

3A

1a) $\lambda = 30$

$L = 3$

x

$T = 4$

$$T = \frac{\lambda x}{L}$$

$$4 = \frac{30x}{3}$$

$$x = 0.4$$

Total length = 3.4 m

b) $\lambda = 12$

$L = 3$

x

$T = 4$

$$4 = \frac{12x}{3}$$

$$x = 1$$

Total length = 4 m

c) $\lambda = 16$

$L = 3$

x

$T = 4$

$$4 = \frac{16x}{3}$$

$$x = 0.75$$

Total length = 3.75

(3A)

2)

$$\lambda = 25$$

$$L$$

$$x = L - 0.8$$

$$T = 20$$

$$T = \frac{\lambda x}{L}$$

$$20 = \frac{25(L - 0.8)}{L}$$

$$20L = 25L - 20$$

$$L = \underline{\underline{4}}$$

3)

$$\lambda = 20$$

$$L = L$$

$$x = 1.4 - L$$

$$T = 19$$

$$19 = \frac{20(1.4 - L)}{L}$$

$$19.8L = 28 - 20L$$

$$39.8L = 28$$

$$L = \frac{140}{149}$$

$$\lambda = 20$$

$$L = \frac{140}{149}$$

$$x =$$

$$T = 0.89$$

$$0.89 = \frac{20(x)}{140/149}$$

$$= 20x$$

$$x = \frac{1372}{3725}$$

$$\text{Total length} = \frac{140}{149} + \frac{1372}{3725}$$

$$= \underline{\underline{1.31m (3sf)}}$$

(3A)

4)

$$\lambda = \gamma$$

$$L = a$$

$$x = x_1$$

$$T = Mg$$

Initial

$$Mg = \frac{\lambda x_1}{a}$$

$$\Rightarrow x_1 = \frac{Mga}{\lambda}$$

with mass

$$\lambda = \gamma$$

$$L = a$$

$$x = x_2$$

$$T = (m + M)g$$

$$m + Mg = \frac{\lambda x_2}{a}$$

$$\Rightarrow x_2 = \frac{a(m + Mg)}{\lambda}$$

$$x_2 - x_1 = \frac{a(m + Mg)}{\lambda} - \frac{Mga}{\lambda}$$

$$x_2 - x_1 = \frac{amg + Mga - Mga}{\lambda}$$

$$x_2 - x_1 = \frac{amg}{\lambda}$$

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5)

mass m_1

$$\lambda = \lambda$$

$$l = L$$

$$x = a_1 - L$$

$$T = m_1 g$$

$$m_1 g = \frac{\lambda (a_1 - L)}{L} \quad \textcircled{A}$$

$$\Rightarrow L = \frac{\lambda (a_1 - L)}{m_1 g}$$

mass m_2

$$\lambda = \lambda$$

$$L = L$$

$$x = a_2 - L$$

$$T = m_2 g$$

$$m_2 g = \frac{\lambda (a_2 - L)}{L} \quad \textcircled{B}$$

$$\Rightarrow L = \frac{\lambda (a_2 - L)}{m_2 g}$$

$$\frac{\lambda (a_1 - L)}{m_1 g} = \frac{\lambda (a_2 - L)}{m_2 g}$$

$$m_2 g (a_1 - L) = m_1 g (a_2 - L)$$

$$m_2 (a_1 - L) = m_1 (a_2 - L)$$

$$m_2 a_1 - L m_2 = m_1 a_2 - L m_1$$

$$L m_1 - L m_2 = m_1 a_2 - m_2 a_1$$

$$L (m_1 - m_2) = m_1 a_2 - m_2 a_1$$

(3A)

5) conti

$$L = \frac{m_1 a_2 - m_2 a_1}{m_1 - m_2}$$

A - B

$$m_1 g - m_2 g = \frac{\lambda a_1 - \lambda L}{L} - \frac{\lambda a_2 - \lambda L}{L}$$

$$m_1 g - m_2 g = \left(\frac{\lambda a_1}{L} - \lambda \right) - \left(\frac{\lambda a_2}{L} - \lambda \right)$$

$$m_1 g - m_2 g = \frac{\lambda a_1}{L} - \frac{\lambda a_2}{L}$$

$$g(m_1 - m_2) = \lambda(a_1 - a_2)$$

$$\lambda = \frac{g(m_1 - m_2)}{(a_1 - a_2)}$$

sub L

$$\lambda = \frac{g(m_1 a_2 - m_2 a_1)}{(m_1 - m_2)(a_1 - a_2)}$$

$$\lambda = \frac{g(m_1 a_2 - m_2 a_1)}{(a_1 - a_2)}$$

(3A)

