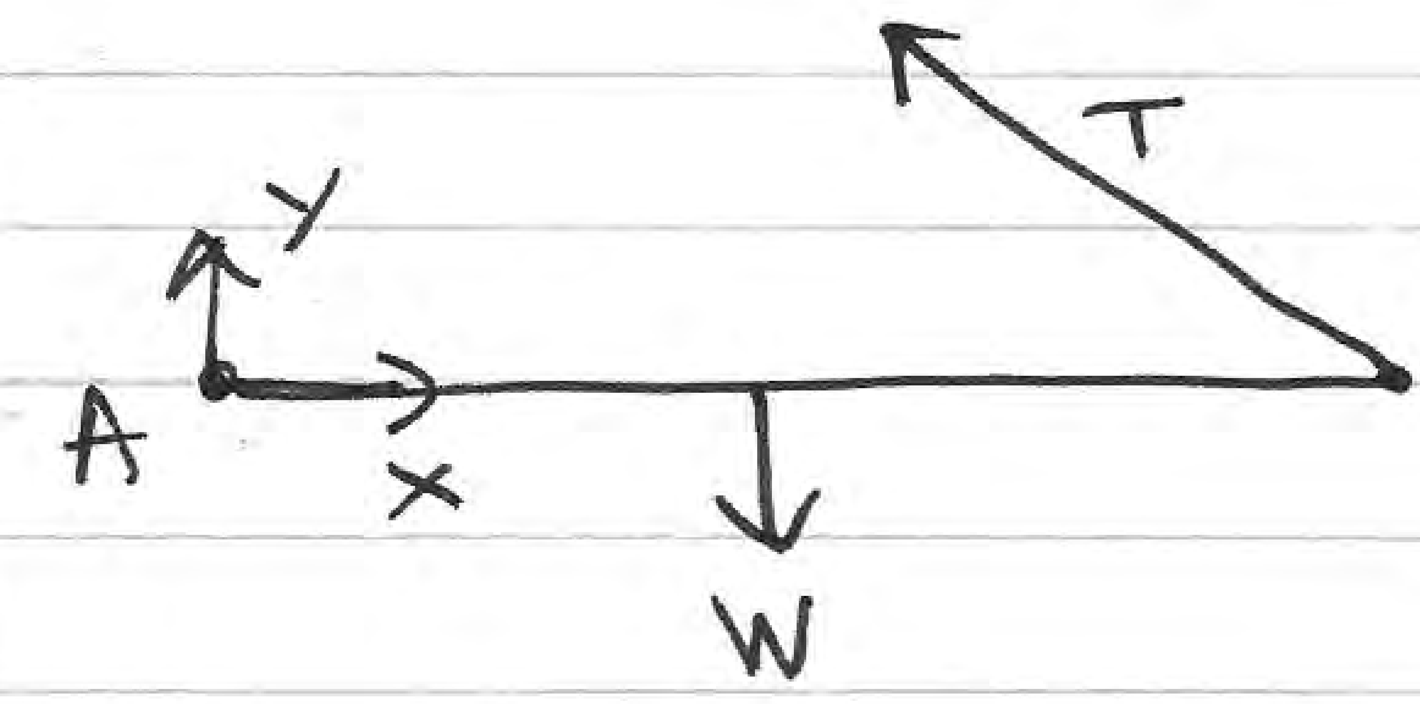
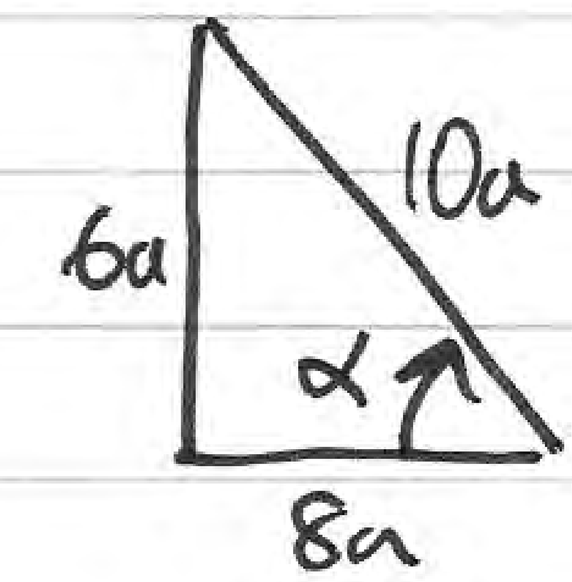
M2 JAN 05

