

M2 JAN 06

a) $KE_{lost} = \frac{1}{2}mu^2 = \frac{1}{2}(3)(8)^2 = \underline{96J}$

b) $KE_{lost} = Wd \text{ against friction}$

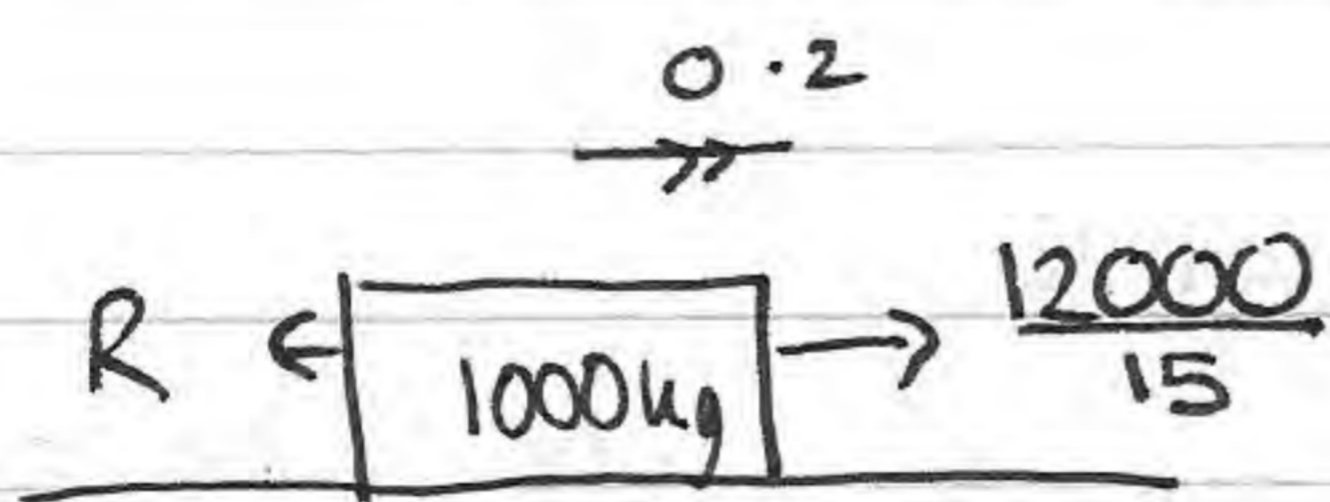
$\Rightarrow 96 = f_{max} \times 12 \Rightarrow \mu \times NR = 8 \Rightarrow \mu = \frac{8}{3g} = 0.27(24)$

2) $vel = \frac{dr}{dt} = (2t+4)i + (3-3t^2)j$

$t=3, v = 10i - 24j \Rightarrow \text{speed} = \sqrt{10^2 + 24^2} = \underline{13ms^{-1}}$

b) Initial momentum = $MU = 0.4(10i - 24j) = 4i - 9.6j$
 + Impulse = $8i - 12j$
 = final mom = $MV = 12i - 21.6j$
 $\div 0.4 \quad v = \underline{30i - 54j}$

3)

