

$$1) \quad v = 3t^2 - 4t + 3$$

$$a = \frac{dv}{dt} = 6t - 4$$

$$s = \int v dt = t^3 - 2t^2 + 3t + c \quad t=0, s=0 \Rightarrow s = t^3 - 2t^2 + 3t$$

$$\text{at Min Vel } \frac{dv}{dt} = 0 \Rightarrow 6t = 4 \Rightarrow t = \frac{2}{3}$$

$$s = \left(\frac{2}{3}\right)^3 - 2\left(\frac{2}{3}\right)^2 + 3\left(\frac{2}{3}\right) = \frac{8}{27} - \frac{24}{27} + \frac{54}{27} = \frac{38}{27} = \underline{\underline{1\frac{11}{27}}}$$



$$2m \times 2u + m \times (-u) = 2m \times v_1 + m \times v_2$$

$$3u = 2v_1 + v_2 \quad \text{--- (i)}$$

$$e = \frac{v_2 - v_1}{u_1 - u_2} = \frac{v_2 - v_1}{3u} \Rightarrow v_2 - v_1 = 3eu \Rightarrow v_2 = v_1 + 3eu$$

into (i)

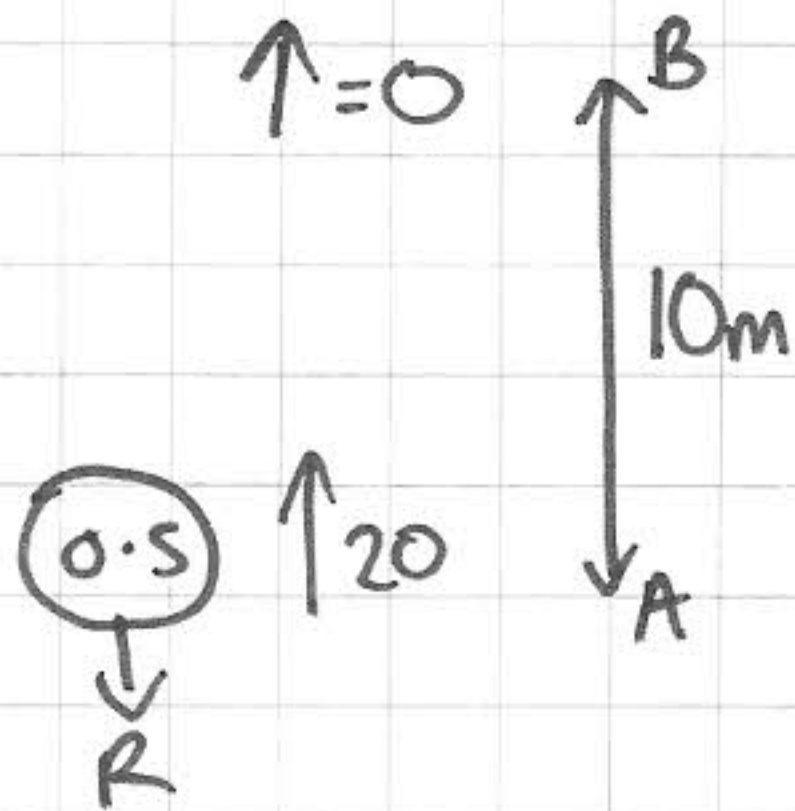
$$3u = 2v_1 + (v_1 + 3eu) \Rightarrow 3u = 3v_1 + 3eu$$

$$v_1 = u - eu \Rightarrow \underline{\underline{v_1 = (1-e)u}}$$

$$v_2 = v_1 + 3eu \Rightarrow v_2 = u - eu + 3eu \Rightarrow v_2 = u + 2eu$$

$$\underline{\underline{v_2 = (1+2e)u}}$$

3)



