg \times \frac{3}{11}a$

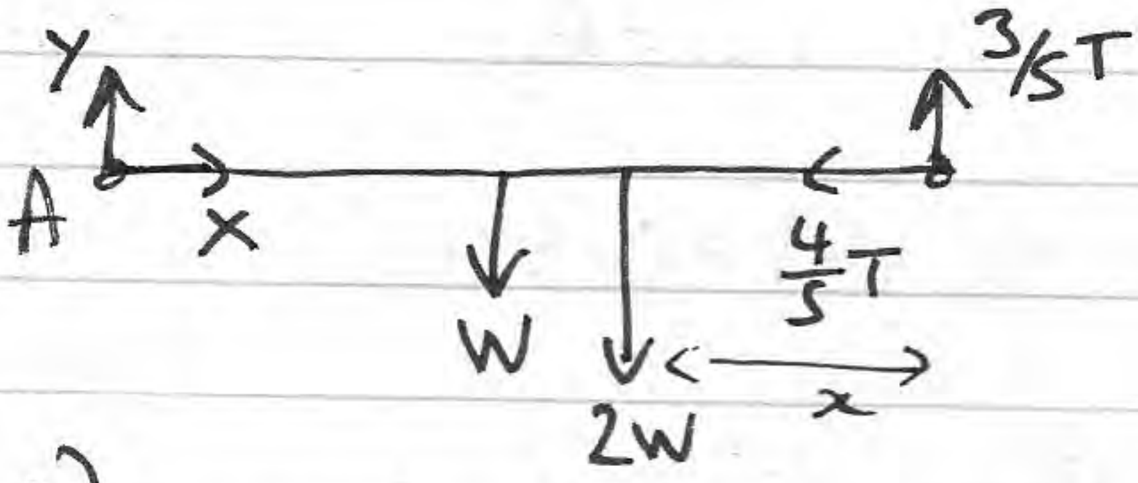
$= 5k = \frac{3}{11} \Rightarrow k = \frac{3}{55}$

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



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

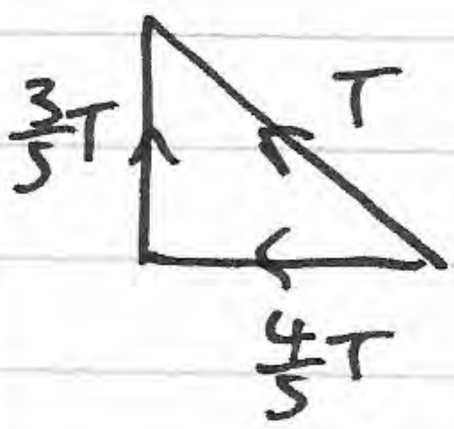
$\tan\theta = \frac{3}{4}$



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

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

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



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

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

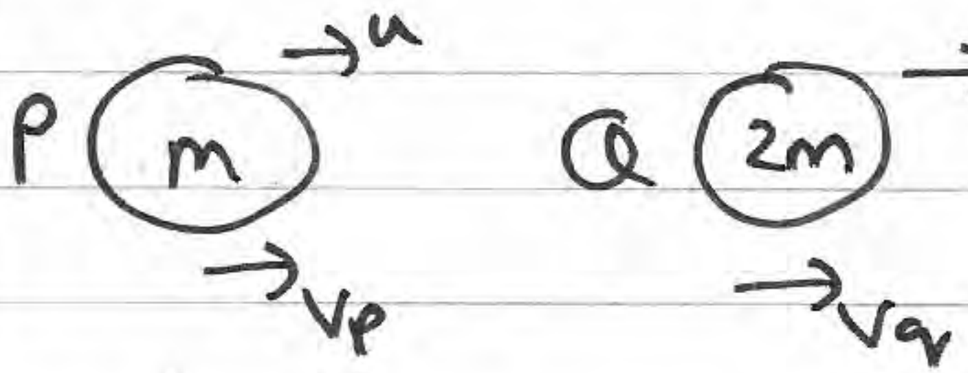
$\therefore \frac{55}{18}W = \frac{5W(5a-2x)}{6a} \Rightarrow \frac{11}{18} \times 6a = 5a - 2x$

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

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

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

6)



$e = \frac{V_Q - V_P}{u} \Rightarrow eu = V_Q - V_P$

$V_P = V_Q - eu$

CLM $\Rightarrow mu = mV_P + 2mV_Q \Rightarrow u = V_Q - eu + 2V_Q$

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

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

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

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

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

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

$V_q = \frac{1}{3}u(1+\frac{21}{4}) = \frac{5}{12}u$

(2) KE before $= \frac{1}{2}m(u)^2$ J

KE 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 lost $= \underline{\frac{5}{16}Mu^2}$

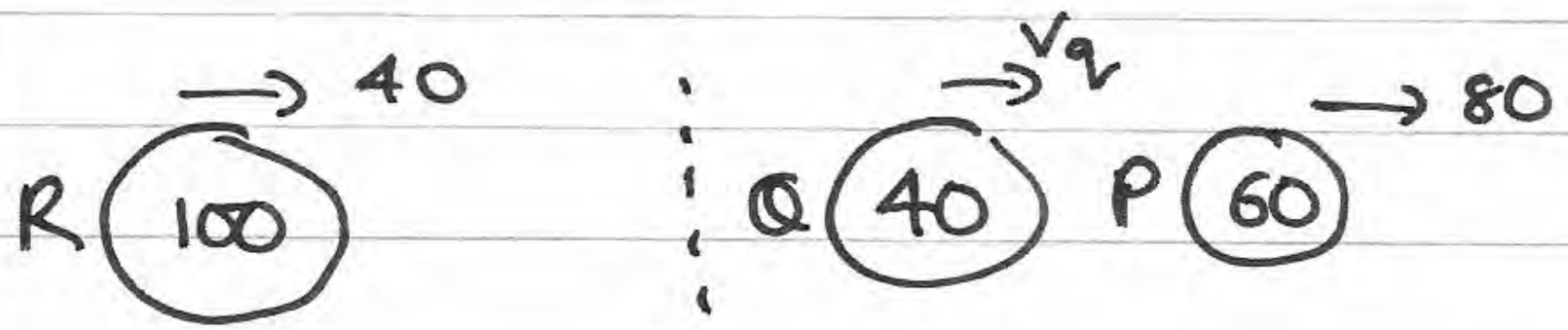
d) Heat, Sound.

7) (V↑) $\uparrow u = 80\sin 60$ $a\uparrow = -9.8$ $V\uparrow = 0$

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

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

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



CLM $\Rightarrow 100\times40 = 40Vq + 60\times80$

$\Rightarrow -800 = 40Vq \Rightarrow Vq = -20$ ←

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

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

(Q) $u\downarrow = 0$ $S = ut + \frac{1}{2}at^2$

$a\downarrow = 9.8$ $265\ldots = 4.9t^2 \Rightarrow t = 7.35\ldots$

$S\downarrow = 265\ldots$

$\leftarrow u = 20$ $t = 7.35 \Rightarrow BC = 147.052\ldots$

$\therefore$ OC = 136m