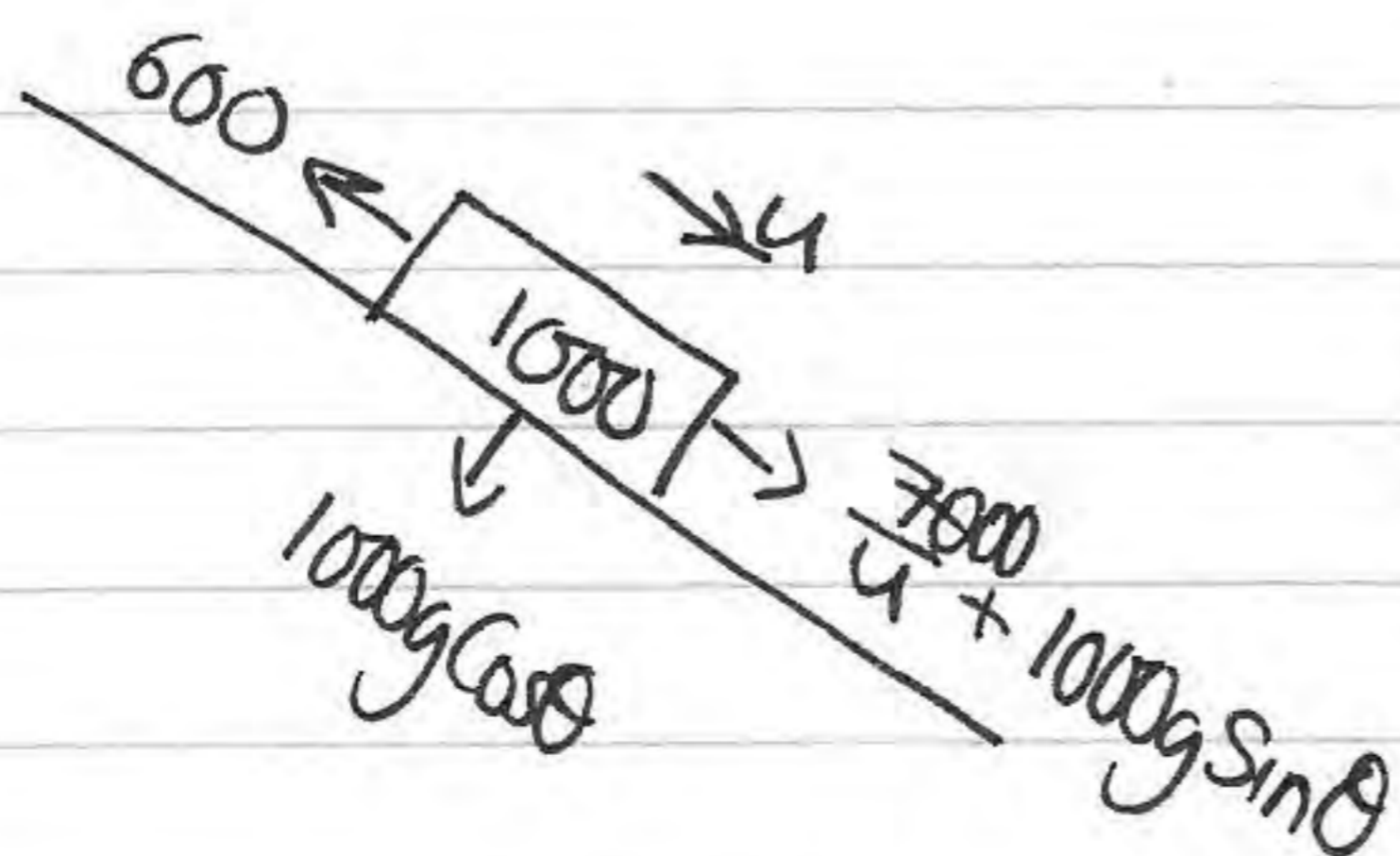


$\vec{Rf} = ma$

$\Rightarrow \frac{12000}{15} - R = 1000 \times 0.2$

$\Rightarrow 800 - R = 200 \Rightarrow R = 600N \neq$

b)