$$KE_A = \frac{1}{2}(0.5)(20)^2 = 100$$

$$PE_B = mgh = \frac{1}{2}g \times 10 = 5g$$

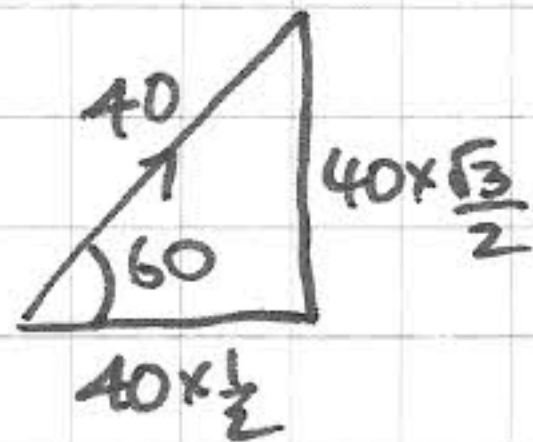
$$Wd_{\vec{AB}} = R \times 10 = 10R$$

$$KE_A = PE_B + Wd_{\text{against } R}$$

$$100 = 5g + 10R \Rightarrow 10R = 51 \Rightarrow \underline{R = 5.1 \text{ N}}$$

$$4) \text{ Mom before} = \frac{1}{4}(30i + 0j) = \frac{15}{2}i$$

$$\text{Mom after} = \frac{1}{4}(20i + 20\sqrt{3}j) = 5i + 5\sqrt{3}j$$

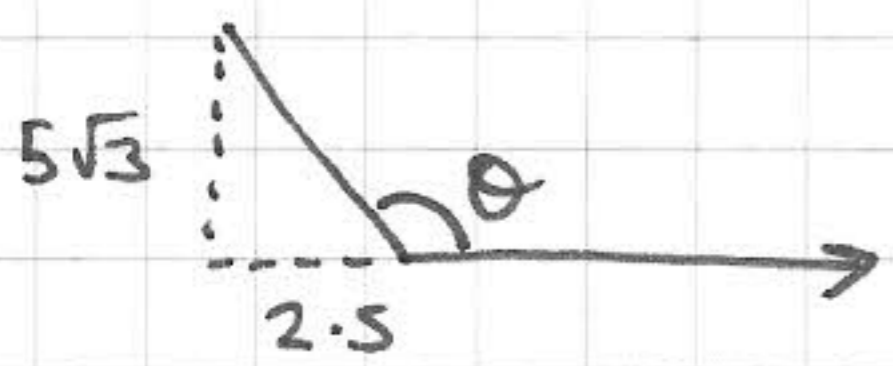


$$\text{Impulse} = \text{Change in Mom} = -\frac{5}{2}i + 5\sqrt{3}j$$

$$\text{Magnitude} = \sqrt{\left(\frac{5}{2}\right)^2 + (5\sqrt{3})^2} = \sqrt{\frac{25}{4} + 75} = \frac{\sqrt{325}}{2} = \frac{5}{2}\sqrt{13} \text{ N s}$$

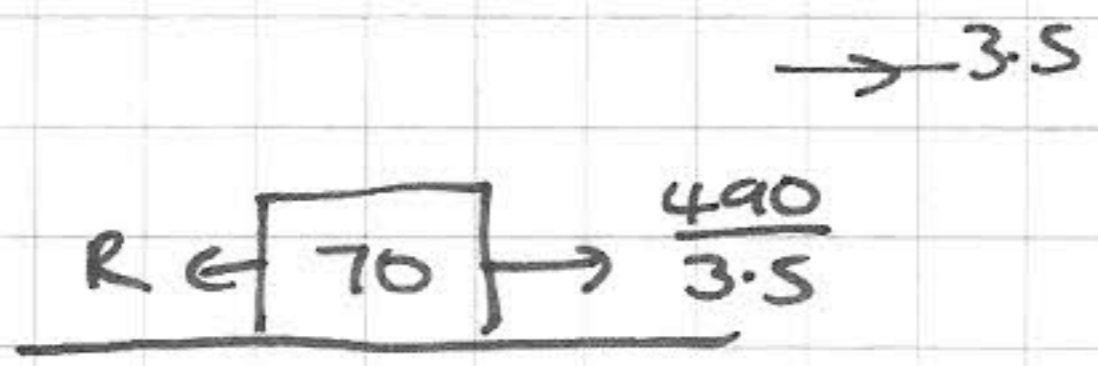
$$\tan \theta = -\frac{5}{2}$$

(ii)