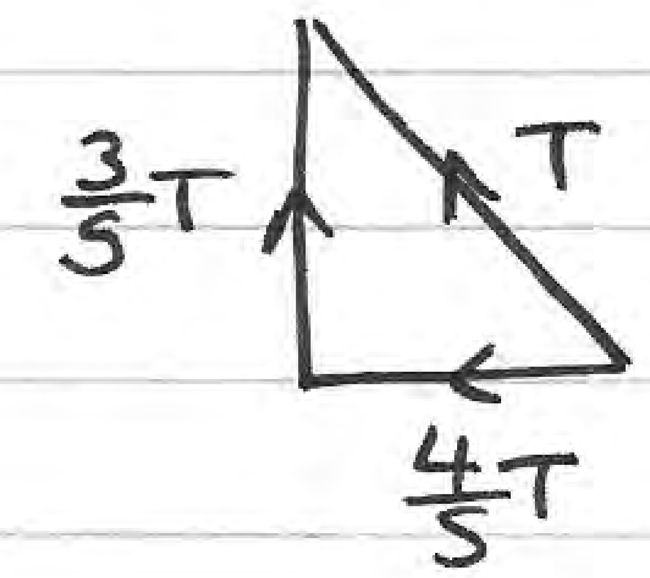
1)





$\cos\alpha = \frac{8}{10}$

$\sin\alpha = \frac{6}{10}$



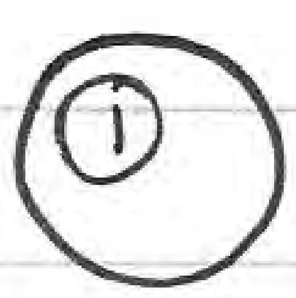
$R_f \uparrow = 0 \quad \frac{3}{5}T + Y = W$

$\overrightarrow{R_f} = 0 \Rightarrow X = \frac{4}{5}T$

a) $A \curvearrowleft \quad W \times 4a = \frac{3}{5}T \times 8a \Rightarrow T = \frac{4W \times 5}{24} \Rightarrow T = \frac{5}{6}W$ #

b) $X = \frac{4}{5}T = \frac{4}{5} \times \frac{5}{6}W \Rightarrow X = \frac{2}{3}W$

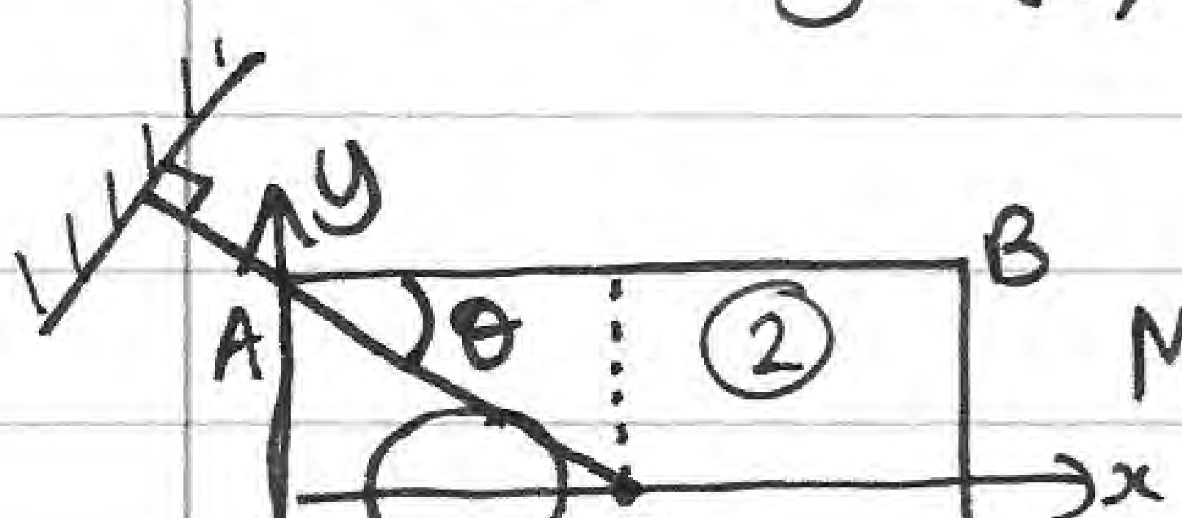
2)