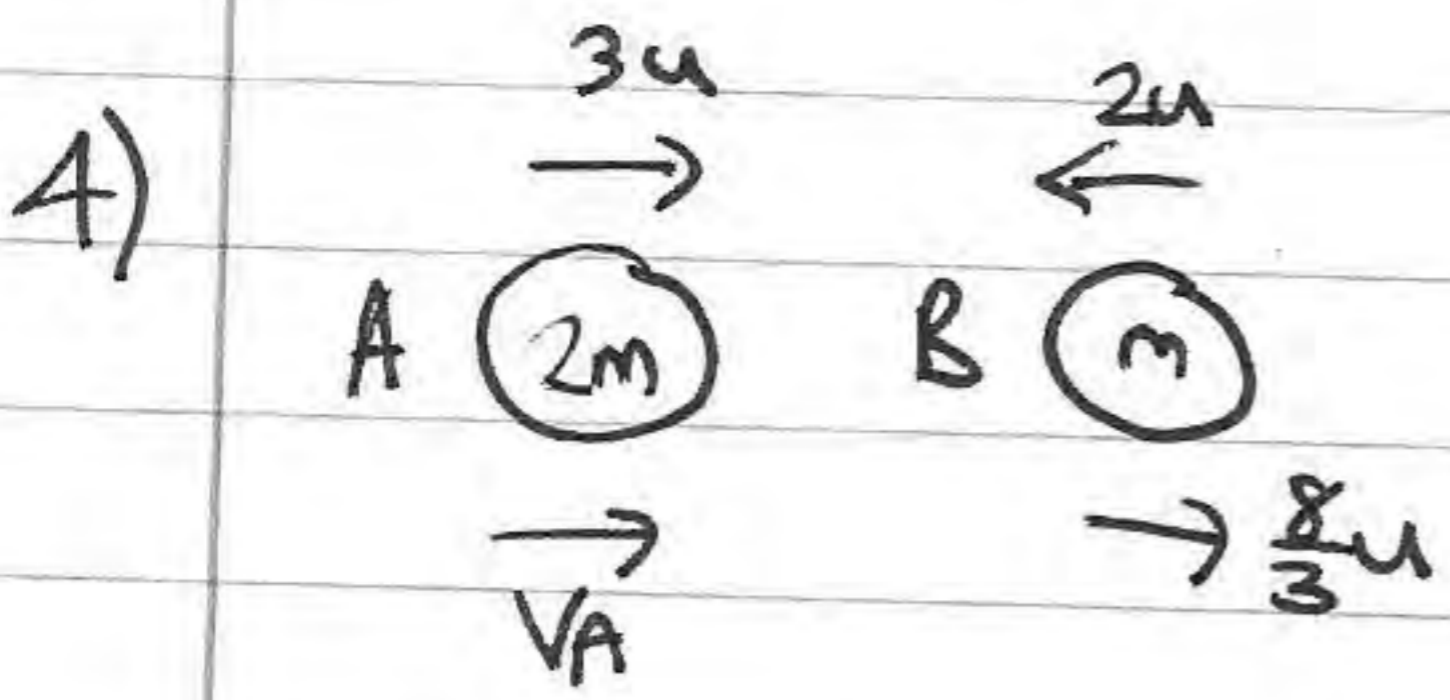


$Rf \downarrow = 0$

$\Rightarrow \frac{7000}{u} + 1000g \times \frac{1}{40} = 600$

$\Rightarrow \frac{7000}{u} = 600 - 25g$

$\Rightarrow u = \frac{7000}{600 - 25g} \Rightarrow u = \underline{19.7ms^{-1}}$
(3sf)



CLM $\Rightarrow 2m(3u) + m(-2u) = 2m(v_A) + m(\frac{8}{3}u)$
 $= 2m(v_A) + m(\frac{8}{3}u)$

$\Rightarrow 6mu - 2mu = 2mv_A + \frac{8}{3}mu$
 $\Rightarrow \frac{4}{3}u = 2v_A \Rightarrow v_A = \frac{2}{3}u$

$e = \frac{Sep}{app} = \frac{2u}{5u} \Rightarrow e = \frac{2}{5}$

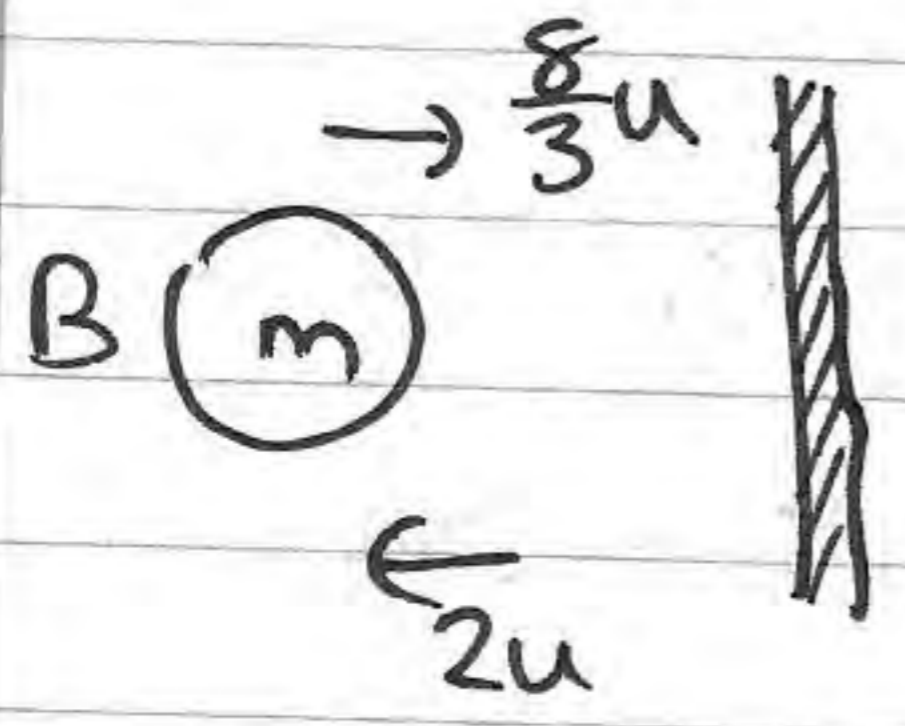
b) total KE before $= \frac{1}{2}(2m)(3u)^2 + \frac{1}{2}m(2u)^2 = 11u^2$