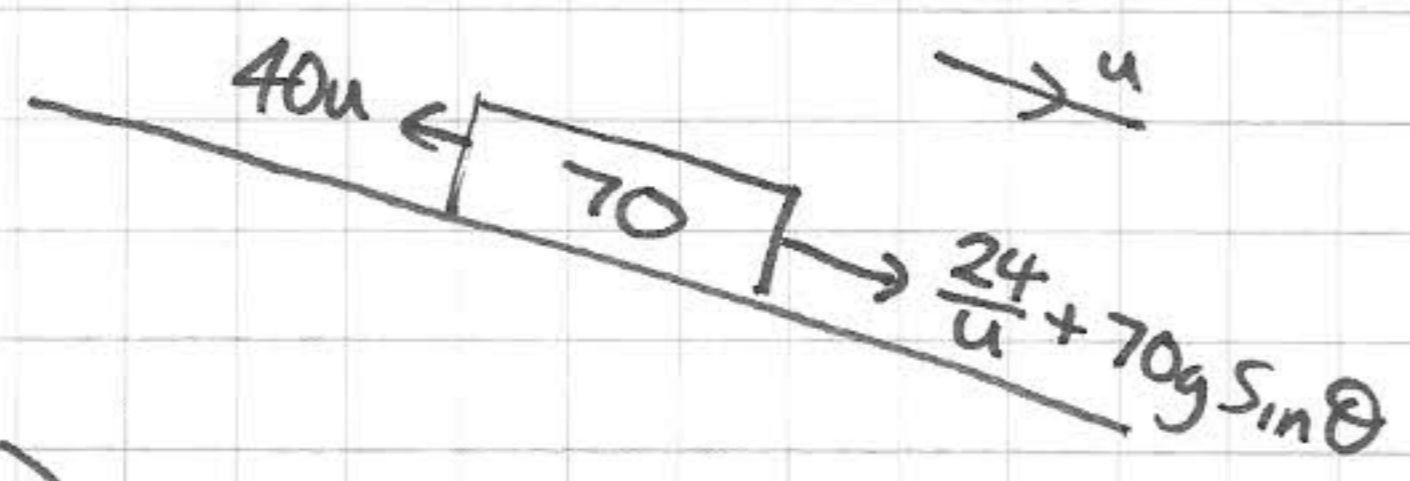
$$\theta = 180 - \tan^{-1}\left(\frac{5\sqrt{3}}{2.5}\right) = 106.1^\circ$$

5)



$$\vec{R}_f = 0 \Rightarrow \frac{490}{3.5} = R = \underline{140\text{ N}}$$

b)



