

$$(15\hat{i} + \hat{j}) + (5p\hat{i} + q\hat{j}) + (-3p\hat{i} - q\hat{j})$$

in equilibrium \therefore for resultant = 0

equate coeffs of \hat{i}

$$15 + 5p - 3p = 0 \quad \dots \textcircled{1}$$

equate coeffs of \hat{j}

$$1 - p - q = 0 \quad \dots \textcircled{2}$$

$$1 - p = q$$

Sub into equation $\textcircled{1}$

$$15 + 5(1-p) - 3p = 0$$

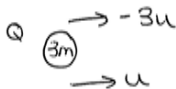
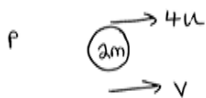
$$15 + 5 - 5p - 3p = 0$$

$$20 = 8p$$

$$p = 2.5 \quad \therefore q = 1 - 2.5$$

$$q = -1.5$$

a)



$$4u \times 2m + (-3u) \times 3m = 3mu + 2mv$$

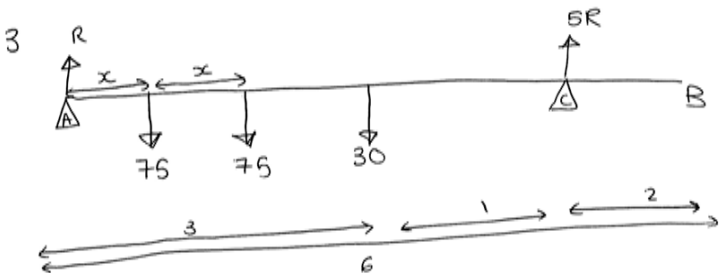
$$-4um = 3mu + 2mv$$

$$\frac{-4um}{2m} = v = -2u$$

$$\text{speed} = |-2u| = 2u$$

b) direction of P has been reversed
 as I took initial direction as positive
 \rightarrow and the ~~dir~~ answer was negative.

c) on Q $I = m(v - u)$
 $= 3m(u - -3u)$
 $= 3m \times 4u$
 $= \underline{12mu}$



moments $\uparrow A$: $75x + (75 \times 2x) + (30 \times 3) - (5R \times 4) = 0$
 $= \therefore 225x + 90 - 20R = 0$

moments $\uparrow C$: $(30 \times 1) + (75 \times (4 - 2x)) + (75 \times (4 - x)) - 4R = 0$
 $= 30 + 300 - 150x + 300 - 75x - 4R = 0$

$$\boxed{630 - 225x = 4R} \dots \textcircled{1}$$

$$\boxed{90 + 225x = 20R} \dots \textcircled{2}$$

multiply $(1) \times 5$
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$$\boxed{3150 - 1125x = 90 + 225x} \dots (3)$$

equate (3) and (2)

$$3150 - 1125x = 90 + 225x$$

$$3060 = 1350x$$

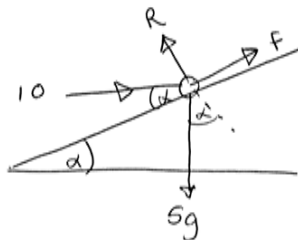
$$x = \underline{2.27 \text{ m}}$$

b) by assuming the plank is:

uniform = the mass acts at the centre of the plank.

a rod = does not bend when weight / forces are applied.

4)



$$F = \mu R$$

$$\uparrow R - 5g \cos \alpha - 10 \sin \alpha = 0$$

$$R = 5g \left(\frac{4}{5}\right) + 10 \left(\frac{3}{5}\right)$$

$$R = 45.2$$

$$\therefore F = \mu 45.2$$

$$\rightarrow + 45.2\mu + 10 \cos \alpha - 5g \sin \alpha = 0$$

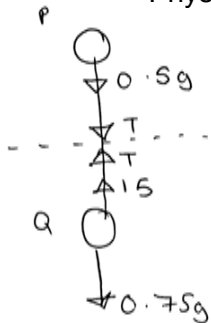
$$45.2\mu = 5g \left(\frac{3}{5}\right) - 10 \left(\frac{4}{5}\right)$$

$$45.2\mu = 21.4$$

$$\mu = \underline{0.47}$$

5)

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$$\textcircled{2} \dots \text{ at } Q \uparrow -0.75g + 15 + T = 0.75a$$

add $\textcircled{1}$ and $\textcircled{2}$ together

$$-1.25g + 15 = 1.25a$$

$$2.75 = 1.25a$$

$$a = \underline{\underline{2.2}}$$

sub 'a' into $\textcircled{1}$

$$-0.5g - T = 0.5 \times 2.2$$

$$-0.5g - 0.5 \times 2.2 = T$$

$$T = -6 \text{ N}$$

$$T = |-6| = \underline{\underline{6 \text{ N}}}$$

6) \vec{AB}

$$s = 40$$

$$u =$$

$$v = 10$$

$$a = ?$$

$$t = 5$$

$$s = vt - \frac{1}{2}at^2$$

$$40 = 50 - \frac{1}{2}a \times 25$$

$$-20 = -25a$$

$$a = \underline{\underline{0.8}}$$

\vec{A}^{mid}

$$b) s = 20$$

$$u =$$

$$v =$$

$$a = 0.8$$

$$t =$$

\vec{AB}

$$s = 40$$

$$u = ?$$

$$v = 10$$

$$a = 0.8$$

$$t = 5$$

$$s = \left(\frac{u+v}{2} \right) t$$

$$40 = \left(\frac{u+10}{2} \right) 5$$

$$\underline{\underline{u = 6}}$$

$$\begin{aligned} \therefore s &= 20 \\ u &= 6 \\ v &= \\ a &= 0.8 \\ t &= ? \end{aligned}$$

