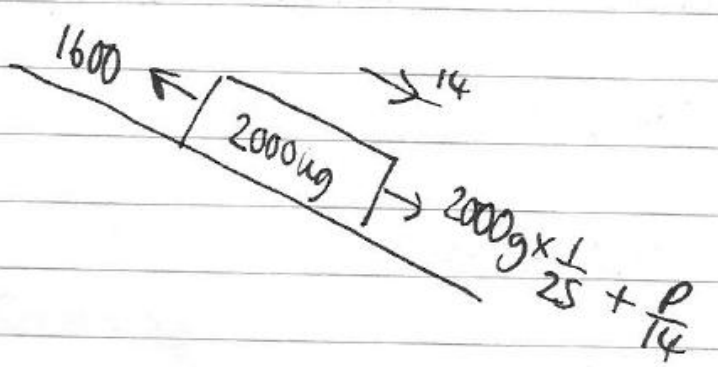
M2 JUNE 08

1)

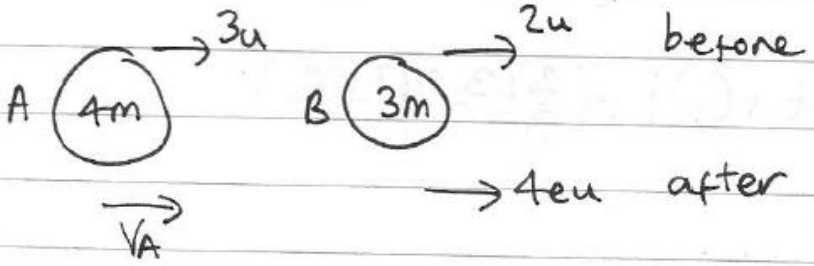


$$\frac{P}{14} + \frac{2000g}{25} = 1600$$

$$\frac{P}{14} = 816 \Rightarrow P = 11424 \text{ N}$$

$$P = 11.4 \text{ kN} \quad (3\text{sf})$$

2)



$$e = \frac{4eu - V_A}{u}$$

$$eu = 4eu - V_A$$

$$\Rightarrow V_A = 3eu.$$

CLM $\Rightarrow$ $12mu + 6mu = 4m \times 3eu + 3m \times 4eu$

$$18mu = 24meu \quad \Rightarrow e = \frac{18}{24} \Rightarrow e = \frac{3}{4}$$

b) $KE_{before} = \frac{1}{2}(4m)(3u)^2 + \frac{1}{2}(3m)(2u)^2 = 24mu^2$

$V_A = 3eu = 3\left(\frac{3}{4}\right)u = \frac{9}{4}u \qquad V_B = 4eu = 4\left(\frac{3}{4}\right)u = 3u$

$KE_{after} = \frac{1}{2}(4m)\left(\frac{9}{4}u\right)^2 + \frac{1}{2}(3m)(3u)^2 = \frac{189}{8}mu^2$

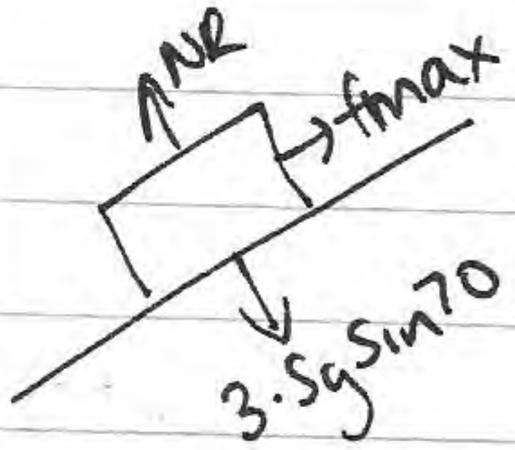
$\Rightarrow KE \text{ lost} = \frac{3}{8}mu^2$ J.

3) loss in KE $= \frac{1}{2}(3.5)(12^2 - 8^2) = 140 J$

loss in PE $= 3.5g(14\sin 20) = 164.238\ldots J$

Total Energy lost $= \underline{304 J}$ (3sf)