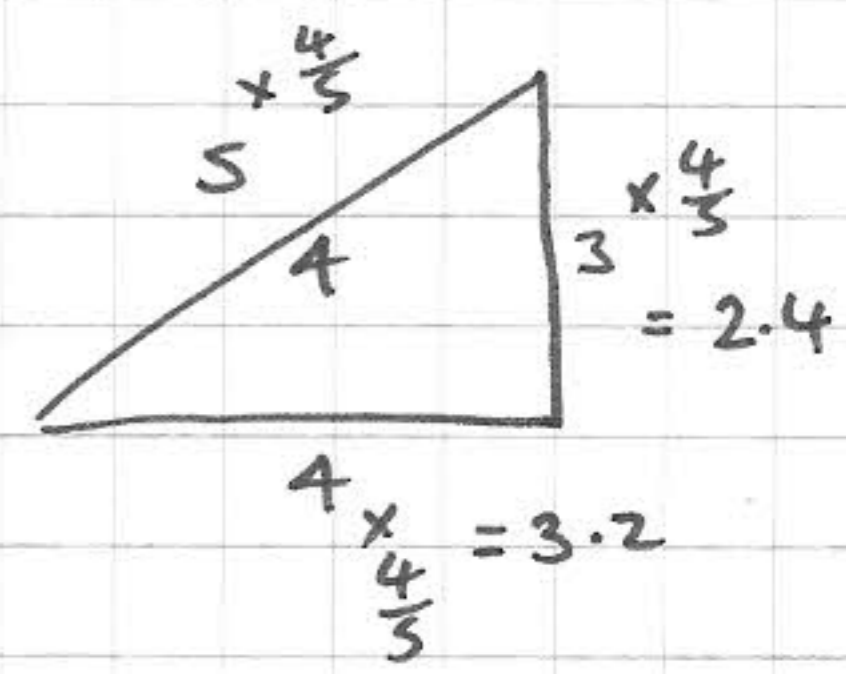
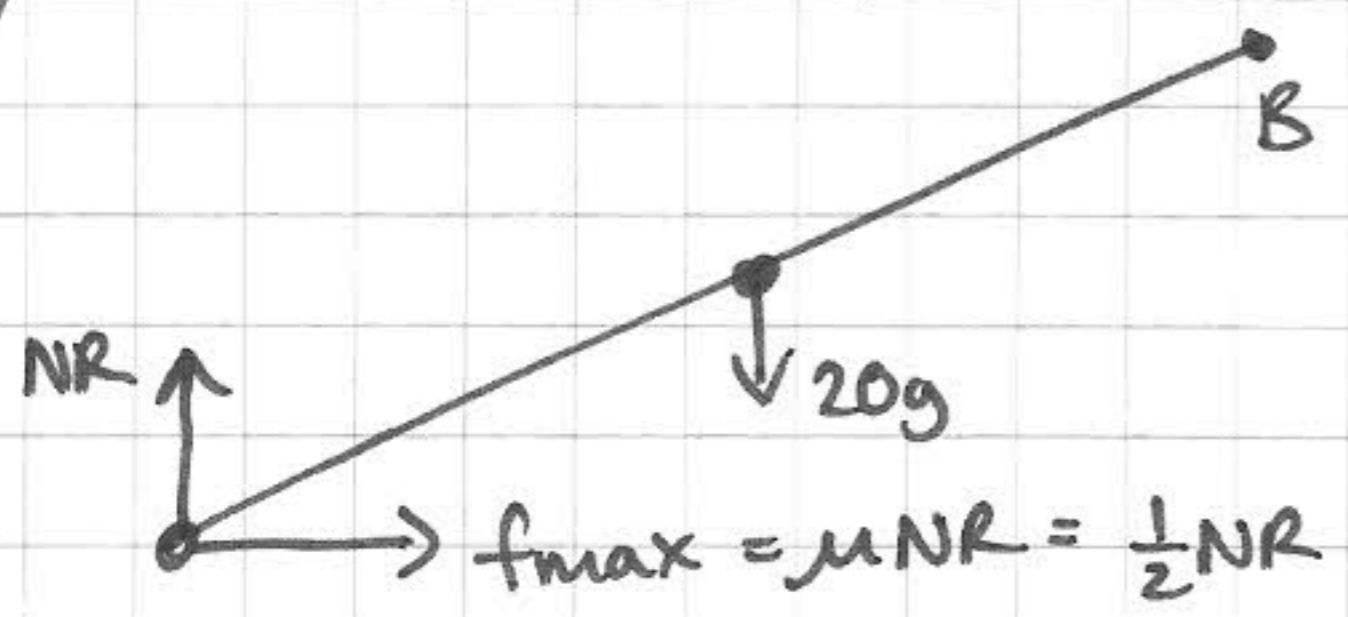
$$R_f \downarrow = 0$$

$$\frac{24}{u} + \frac{70g}{14} = 40u \Rightarrow 24 + 5g u = 40u^2$$

$$40u^2 - 49u - 24 = 0$$

$$u = \frac{49 \pm \sqrt{49^2 - 4(40)(-24)}}{80} \Rightarrow u = \frac{49 + 79}{80} = \underline{1.6\text{ m s}^{-1}}$$