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

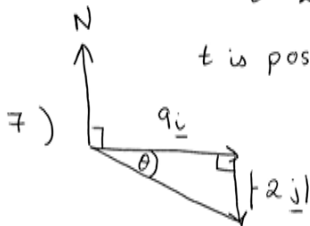
$$20 = 6t + 0.4t^2$$

$$0.4t^2 + 6t - 20 = 0$$

$$\frac{-6 \pm \sqrt{6^2 - 4(0.4)(-20)}}{2 \times 0.4}$$

$$t = 2.81 \text{ or } -17.8$$

t is positive $\therefore t = \underline{\underline{2.81}}$



$$\theta = \tan^{-1}\left(\frac{2}{9}\right) = 12.5^\circ$$

$$\begin{aligned} \text{bearing} &= 12.5 + 90 \\ &= \underline{\underline{103^\circ}} \end{aligned}$$

$$b) \quad p = (9\underline{i} + 10\underline{j}) + t(9\underline{i} - 2\underline{j})$$

$$q = (\underline{i} + 4\underline{j}) + t(4\underline{i} + 8\underline{j})$$

$$c) \quad \overrightarrow{QP} = p - q$$

$$= 9\underline{i} - \underline{i} + 10\underline{j} - 4\underline{j} + 9t\underline{i} - 4t\underline{i} - 2t\underline{j} - 8t\underline{j}$$

$$= 8\underline{i} + 6\underline{j} + 5t\underline{i} - 10t\underline{j}$$

$$= (8 + 5t)\underline{i} + (6 - 10t)\underline{j} \quad \text{+ as given}$$

d) distance = $\sqrt{100}$
 points = pythagoras.

$$\sqrt{(8+5t)^2 + (6-10t)^2} = 10$$

$$(8+5t)(8+5t) + (6-10t)(6-10t) = 100$$

$$64 + 80t + 25t^2 + 36 - 120t + 100t^2 = 100$$

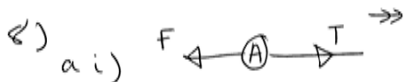
$$125t^2 - 40t + 100 = 100$$

$$125t^2 - 40t = 0$$

$$t(125t - 40) = 0$$

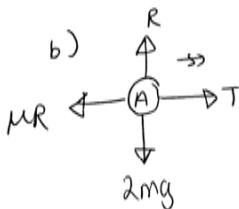
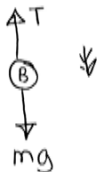
$$\underline{t=0} \text{ or } 125t = 40$$

$$\underline{t=0.32}$$



$$A \rightarrow + T - F = 2ma$$

$$B \text{ ii) } mg - T = ma$$



$$\uparrow + R = 2mg$$

$$\therefore F = \mu R = 2mg\mu$$

sub into equation for A

$$T - 2mg\mu = 2ma$$

as T is [PhysicsAndMathsTutor.com](http://www.PhysicsAndMathsTutor.com)

for both B and A

$$mg - ma = T$$

\therefore

$$mg - ma - 2mg\mu = 2ma$$

$$mg(1 - 2\mu) = 3ma$$

$$a = \frac{mg}{3m}(1 - 2\mu) = \frac{g}{3}(1 - 2\mu)$$

c) When B hits floor $s = h$

\downarrow

$$s = h$$

$$u = 0$$

$$v = ?$$

$$a = \frac{g}{3}(1 - 2\mu)$$

t

$$v^2 = u^2 + 2as$$

$$v^2 = 0^2 + \frac{2hg}{3}(1 - 2\mu)$$

$$v = \sqrt{\frac{2gh}{3}(1 - 2\mu)}$$

d) when B hits floor \Rightarrow no tension

$$\therefore s = d - h$$

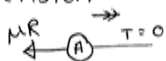
$$u = \sqrt{\frac{2gh}{3}}$$

$$v = 0$$

$$a = -\frac{1}{3}g$$

$t =$

$$v^2 = u^2 + 2as$$



$$\therefore -\mu R = 2ma$$

$$-\frac{1}{3} \times 2mg = 2ma$$

$$a = -\frac{1}{3}g$$

$$0^2 = \frac{2}{9}gh + 2\left(-\frac{1}{3}g\right)(d-h)$$

$$0 = \frac{2}{9}gh - \frac{2}{3}g(d-h)$$

$$0 = \frac{h}{9} - \frac{1}{3}d + \frac{1}{3}h$$

$$\frac{1}{3}d = \frac{4}{9}h$$

$$d = \frac{4}{3}h$$

e) the system would not move