total KE after $= \frac{1}{2}(2m)(\frac{2}{3}u)^2 + \frac{1}{2}(m)(\frac{8}{3}u)^2 = \frac{4}{9}u^2 + \frac{32}{9}u^2 = 4u^2$

KE lost $= 11u^2 - 4u^2 = \underline{7u^2}$


3c) Initial mom $= m(\frac{8}{3}u) = \frac{8}{3}mu$
 \pm Impulse $= \frac{14}{3}mu$ (must be -)
 final mom $= -\frac{6}{3}mu = -2mu$

$\Rightarrow mv = -2mu \Rightarrow v = -2u$




$e = \frac{Sep}{app} = \frac{2u}{\frac{8}{3}u} = \frac{6}{8}$

$\Rightarrow e = \frac{3}{4}$

5) 

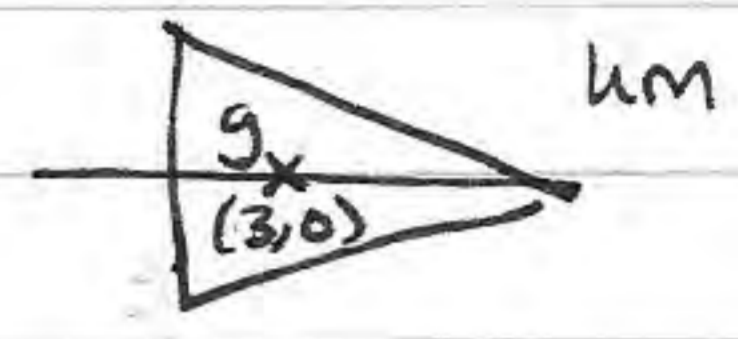
$$4mg \times 0 + 2mg \times 0 + 6mg \times 9 = 12mg \bar{x} \Rightarrow \bar{x} = \frac{54}{12}$$


$$\bar{x} = 4.5$$



$$2mg \times -4 + 4mg \times 4 + 6mg \times 0 = 12mg \bar{y}$$

$$\bar{y} = \frac{8}{12} = \frac{2}{3} \quad (4.5, \frac{2}{3})$$




b) 