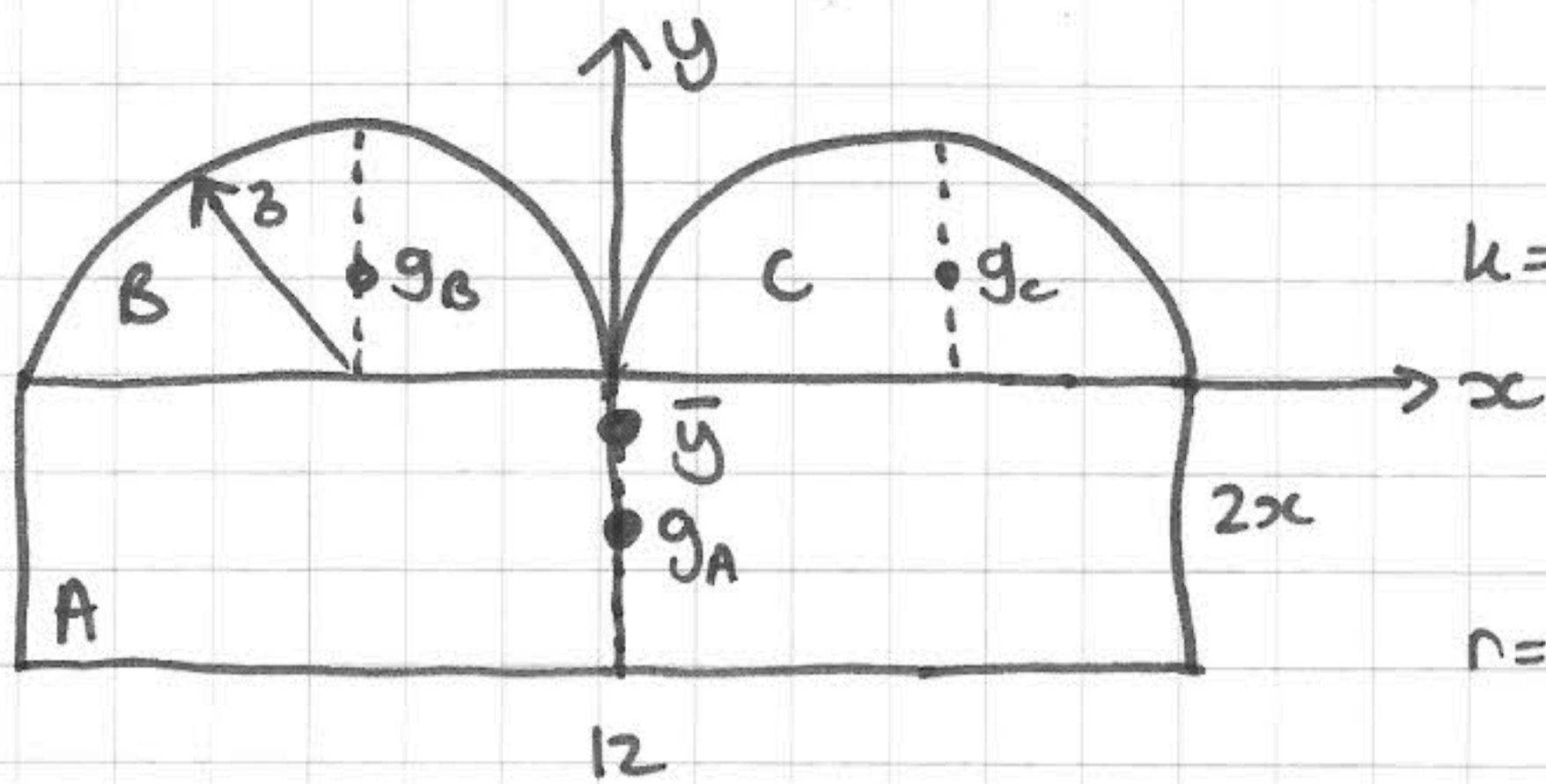
6)



$$B \curvearrowright 20g \times 1.6 + \frac{1}{2} NR \times 2.4 = NR \times 3.2$$

$$32g = 2NR \Rightarrow \underline{NR = 16g\text{ N}}$$

7)

 $k = \text{mass per unit area}$ 

$$r=3 \quad \frac{4r}{3\pi} = \frac{12}{3\pi} = \frac{4}{\pi}$$

$$\begin{aligned} \text{Mass A} &= 24x k & G_A(0, -\bar{y}) \\ \text{Mass B} &= \frac{9}{2}\pi k & G_B(-3, \frac{4}{\pi}) \\ \text{Mass C} &= \frac{9}{2}\pi k & G_C(3, \frac{4}{\pi}) \end{aligned}$$