6) $\lambda = \lambda$

$L = L$

$x = 0.1$

$T = W$

$$W = \frac{\lambda 10}{L}$$

$$\Rightarrow L = \frac{\lambda 0.1}{W}$$

$\lambda = \lambda$

$L = L$

$x = 0.25$

$T = W + 50$

$$W + 50 = \frac{\lambda 0.25}{L}$$

$$\Rightarrow L = \frac{\lambda 0.25}{W + 50}$$

$$\frac{\lambda 0.1}{W} = \frac{\lambda 0.25}{W + 50}$$

$$0.1\lambda(W + 50) = 0.25\lambda W$$

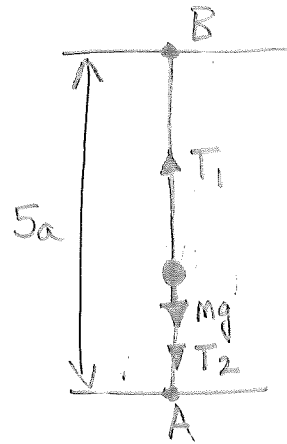
$$0.1\lambda W + 5\lambda = 0.25\lambda W$$

$$5\lambda = 0.15\lambda W$$

$$W = \frac{5}{0.15} = \underline{\underline{\frac{100}{3} \text{ N}}}$$

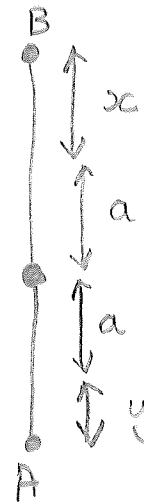
(3A)

7)