$$12mg \times 4.5 + kmg \times 3 = (12+k)mg \times 4$$

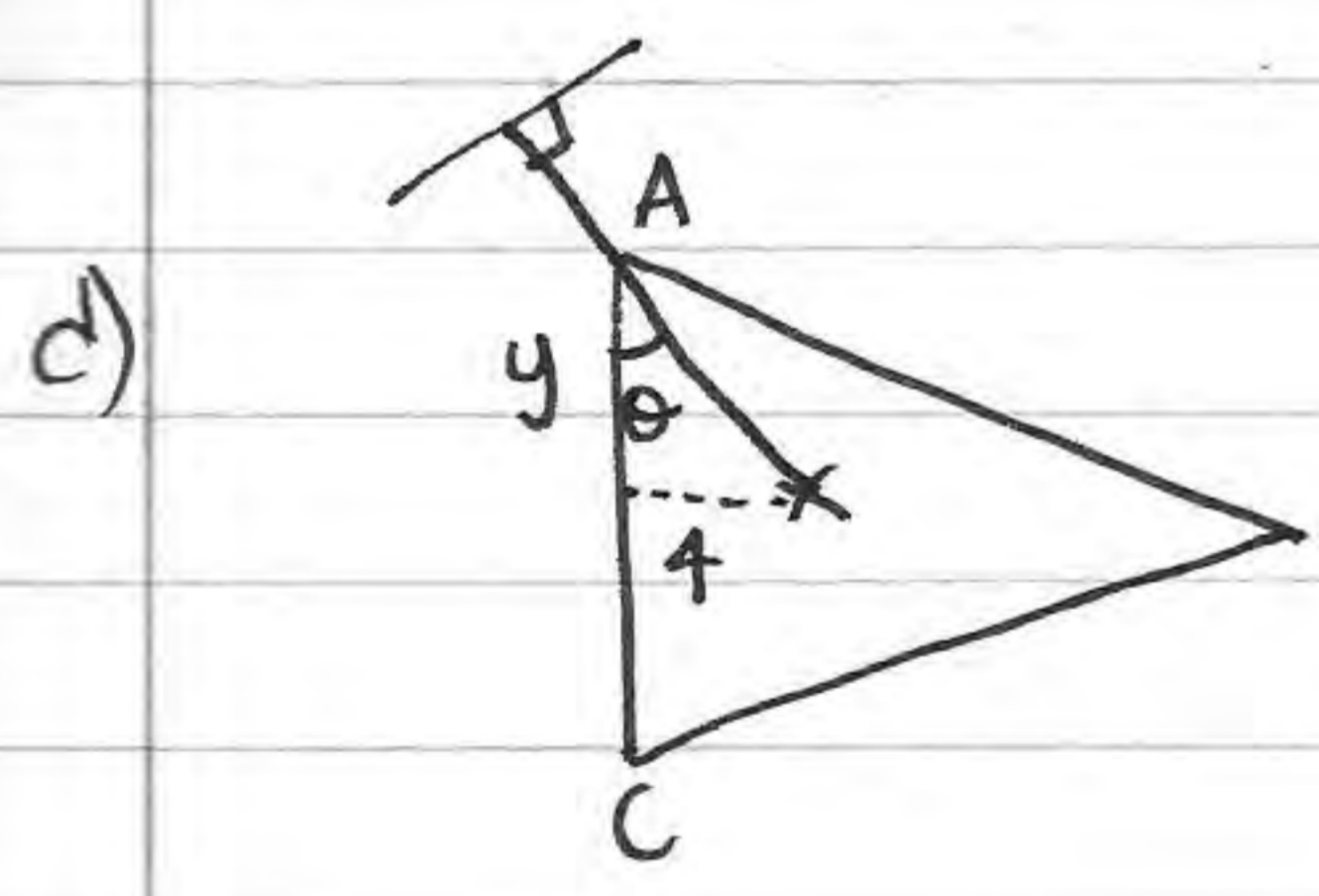
$$\Rightarrow 54 + 3k = 4(12+k) \Rightarrow 54 + 3k = 48 + 4k$$

$$\Rightarrow \underline{k = 6} \#$$

c) 