$M = 9\pi k$
$g_1 = (6,0)$

$9\pi k g \times 6 + (200 - 9\pi)k g \times \bar{x} = 200 k g \times 10$

$54\pi + (200 - 9\pi)\bar{x} = 2000$

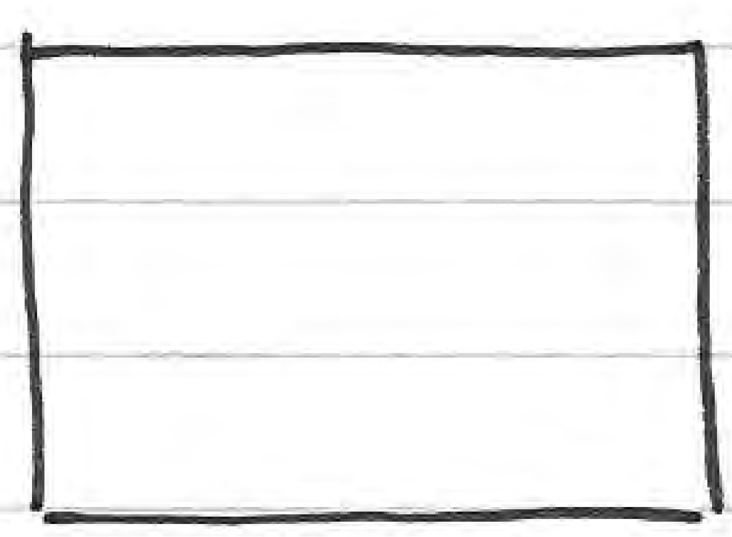


$M = (200 - 9\pi)k$

$g_2(\bar{x}, 0)$

$\Rightarrow \bar{x} = \frac{2000 - 54\pi}{200 - 9\pi}$

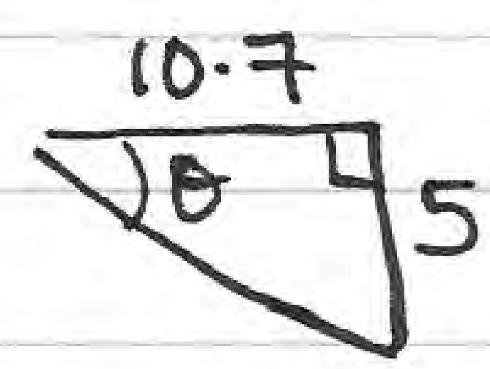
$\bar{x} = 10.7 \quad (3sf)$



$M = 200k$
$G(10,0)$

k = mass per cm^2

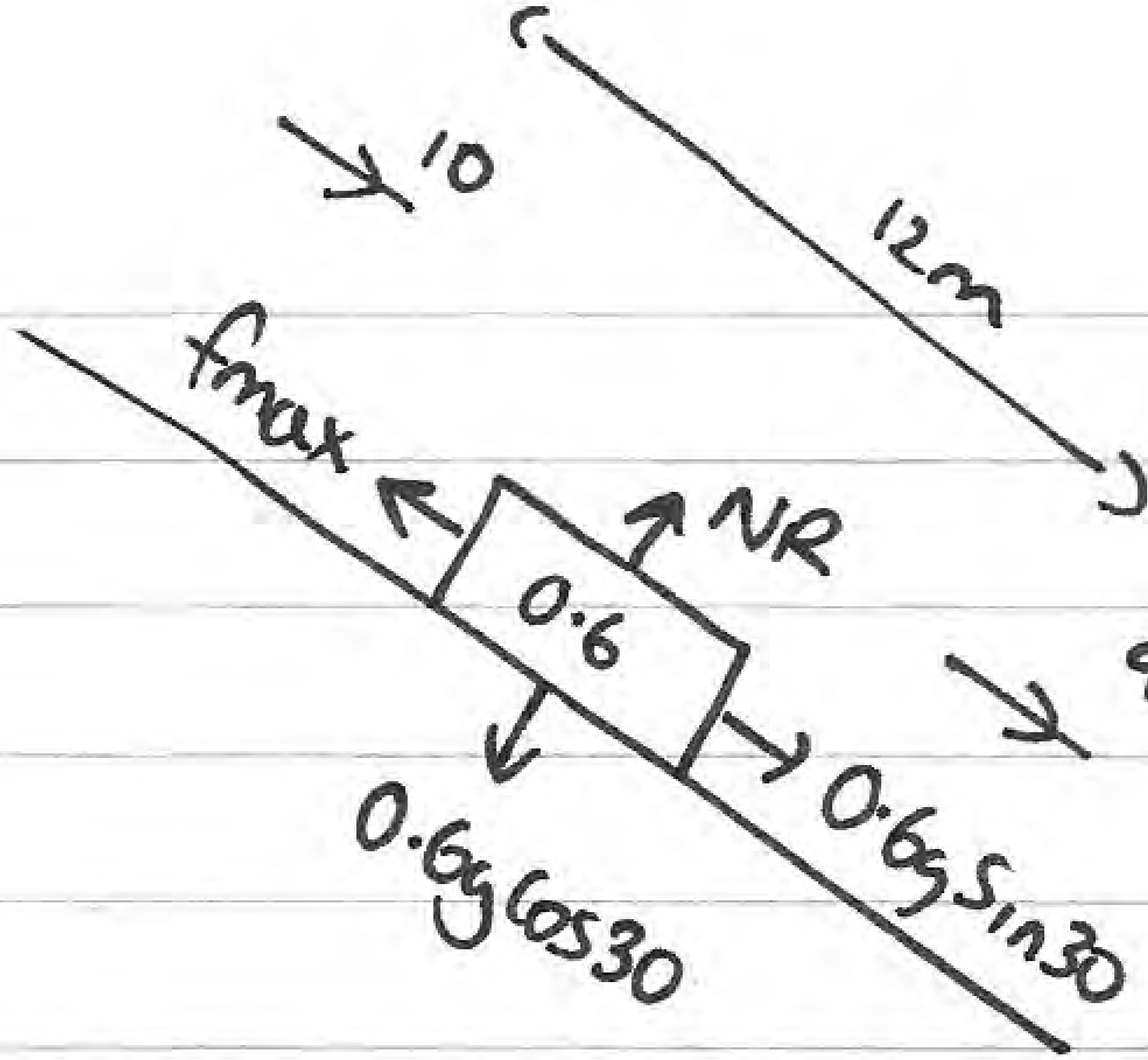