$$2a + x + y = 5a$$

$$y = 3a - x$$



$$T_1 = T_2 + mg$$

$$\frac{2mgx}{a} = \frac{2mg(3a-x)}{a} + mg$$

$$2mgx = 2mg(3a-x) + mga$$

$$2x = 2(3a-x) + a$$

$$2x = 6a - 2x + a$$

$$4x = 7a$$

$$x = \frac{7a}{4}$$

$\therefore$ Distance from ceiling

$$T_1 = \frac{\lambda x}{l}$$

$$\lambda = 2mg$$

$$l = a$$

$$T_1 = 2mgx$$

$$x = x$$

$$T_1 = \frac{2mgx}{a}$$

$$T_1:$$

$$T_2 = \lambda x$$

$$\lambda = 2mg$$

$$T_2 = \frac{2mg(3a-x)}{a}$$

$$l = a$$

$$x = 3a - x$$

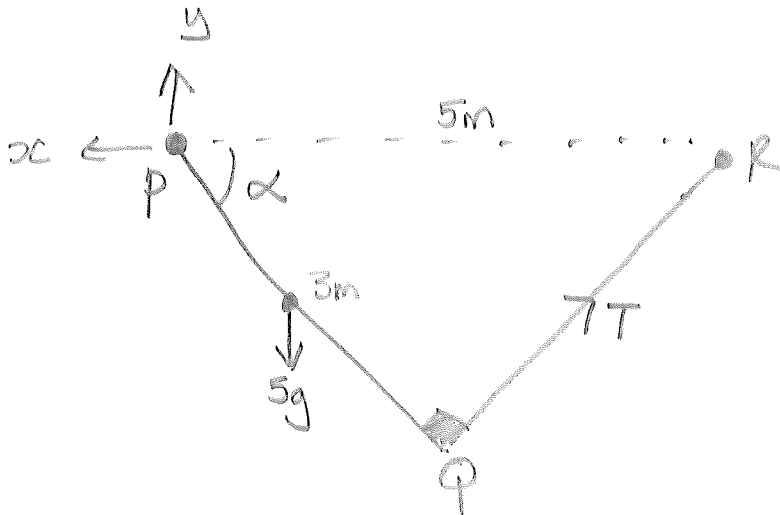
$$T_2$$

$$= x + a = \frac{7a}{4} + a = \frac{11a}{4}$$

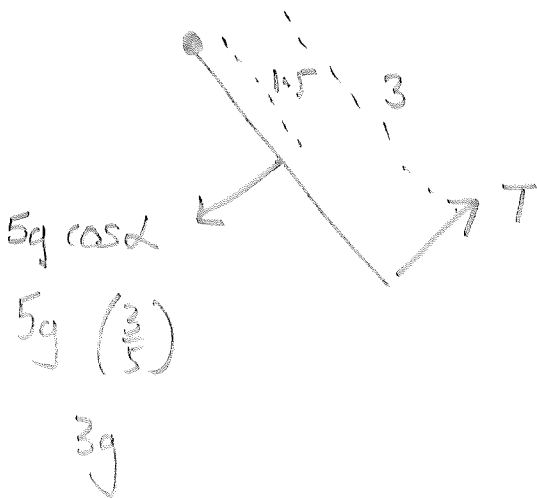
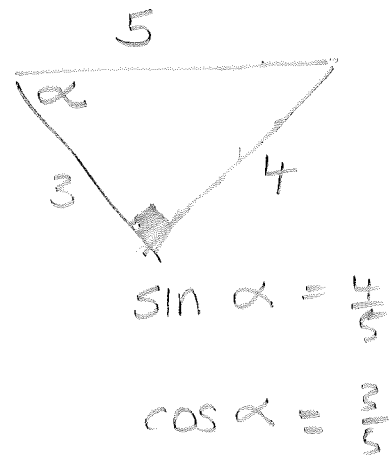
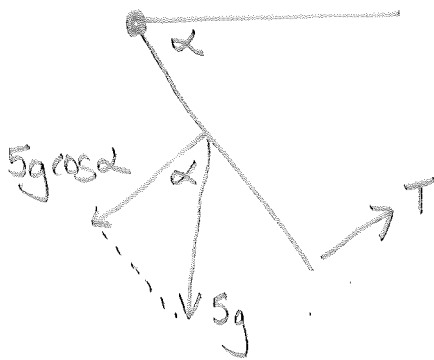
3A

8)

a)



a) moments at P



M(P)

$$3g \times 1.5 = 3T$$

$$4.5g = 3T$$

$$T = 14.7$$

(3A)

8.
b)

$$\lambda = 30$$

$$L = L$$

$$x = 4 - L$$

$$T = 14.7$$

$$T = \frac{\lambda x}{L}$$

$$14.7 = \frac{30(4-L)}{L}$$

$$14.7L = 120 - 30L$$

$$44.7L = 120$$

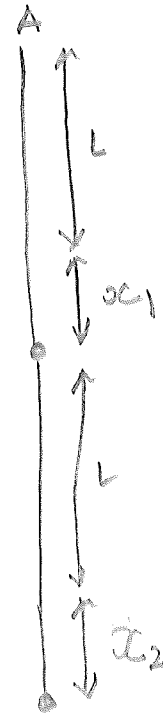
$$L = 2.68 \text{ m (3sf)}$$

3A

9)



$$T = mg$$



$$\lambda = 2mg$$

$$L = L$$

$$x_1 = x_1$$

$$T = mg$$

$$mg = \frac{2mgx_1}{L} \Rightarrow x_1 = \frac{L}{2}$$

$$\lambda = 4mg$$

$$L = L$$

$$x_2 = x_2$$

$$T = mg$$

$$mg = \frac{4mgx_2}{L} \Rightarrow x_2 = \frac{L}{4}$$

(3A)

$$9) \text{ AD length} = 2L + x_1 + x_2$$

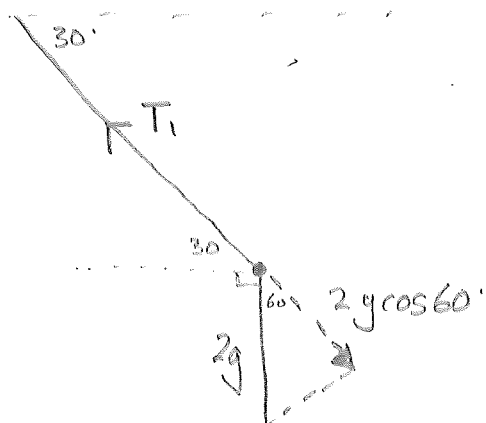
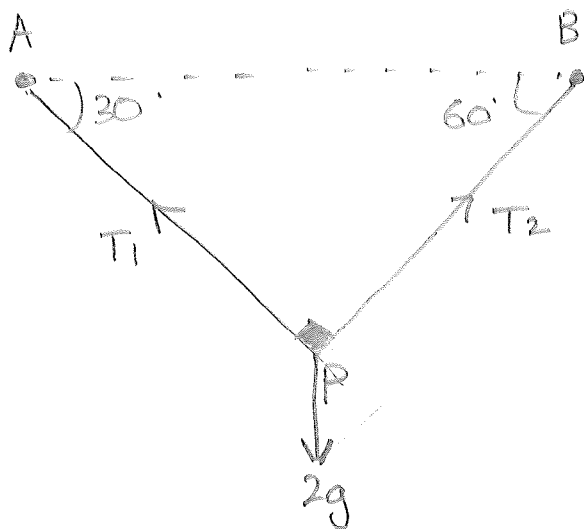
$$= 2L + \frac{L}{2} + \frac{L}{4}$$

$$= \frac{8L}{4} + \frac{2L}{4} + \frac{L}{4}$$

$$= \frac{11L}{4}$$

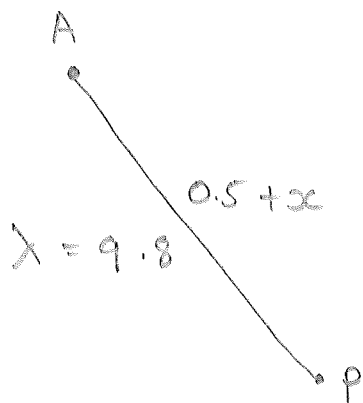
3A

10)
a)