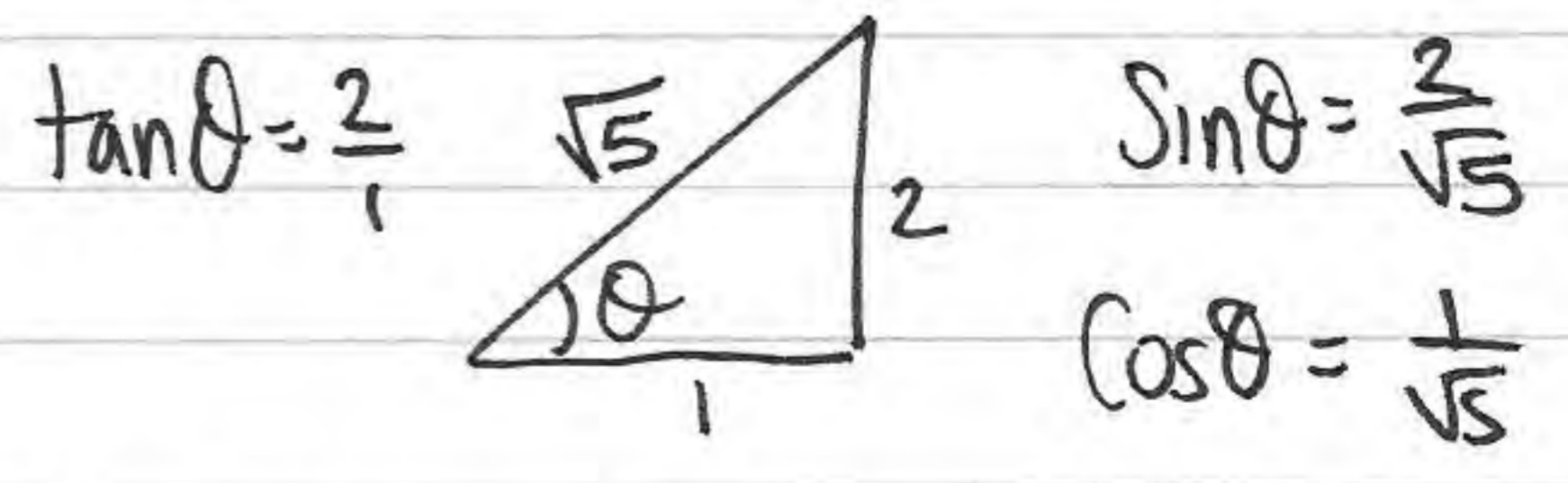
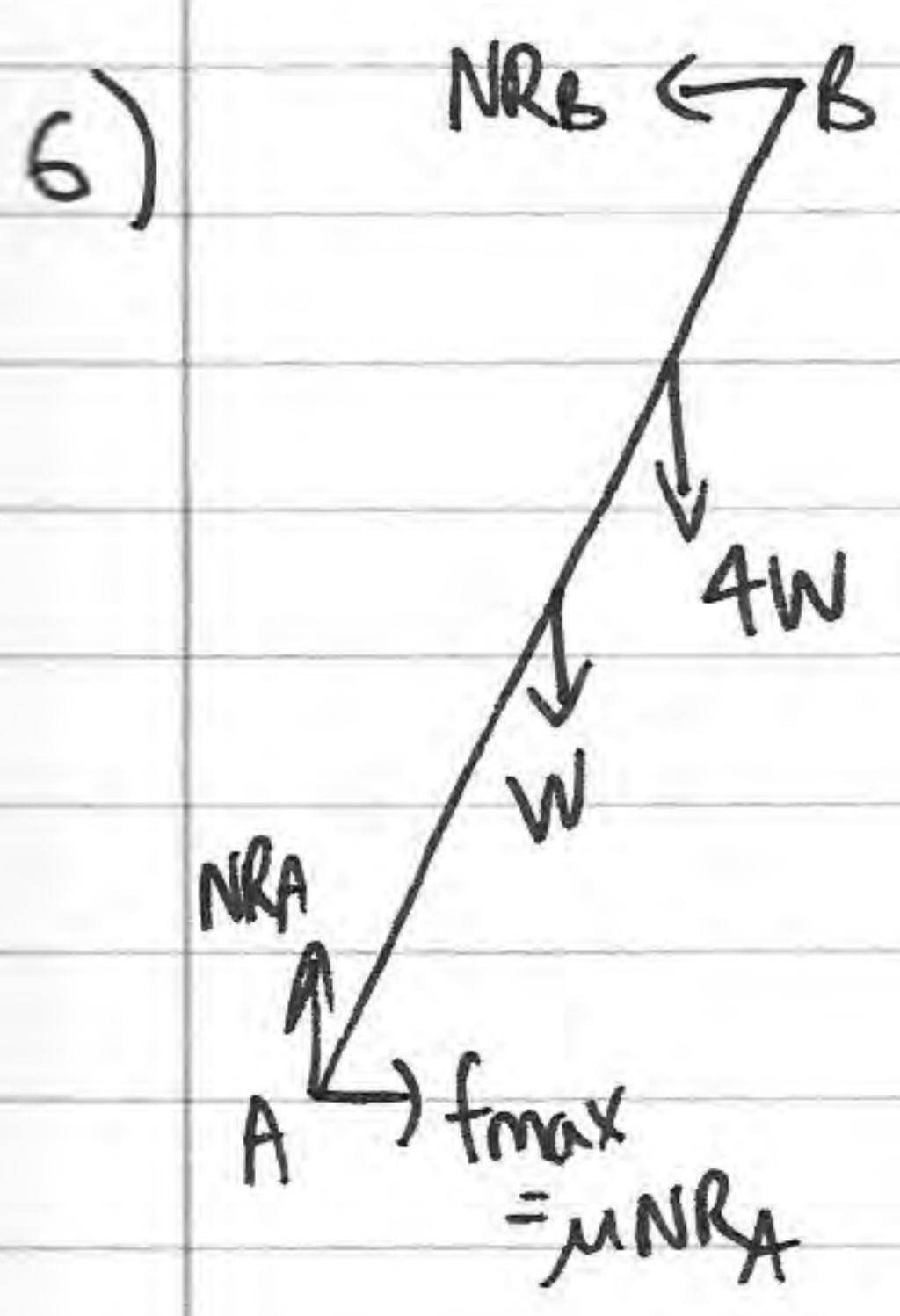
$$12mg \times \frac{2}{3} + kmg \times 0 = (12+k)mg \times \lambda$$