b) Total Energy lost = Wd against friction $= f_{max} \times 14$



$f_{max} = \mu NR = \mu(3.5g\sin 70)$

$304.238\ldots = \mu \times 32.2314\ldots \times 14$

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

4) $F = (6t-5)i + (t^2-2t)j = ma = \frac{1}{2}a$

$\Rightarrow a = (12t-10)i + (2t^2-4t)j$

$v = \int a\,dt = (6t^2-10t+C_1)i + (\frac{2}{3}t^3 - 2t^2 + C_2)j$

$t=0 \quad v = i - 4j = C_1 i + C_2 j \qquad C_1 = 1 \quad C_2 = -4$

$v = (6t^2-10t+1)i + (\frac{2}{3}t^3 - 2t^2 - 4)j$

$t=3, \quad v = 25i + -4j$

Mom at $t=3 = mv = 12.5i - 2j$

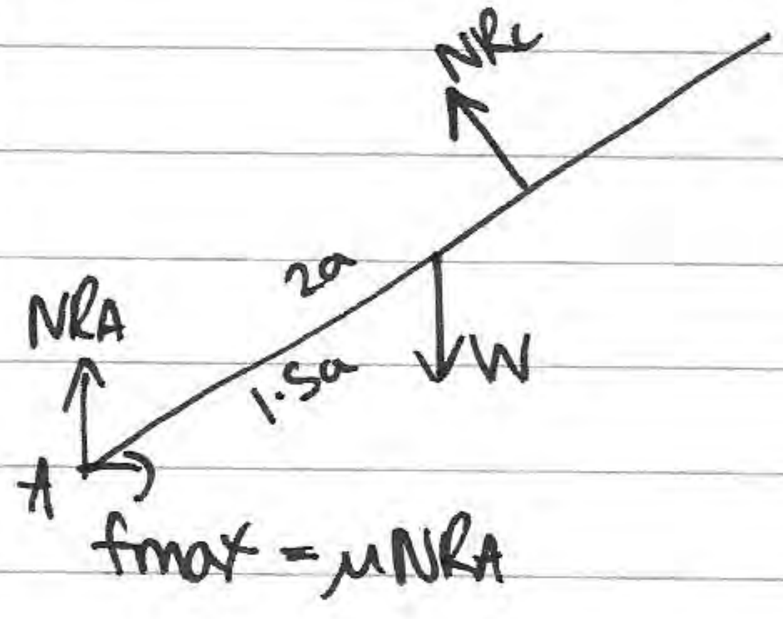
$+$ Impulse $= -5i + 12j$

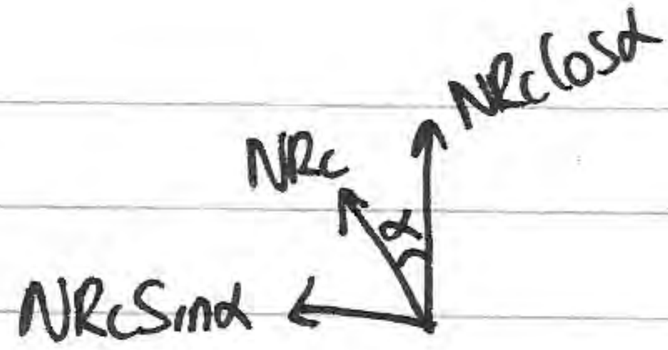
$\Rightarrow$ Mom after $= mv = 7.5i + 10j$

$\Rightarrow v$ after $= 15i + 20j$

$\Rightarrow$ Speed $= \sqrt{15^2+20^2} = \underline{25\ ms^{-1}}$

5)





$\uparrow Rf = 0$

$NRc\cos\alpha + NRA = W$

$\overrightarrow{Rf} = 0$

$NRc\sin\alpha = fmax = \mu NRA$

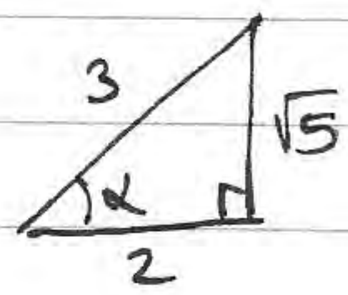
$A\circlearrowleft \quad W \times 1.5a\cos\alpha = NRc \times 2a \Rightarrow NRc = \frac{3}{4}W\cos\alpha$

$\Rightarrow \left(\frac{3}{4}W\cos\alpha\right)\cos\alpha + NRA = W \quad \Rightarrow NRA = W - \frac{3}{4}W\cos^2\alpha$