b)

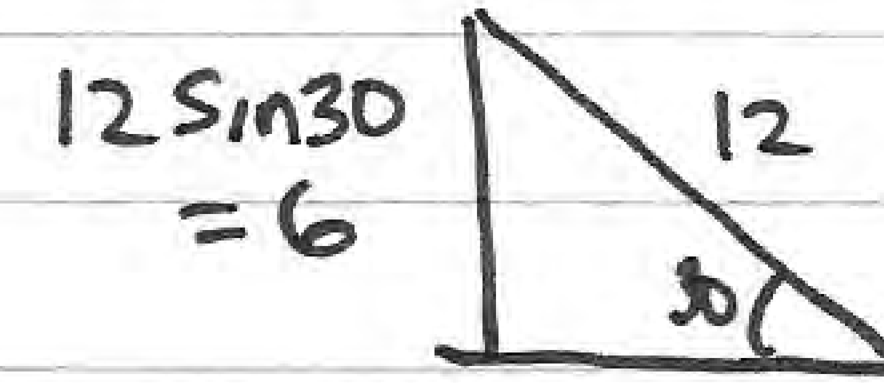


$\theta = \tan^{-1}\left(\frac{5}{10.65859...}\right)$

$\theta = 25°$ (nd)

3)





PE lost $= 0.6g(6) = \underline{3.6g\ J}$.

KE lost $= \frac{1}{2}(0.6)(10^2 - 9^2)$

$= \underline{5.7\ J}$.

Total loss $= 5.7 + 3.6g$

$= \underline{41.0\ J}$ (3sf)

b) $KE_A + PE_A$ - Wd against friction $= KE_B + PE_B$

$\Rightarrow$ KE lost + PE lost = Wd against friction.