$$\Rightarrow 8 = (12+6)\lambda \Rightarrow \lambda = \frac{8}{18} = \underline{\frac{4}{9}}$$



$$y = 4 - \frac{4}{9}$$

$$\Rightarrow \theta = \tan^{-1} \left(\frac{4}{4 - \frac{4}{9}} \right) \Rightarrow \theta = \tan^{-1} \left(\frac{9}{8} \right) = \underline{48.4^\circ}$$



$$R_f \uparrow = 0 \Rightarrow N_{RA} = 5W$$

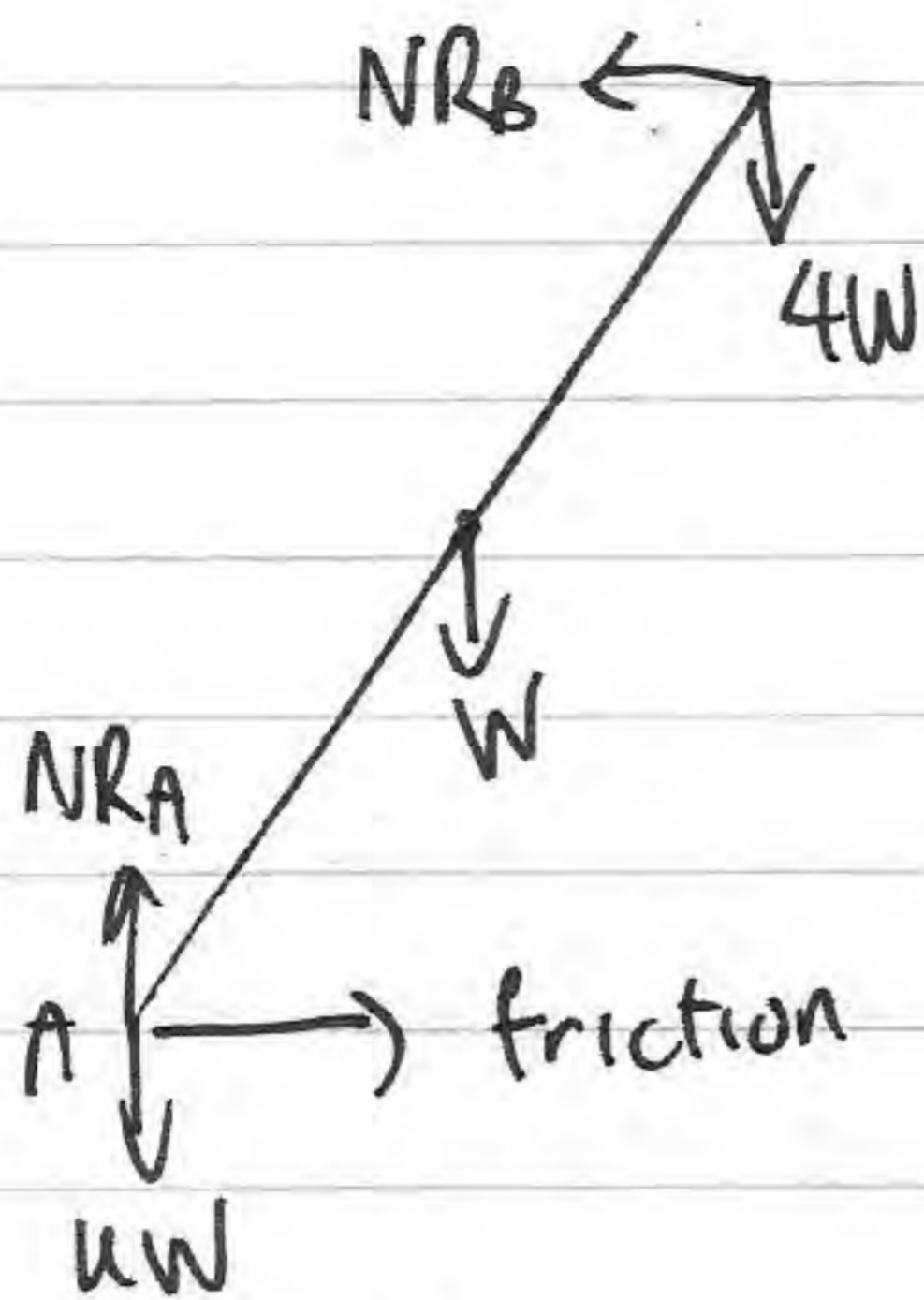
$$\vec{R}_f = 0 \quad f_{\max} = N_{RB} \Rightarrow \mu N_{RA} = N_{RB} \Rightarrow \mu = \frac{N_{RB}}{5W}$$