$\therefore NRA = \frac{1}{4}W(4 - 3\cos^2\alpha)$ #

$\cos\alpha = \frac{2}{3}$

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

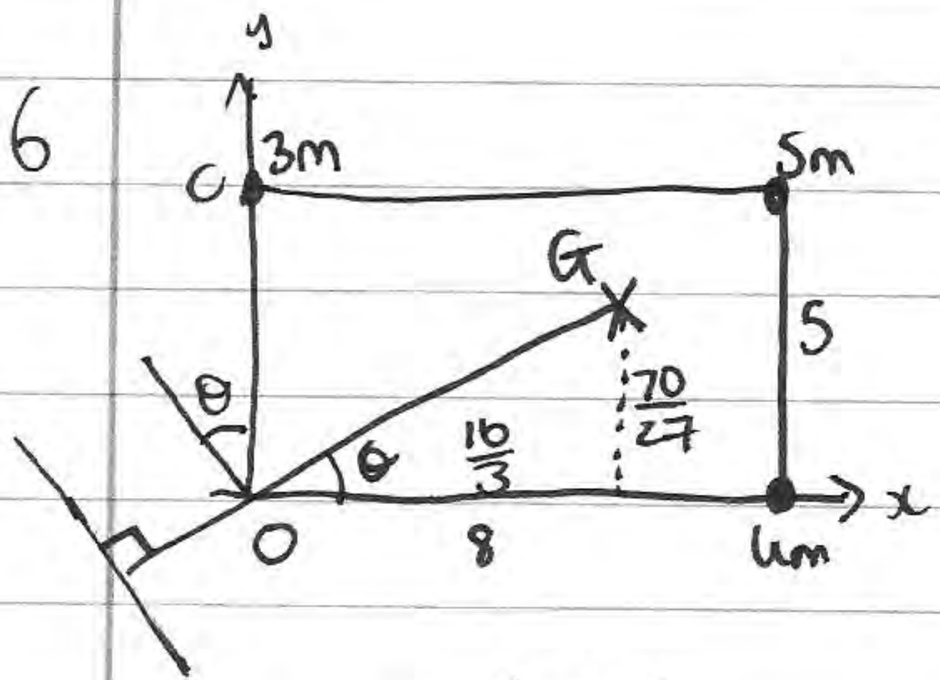


$NRA = \frac{1}{4}W\left(4 - \left(\frac{2}{3}\right)^2\right) = \frac{2}{3}W$

$NRc = \frac{3}{4}W\left(\frac{2}{3}\right) = \frac{1}{2}W$

$\Rightarrow \left(\frac{1}{2}W\right)\frac{\sqrt{5}}{3} = \mu\left(\frac{2}{3}W\right) \Rightarrow \frac{\sqrt{5}}{6} = \frac{2}{3}\mu \Rightarrow \mu = \frac{\sqrt{5}}{4}$

6



$\overleftrightarrow{} \quad 3mg \times 0 + 5mg \times 8 + 4mg \times 8 = (8+4)mg \times \bar{x}$

$\Rightarrow 40 + 8u = (8+4) \times 6.4$

$\Rightarrow 1.6u = 11.2$

$\Rightarrow u = 7$ #

$\updownarrow \quad 15mg \times 6.4 + 12mg \times 4 = 27mg \times \bar{x}$

$\bar{x} = \frac{16}{3}$

c) $\theta = \tan^{-1}\left(\frac{\frac{70}{27}}{\frac{16}{3}}\right)$

$\theta = \tan^{-1}\left(\frac{35}{72}\right)$

$\theta = \underline{25.9°\,(3sf)}$

$\overleftrightarrow{} \quad 7mg \times 0 + 5mg \times 5 + 3mg \times 5 + 12mg \times 2.5 = 27mg \times \bar{y}$

$\Rightarrow 70 = 27\bar{y} \Rightarrow y = \frac{70}{27} \quad G\left(\frac{16}{3}, \frac{70}{27}\right)$

7) (V↓) $u\downarrow = 25\sin 30 = 12.5$ $\quad S = ut + \frac{1}{2}at^2$

$a\downarrow = 9.8$ $\quad 12 = 12.5t + 4.9t^2$

$s\downarrow = 12$ $\quad 4.9t^2 + 12.5t - 12 = 0$

$t = 0.743377...$

(→H) $Vel = 25\cos 30 = \frac{25\sqrt{3}}{2}$ $\quad x = OB$ $\quad t = 0.743377...$

$t = \underline{0.74}$ (2sf)

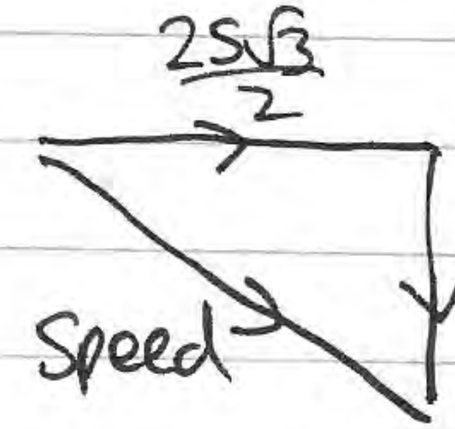
b) $OB = \frac{25\sqrt{3}}{2} \times 0.743377... = 16.1 \Rightarrow TB = \underline{1.1\text{ m}}$ (2sf)

c) (→H) $x = 15$ $\quad Vel = \frac{25\sqrt{3}}{2} \Rightarrow t = \frac{15}{\frac{25\sqrt{3}}{2}} = \frac{6}{5\sqrt{3}}$

(V↓) $u\downarrow = 12.5$ $\quad V\downarrow = u + at = 12.5 + 9.8 \times \frac{6}{5\sqrt{3}}$

$a\downarrow = 9.8$

$t = \frac{6}{5\sqrt{3}}$ $\quad V\downarrow = 19.289639...$



$\Rightarrow Speed = \sqrt{19.289639...^2 + \left(\frac{25\sqrt{3}}{2}\right)^2}$

$Speed = \underline{29\text{ ms}^{-1}}$ (2sf)