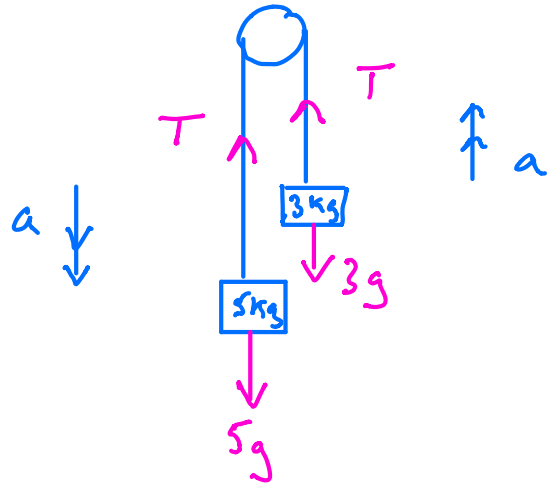
Example



N2L ($F = ma$)

for 5kg mass $5g - T = 5a$ (1)

$T - 3g = 3a$ (2)

(1) + (2) $2g = 8a$

$\frac{2 \times 9.8}{8} = a$

$a = 2.45\ ms^{-2}$

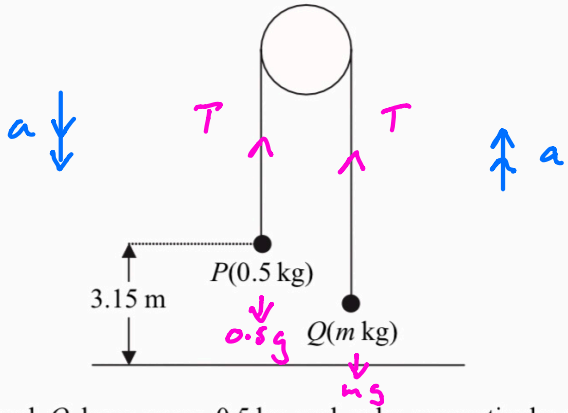
Sub for a in (2)

$T - 3g = 3 \times 2.45$

$T = 3 \times 2.45 + 3 \times 9.8$

$T = 36.75\ N$

$T = 36.8\ N$



Two particles P and Q have mass 0.5 kg and m kg respectively, where $m < 0.5$. The particles are connected by a light inextensible string which passes over a smooth, fixed pulley. Initially P is 3.15 m above horizontal ground. The particles are released from rest with the string taut and the hanging parts of the string vertical, as shown in Figure 4. After P has been descending for 1.5 s, it strikes the ground. Particle P reaches the ground before Q has reached the pulley.

(a) Show that the acceleration of P as it descends is 2.8 m s^{-2}.

(3)

(b) Find the tension in the string as P descends.

(3)

(c) Show that $m = \frac{5}{18}$.

(4)

(d) State how you have used the information that the string is inextensible.

(1)

When P strikes the ground, P does not rebound and the string becomes slack. Particle Q then moves freely under gravity, without reaching the pulley, until the string becomes taut again.

(e) Find the time between the instant when P strikes the ground and the instant when the string becomes taut again.

(6)

a) P falls 3.15 m in 1.5 s

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

$3.15 = 0 + \frac{1}{2} a \times 1.5^2$

$3.15 = \frac{9}{8}a$

$3.15 \times \frac{8}{9} = a$

$a = 2.8 \text{ ms}^{-2}$

b) N2L for P $F = ma$

$0.5g - T = 0.5 \times 2.8$

$0.5 \times 9.8 - 0.5 \times 2.8 = T$

$T = 3.5 \text{ N}$

c) N2L for Q

$$T - mg = ma$$
$$T = ma + mg$$
$$T = m(a+g)$$
$$3.5 = m(2.8+9.8)$$
$$\frac{3.5}{12.6} = m$$
$$m = \frac{5}{18}\ kg$$

d) accelerations for both particles are the same

e) Find speed of P (and therefore Q) when it hits ground

$$v = u + at$$
$$v = 0 + 2.8 \times 1.5 = 4.2\ ms^{-2}$$

Consider Q under gravity measuring distance above point where string becomes slack and then taut again

$$s = ut + \frac{1}{2}at^2$$
$$0 = 4.2t - 4.9t^2$$
$$0 = t(4.2 - 4.9t)$$

$t \neq 0$ or $4.2 - 4.9t = 0$

$$4.9t = 4.2$$
$$t = \frac{4.2}{4.9}$$
$$t = \frac{6}{7}\ s$$