$$\text{Symmetry} \Rightarrow \bar{x} = 0$$

$$\text{Total} = (24x + 9\pi)k \quad G(0, -\bar{y})$$

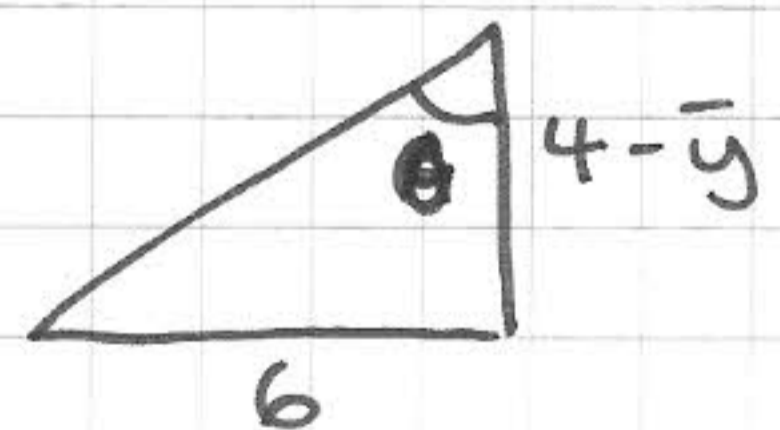
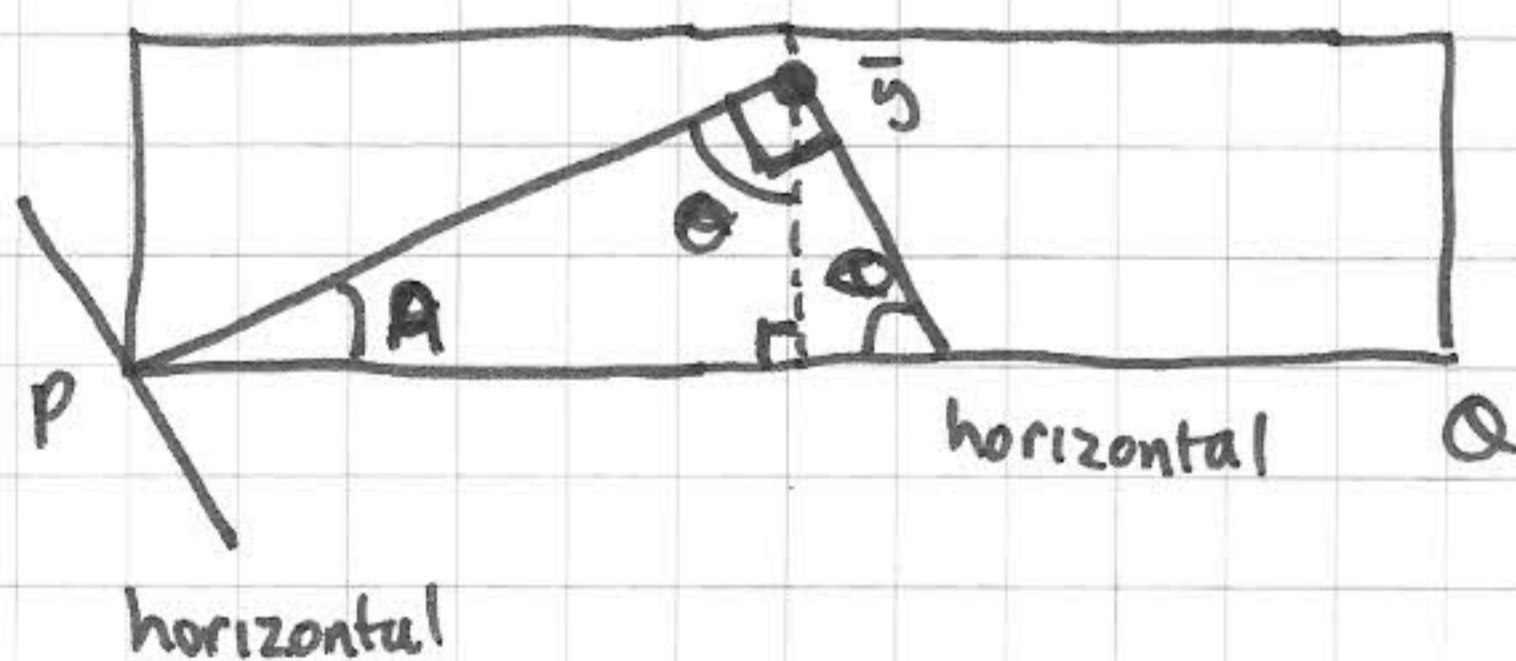
$$\begin{aligned} \overset{\curvearrowright}{\rightarrow} \bar{x} \quad 24x k \cancel{\bar{y}} x - x + 2 \left( \frac{9}{2}\pi k \cancel{\bar{y}} x \times \frac{4}{\pi} \right) &= (24x + 9\pi) k \cancel{\bar{y}} x - \bar{y} \\ -24x^2 + 36 &= -(24x + 9\pi)\bar{y} \end{aligned}$$