$\Rightarrow$ $40.98 = f_{max} \times 12$ $\Rightarrow$ $3.415 = \mu \times NR$

$3.415 = \mu \times 0.6g\left(\frac{\sqrt{3}}{2}\right)$

$\Rightarrow \underline{\mu = 0.67}$ (2sf)

4) $v = (6t+4)i + (t^2+3t)j$

$a = \frac{dv}{dt} = 6i + (2t+3)j \quad t=4,\ a = 6i + 11j$

$F = ma = 0.4(6i+11j) = 2.4i + 4.4j \Rightarrow |F| = \sqrt{2.4^2 + 4.4^2}$

$|F| = 5.01\text{N (3sf)}$

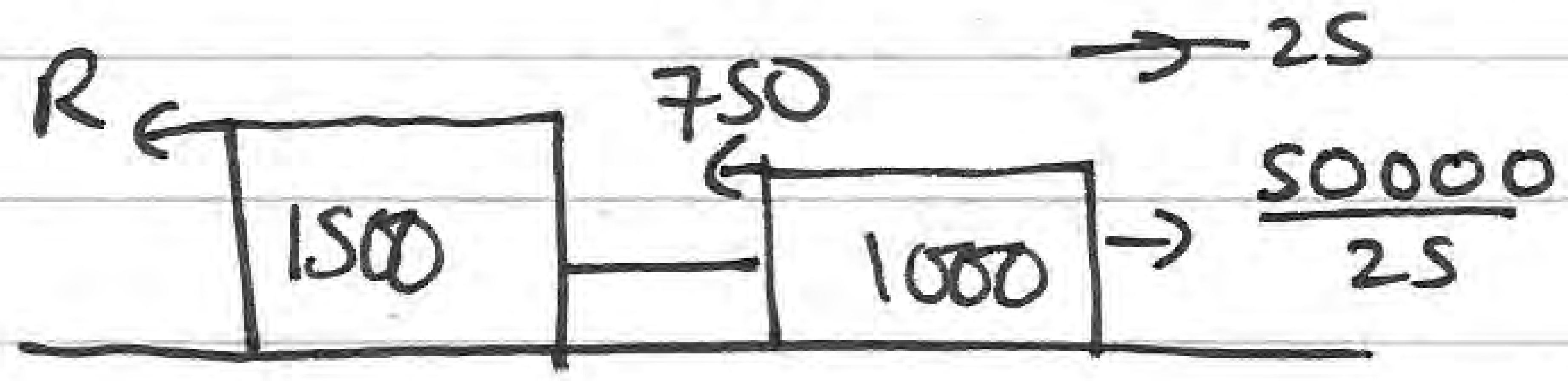
b) $S = \int v\,dt = (3t^2+4t+C_1)i + (\frac{1}{3}t^3 + \frac{3}{2}t^2 + C_2)j$

$t=0,\ S=-3i+4j \Rightarrow C_1 = -3,\ C_2 = 4.$

$S = (3t^2+4t-3)i + (\frac{1}{3}t^3+\frac{3}{2}t^2+4)j$

$t=4 \quad S = 61i + 49\frac{1}{3}j \Rightarrow |OS| = \sqrt{61^2 + (49\frac{1}{3})^2} = 78.5\text{m (3sf)}$

5)