$$A \curvearrowright \quad W \times 2a \times \left(\frac{1}{\sqrt{5}} \right) + 4W \times 3a \times \left(\frac{1}{\sqrt{5}} \right) = N_{RB} \times 4a \times \left(\frac{2}{\sqrt{5}} \right)$$

$$2W + 12W = 8N_{RB} \quad N_{RB} = \underline{\frac{14}{8}W}$$

$$\therefore \mu = \frac{\frac{14}{8}W}{5W} = \frac{14}{40} = \frac{7}{20} \#$$

b)



$$R_f \uparrow = 0 \Rightarrow N_{RA} = (5+k)W$$

$$\vec{R}_t = 0 \Rightarrow \text{friction} = N_{RB}$$

$$\text{A} \curvearrowright W \times 2a \left(\frac{1}{\sqrt{5}}\right) + 4W \times 4a \left(\frac{1}{\sqrt{5}}\right) = N_{RB} \times 4a \left(\frac{2}{\sqrt{5}}\right)$$

$$\Rightarrow 2W + 16W = 8N_{RB} \Rightarrow N_{RB} = \frac{9}{4}W$$

$$f_{\max} = \mu N_{RA} = \frac{7}{20}(5+k)W \quad \text{friction} = N_{RB} = \frac{9}{4}W$$

$$\text{friction} \leq f_{\max} \Rightarrow \frac{9}{4}W \leq \frac{7}{20}(5+k)W$$

$$\Rightarrow \frac{45}{7} \leq 5+k \Rightarrow k \geq \frac{10}{7}$$

7) \vec{H} $v_{el} = 11 \cos 30$ $\text{dist} = 10 \Rightarrow t = \frac{10}{11 \frac{\sqrt{3}}{2}} = \underline{1.05}$

b) $\vec{V} \uparrow$ $u \uparrow = 11 \sin 30 = 5.5$ $a \uparrow = -9.8$ $t = \frac{20\sqrt{3}}{33}$

$$s = ut + \frac{1}{2}at^2$$

$$s = 5.5 \left(\frac{20\sqrt{3}}{33}\right) - 4.9 \left(\frac{20\sqrt{3}}{33}\right)^2$$

$$s = 0.374 \dots \text{ above A}$$

$$\Rightarrow C = 1 - 0.374 \dots \text{ below T}$$

$$\therefore C \text{ is } 0.63 \text{ m below T}$$

c) $u \uparrow = V \sin 30 = \frac{1}{2}V$ $a = -9.8$ $s = 1$ (above A)

$$\vec{H} \quad v_{el} = V \cos 30 \quad x = 10$$

$$\Rightarrow t = \frac{10}{V \frac{\sqrt{3}}{2}} = \frac{20\sqrt{3}}{3V}$$

$$\Rightarrow 1 = \left(\frac{1}{2}V\right) \left(\frac{20\sqrt{3}}{3V}\right) - 4.9 \left(\frac{20\sqrt{3}}{3V}\right)^2$$

$$\Rightarrow 1 - \frac{10\sqrt{3}}{3} = \frac{1960}{3v^2}$$

$$\Rightarrow (3 - 10\sqrt{3})v^2 = 1960 \quad \Rightarrow v = \sqrt{\frac{1960}{3 - 10\sqrt{3}}}$$

$$v = 11.7 \text{ ms}^{-1} \text{ (3sf)}$$

- d) we have ignored wind, air resistance, spin. we have also considered the ball to be a particle, so v could be increased and decreased but still hit the target as the ball might hit the target at the top or bottom of the ball.