$$24x^2 - 36 = (24x + 9\pi)\bar{y}$$

$$\textcircled{\div 3} \quad 8x^2 - 12 = (8x + 3\pi)\bar{y}$$

$$\bar{y} = \frac{4|2x^2 - 3|}{8x + 3\pi}$$

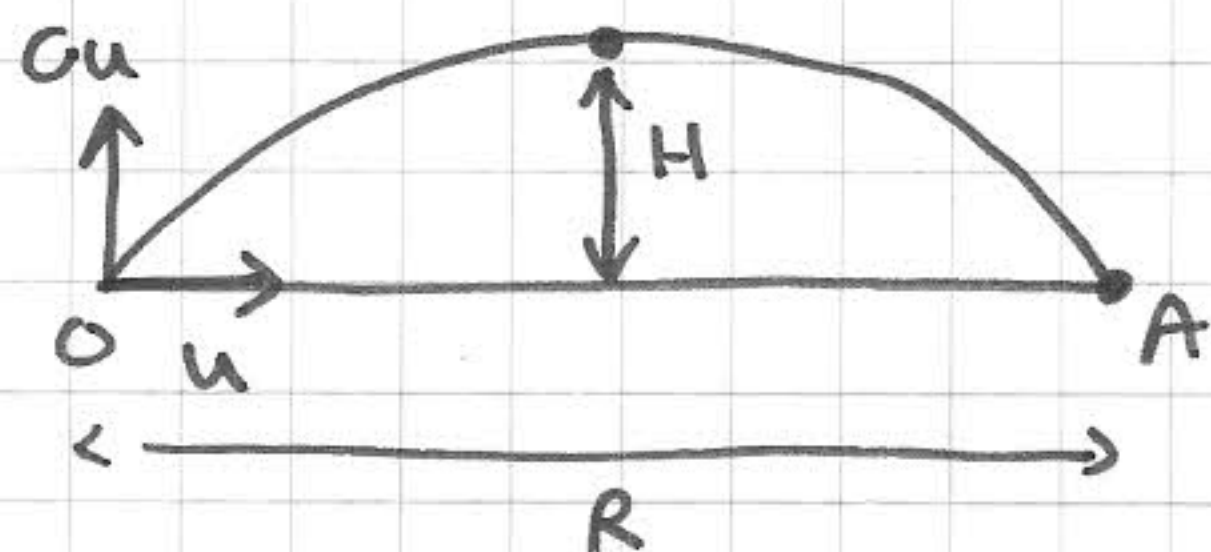
b)



$$x=2 \Rightarrow \bar{y} = \frac{4 \times 5}{16 + 3\pi} \Rightarrow 4 - \bar{y} = \frac{64 + 12\pi - 20}{16 + 3\pi} = \frac{44 + 12\pi}{16 + 3\pi}$$

$$\tan \theta = \frac{6}{1} \div \frac{44 + 12\pi}{16 + 3\pi} \Rightarrow \tan \theta = \frac{6}{1} \times \frac{16\pi + 3\pi}{44 + 12\pi} = \frac{48 + 9\pi}{22 + 6\pi}$$

8)



$$\vec{H} \quad \begin{array}{l} u = u \\ t = t \\ s = ut \\ x = ut \end{array} \quad \begin{array}{l} v \uparrow = u = cu \\ a = -9.8 \\ s = y \end{array}$$

$$v \uparrow \Rightarrow s = ut + \frac{1}{2}at^2 \Rightarrow y = cut - 4.9t^2$$

$$\text{from H} \quad t = \frac{x}{u} \Rightarrow \bar{y} = cu \times \frac{x}{u} - 4.9 \left(\frac{x}{u}\right)^2$$

$$y = cx - \frac{4.9x^2}{u^2}$$

$$b) u = 7 \Rightarrow x = 7t$$

$$\text{at A } y = 0 \Rightarrow 0 = cx - \frac{4.9x^2}{49} \Rightarrow \frac{1}{10}x^2 = cx$$