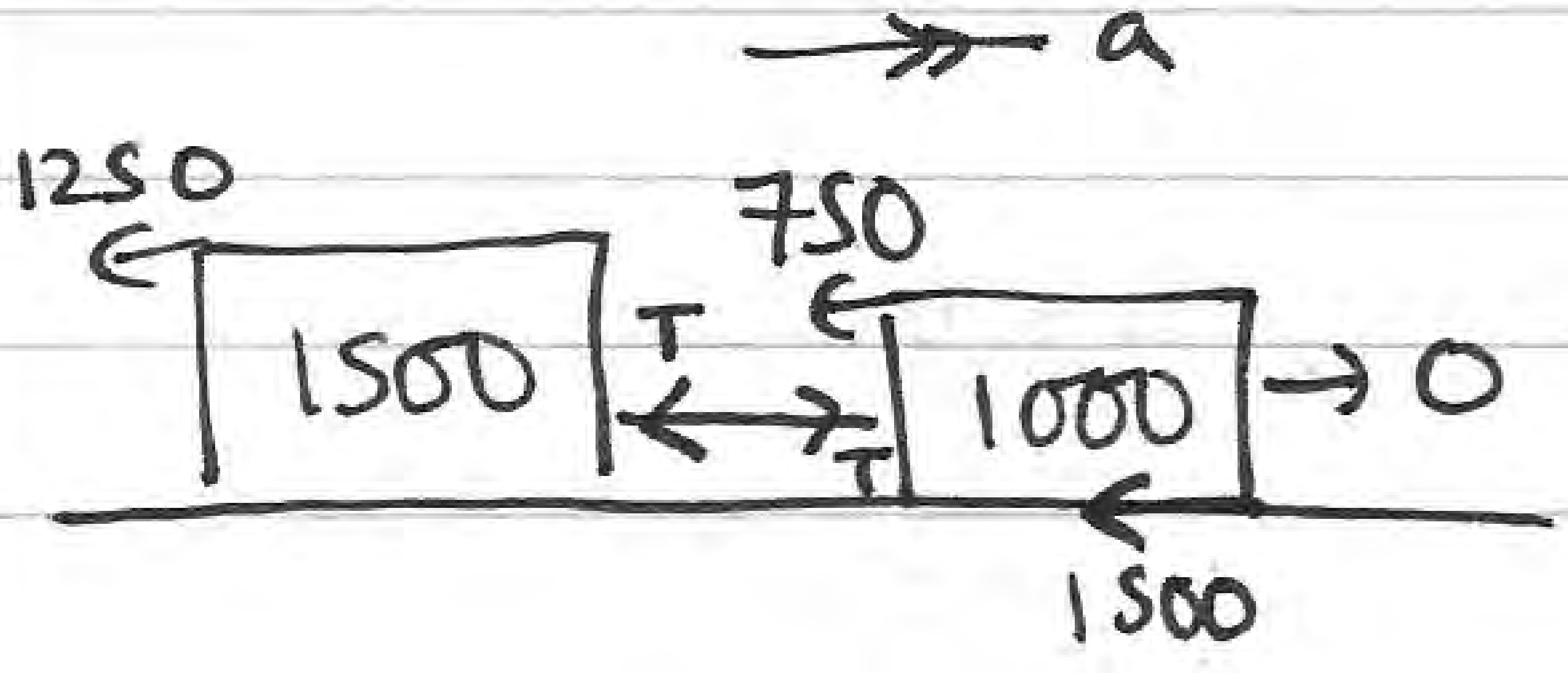


$\overrightarrow{Rt} = 0$

$\frac{50000}{25} - 750 - R = 0$

$\Rightarrow \underline{R = 1250\text{N}}$

b)

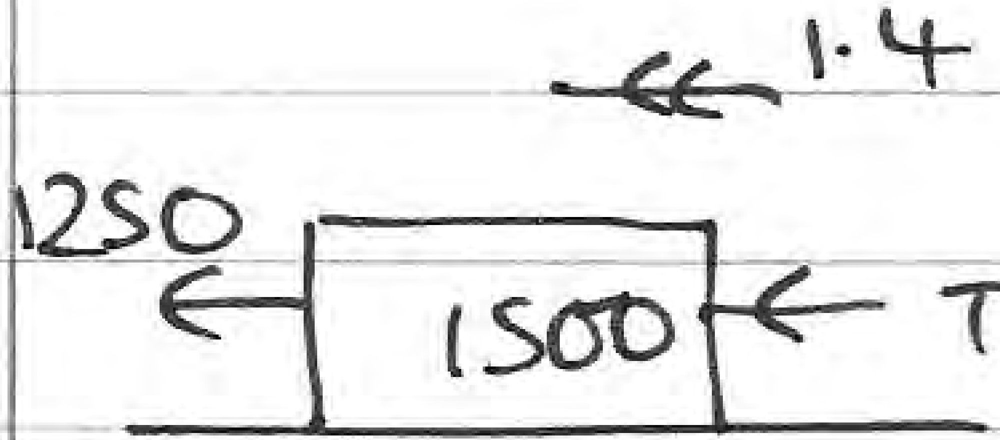


$\overrightarrow{Rt} = ma$

$\cancel{T} - \cancel{T} - 1500 - 750 - 1250 = 2500a$

$a = \frac{-3500}{2500} = \underline{-1.4\ ms^{-2}}$

$\Rightarrow dec = \underline{1.4 ms^{-2}}$

c) 

$\overleftarrow{Rf} = Ma \Rightarrow 1250 + T = 1500(1.4) \Rightarrow \underline{T = 850N}$