$$T_1 = 2g \cos 60$$

$$T_1 = 9.8$$



$$T_1$$

$$L = 0.5$$

$$x = x$$

$$\lambda = 9.8$$

$$T_1 = \frac{9.8x}{0.5}$$

$$T_1 = 19.6x$$

$$9.8 = 19.6x$$

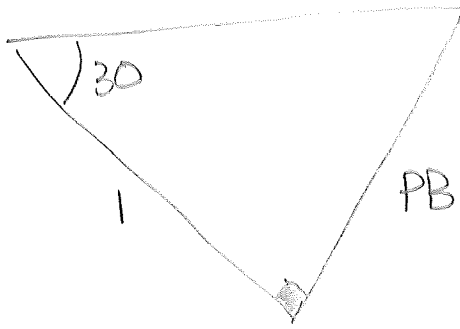
$$x = 0.5$$

$$AP = 0.5 + 0.5$$

$$= \underline{\underline{1\text{m}}}$$

3A
10)

b)

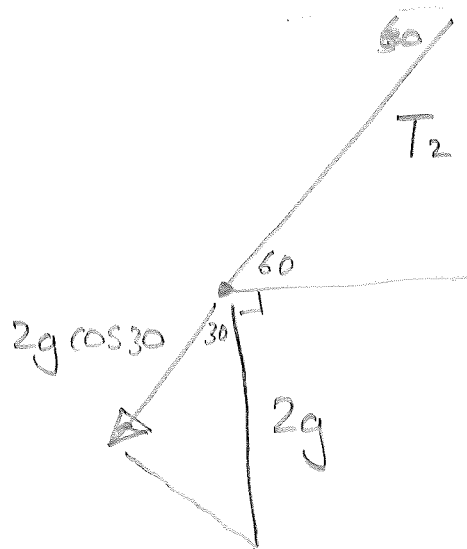


$$\tan 30 = \frac{PB}{1}$$

$$\frac{\sqrt{3}}{3} = PB$$

$$PB = \underline{\underline{0.577\text{m}(3\text{sf})}}$$

c)



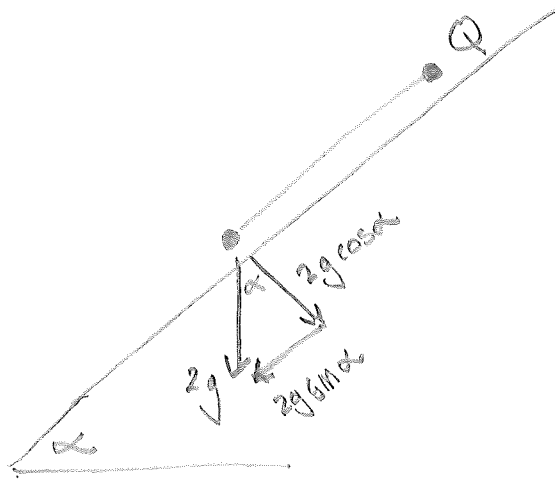
$$T_2 = 2g \cos 30$$

$$T_2 = \underline{\underline{17.0\text{N}(3\text{sf})}}$$

3A

11)

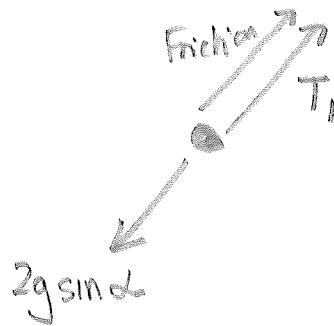
a)



$$\tan \alpha = \frac{3}{4}$$

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

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



$$\text{friction} = \mu R$$

$$= \frac{1}{2} (2g \cos \alpha)$$

$$= \frac{1}{2} (2g) \left(\frac{4}{5} \right)$$

$$= \frac{8g}{10}$$

$$2g \sin \alpha = \frac{8g}{10} + T_1$$

$$T_1 = 2g \left(\frac{3}{5} \right) - \frac{8g}{10}$$

$$T_1 = \frac{4g}{10}$$

$$T_1 = \underline{\underline{3.92 \text{ N (3sf)}}}$$

(3A)

11)

b)

$$T = \frac{4g}{10}$$

$$\lambda = 20$$

$$x$$

$$L = 0.8$$

$$T = \frac{\lambda x}{L}$$

$$\frac{4g}{10} = \frac{20x}{0.8}$$

$$x = 0.1568$$

$$\text{Length of PQ} = 0.8 + 0.1568$$

$$= \underline{\underline{0.9568 \text{ m}}}$$