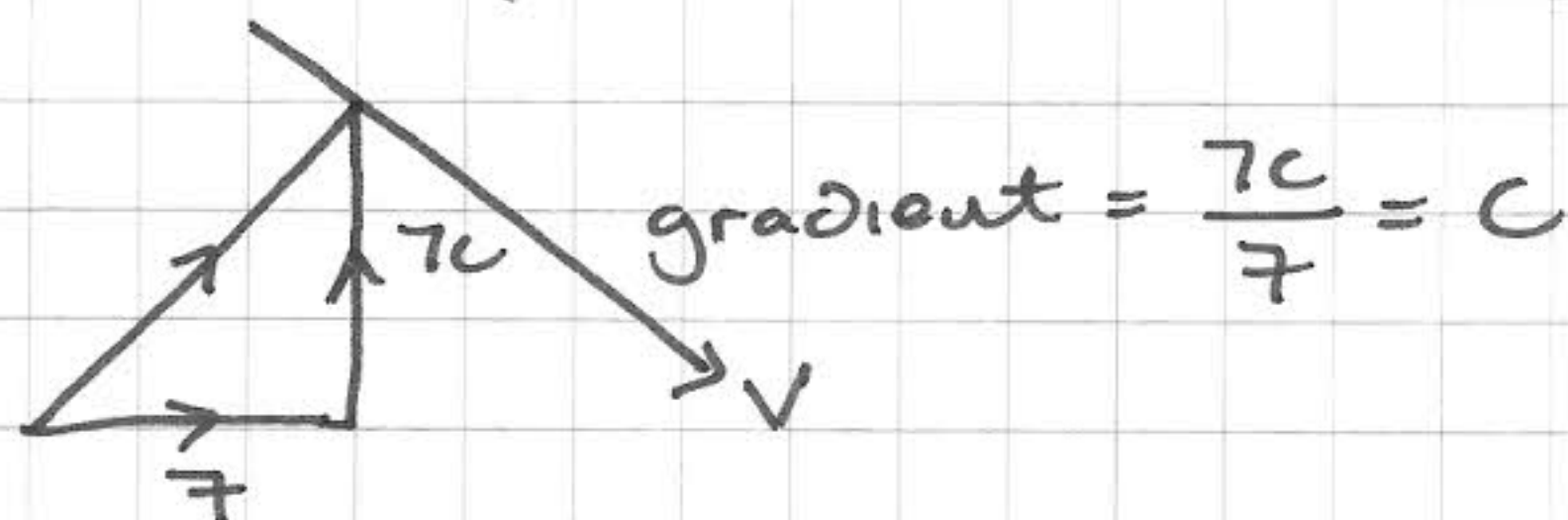
$$(ii) \quad 7t = 10c \Rightarrow t = \frac{10}{7}c \quad \Rightarrow \quad \begin{array}{l} x = 10c \\ R = 10c \end{array}$$

So  $t = \frac{5}{7}c$  at max height.

$$v^2 = u^2 + 2as \Rightarrow 0 = (7c)^2 - 19.6H$$

$$49c^2 = 19.6H \Rightarrow H = \frac{5}{2}c^2$$

c) Originally



at Q Vel is perpendicular  $\Rightarrow$  gradient =  $-\frac{1}{c}$



$$\frac{y}{7} = -\frac{1}{c} \Rightarrow y = -\frac{7}{c}$$

$$\begin{array}{l} u \uparrow = 7c \\ a = -9.8 \end{array} \quad v \uparrow = -\frac{7}{c}$$

7  $\rightarrow$  doesn't change!

$$v = u + at \quad -\frac{7}{c} = 7c - 9.8t$$

$$9.8t = 7c + \frac{7}{c} = \frac{7c^2 + 7}{c} \Rightarrow t = \frac{7c^2 + 7}{9.8c}$$

$$\vec{H} \quad x = 7t \quad x = \frac{7(7c^2 + 7)}{9.8c} = \frac{5(7c^2 + 7)}{7c} = \frac{5(c^2 + 1)}{c}$$