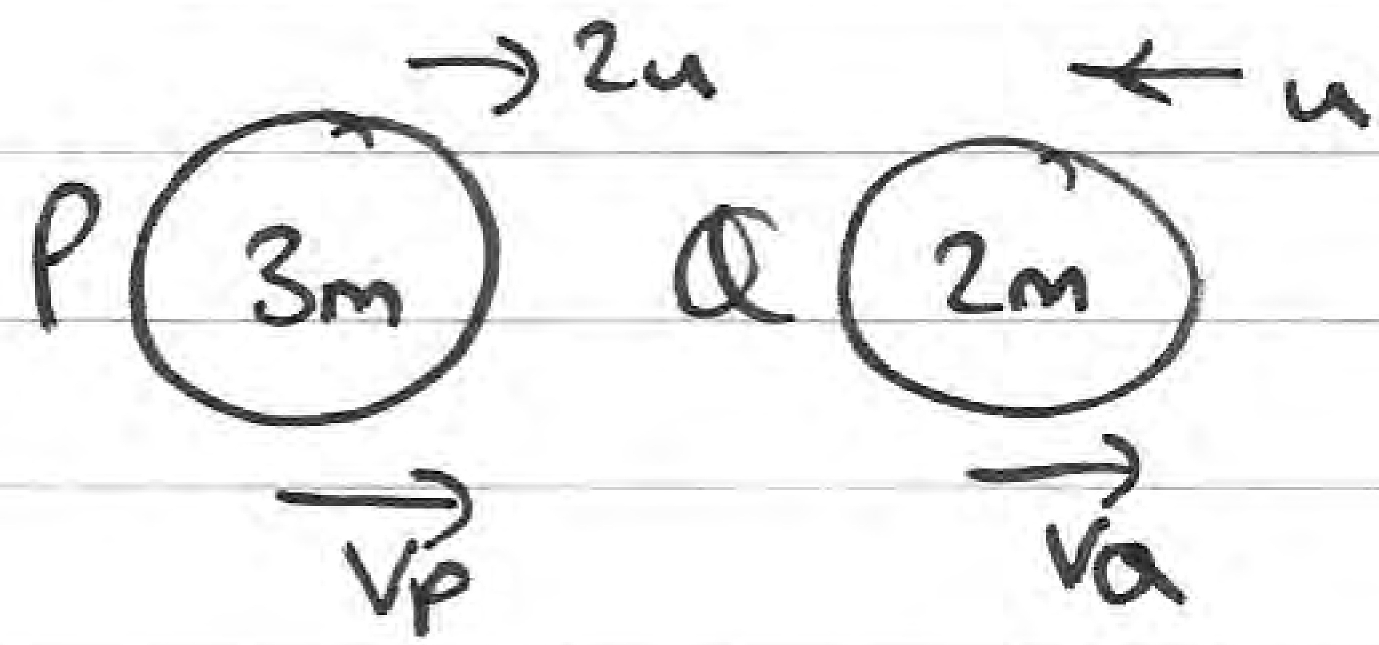
d) $u = 25,\ a = -1.4,\ v = 0 \qquad v^2 = u^2 + 2as \Rightarrow 0 = 25^2 - 2.8s$

$\Rightarrow s = 223.214\ldots m$

WD by braking force $= 1500 \times 223.214\ldots = 334821.42\ldots J$

$= \underline{335kJ}$ (3sf)

e) air resistance will be greater at faster speeds, so resistance should vary during the model.

5) 

CLM $\Rightarrow 6mu - 2mu = 3mV_p + 2mV_q$

$\Rightarrow 4\cancel{m}u = 3\cancel{m}V_p + 2\cancel{m}V_q$

$\Rightarrow 3V_p = 4u - 2V_q$

$e = \frac{Sep}{app} = \frac{V_q - V_p}{3u} \Rightarrow 3eu = V_q - \left(\frac{4u - 2V_q}{3}\right)$

$\Rightarrow 9eu = 3V_q - 4u + 2V_q \Rightarrow 5V_q = 9eu + 4u$

$\Rightarrow V_q = \frac{1}{5}u(9e+4)$

b) $3V_p = 4u - 2V_q \Rightarrow 3V_p = 4u - \frac{2}{5}u(9e+4)$

If P is reversed $V_p < 0 \Rightarrow \frac{2}{5}u(9e+4) > 4u$

$9e+4 > 10$

$9e > 6 \Rightarrow e > \frac{2}{3}$

$\therefore \quad \frac{2}{3} < e < 1$

c) Mom Q before $= -2mu$

+ Impulse $= \frac{32}{5}mu$

$\Rightarrow$ Mom Q after $= \frac{22}{5}mu = (2m)V_q$

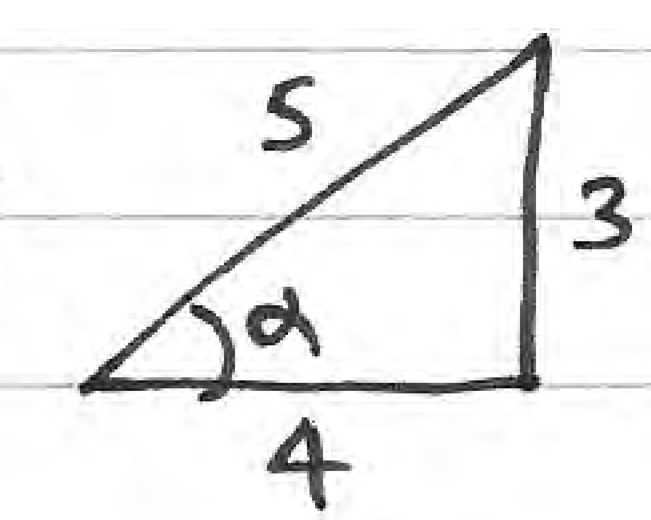
$\Rightarrow \frac{11}{5}u = \frac{1}{5}u(9e+4) \Rightarrow 11 = 9e+4 \Rightarrow 9e = 7 \Rightarrow e = \frac{7}{9}$

6) (V↑) $u = 32\sin\alpha = 19.2\uparrow$

$a\uparrow = -9.8$

$s\uparrow = -20$

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



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

$s = ut + \frac{1}{2}at^2 \Rightarrow -20 = 19.2t - 4.9t^2 \Rightarrow 4.9t^2 - 19.2t - 20 = 0$

$\Rightarrow t = \frac{19.2 + \sqrt{19.2^2 - 4(4.9)(-20)}}{9.8} \Rightarrow t = 4.77s$ (3sf)

b) (→H) Vel $= 32\cos\alpha = 25.6 \quad t = 4.77... \quad OC = 25.6 \times 4.77...$

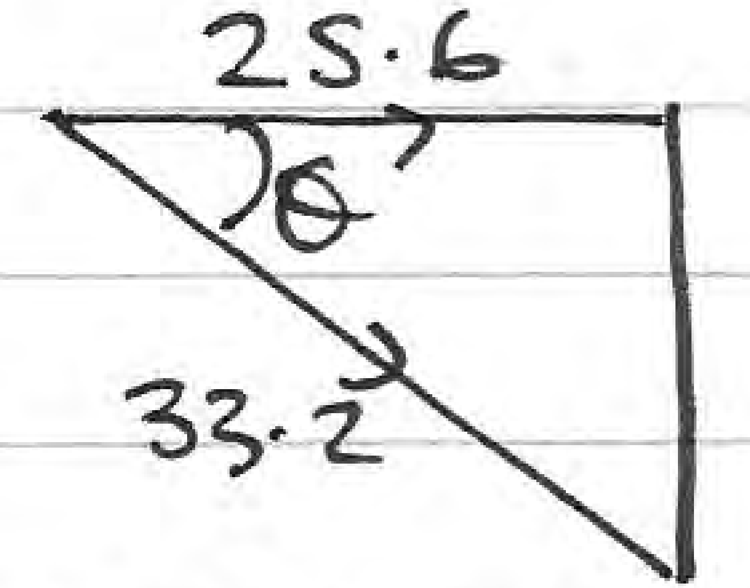
$OC = 122m$ (3sf)

c) $KE_A + PE_{lost} = KE_B$

$\frac{1}{2}(m)(32)^2 + mg(4) = \frac{1}{2}mv^2$

(×2) $v^2 = 32^2 + 8g \Rightarrow v = \sqrt{32^2 + 8g} = \underline{33.2\ ms^{-1}}$ (3sf)

d) $\overrightarrow{Hvel} = 25.6$



$\theta = \cos^{-1}\left(\frac{25.6}{33.2}\right)$ $\theta = \underline{39.6°}$ below the horizontal