WORKED EXAMPLES

EXAMPLE 1

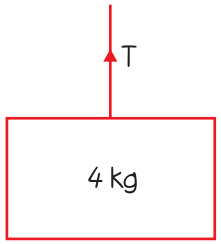
A body of mass 4 kg is lifted up by a vertical string. Find the tension in the string if

(i) the body moves up with an acceleration of 3 m s^{-2},

(ii) the body moves down with an acceleration of 3 m s^{-2},

(iii) the body moves down at a constant velocity of 3 m s^{-1}.

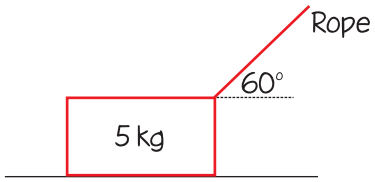
Take $g = 9.8\ \text{m}\,\text{s}^{-2}$.



SOLUTION: Page 2

EXAMPLE 2

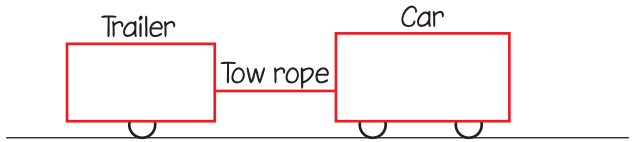
A rope pulls a box along a rough floor. The tension in the rope is 30 N. The frictional resistance force is 6 N. Find the net horizontal force and the acceleration across the floor.



SOLUTION: Page 3

EXAMPLE 3

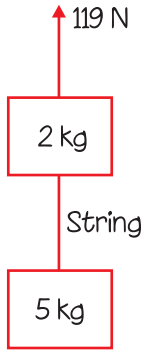
A car of mass 240 kg pulls a trailer of mass 60 kg along a straight horizontal road. If the driving force of the car is 120 N and the resistance to the car is 30 N and the trailer is 15 N, find the common acceleration of the bodies. The resistant forces are horizontal. Find the tension in the tow rope. The tow rope is horizontal.



SOLUTION: Page 4

EXAMPLE 4

A 119 N force in a string pulls up two masses connected by a string as shown. Find the acceleration of each mass and the tension in the connecting string. Take $g = 9.8\ \text{m}\,\text{s}^{-2}$.



SOLUTION: Page 5

EXAMPLE 1: A body of mass 4 kg is lifted up by a vertical string. Find the tension in the string if

(i) the body moves up with an acceleration of 3 m s^{-2},

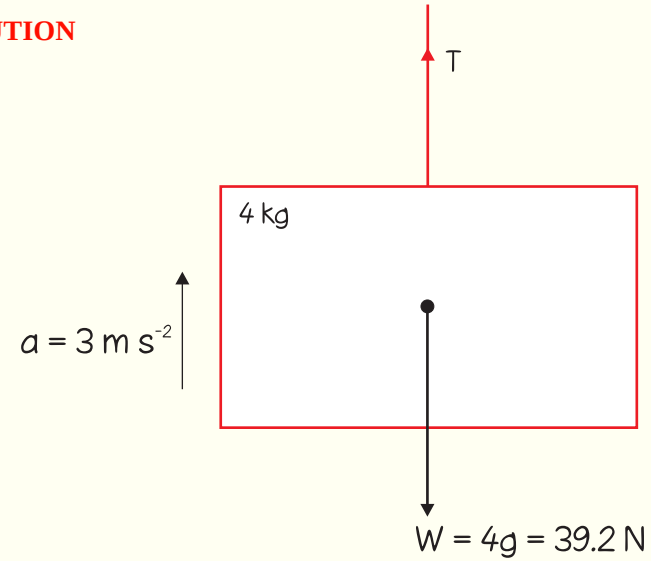
(ii) the body moves down with an acceleration of 3 m s^{-2},

(iii) the body moves down at a constant velocity of 3 m s^{-1}.

Take $g = 9.8\ \text{m}\,\text{s}^{-2}$.

SOLUTION

(i)



$W = mg$

$F_{\text{Net}} = ma$

MATHEMATICAL CALCULATIONS

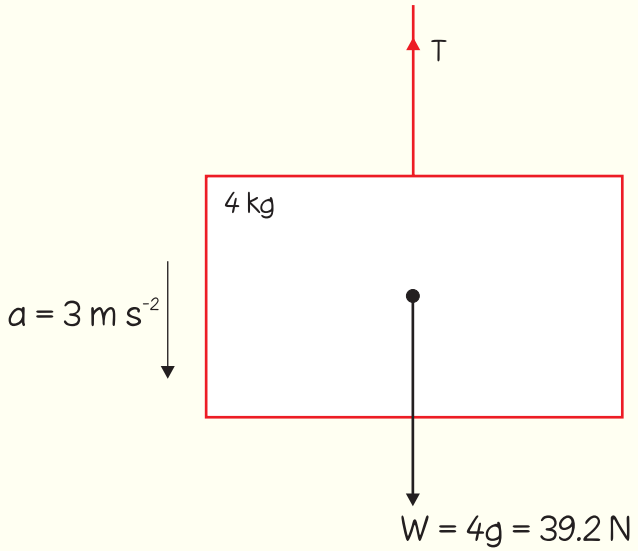
$W = 4g = 4(9.8) = 39.2\ \text{N}$

$T - W = 4(3)$

$T - 39.2 = 12$

$T = 51.2\ \text{N}$

(ii)



$W = mg$

$F_{\text{Net}} = ma$

MATHEMATICAL CALCULATIONS

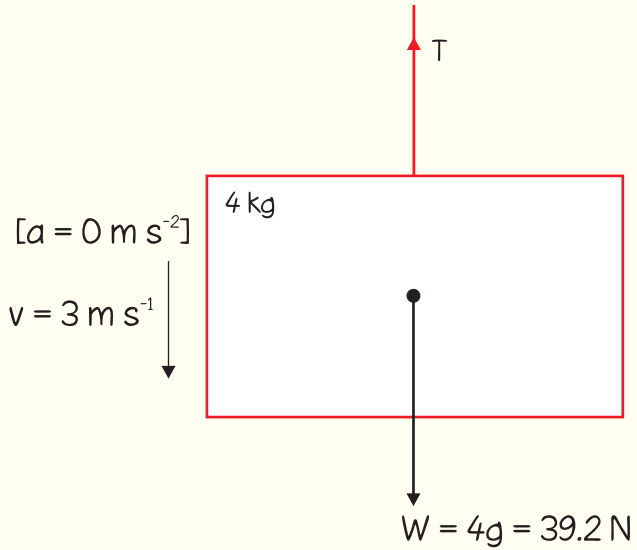
$W = 4g = 4(9.8) = 39.2\ \text{N}$

$W - T = 4(3)$

$39.2 - T = 12$

$T = 27.2\ \text{N}$

(iii)



$W = mg$

MATHEMATICAL CALCULATIONS

$W = 4g = 4(9.8) = 39.2 \text{ N}$

$F_{\text{Net}} = ma$

$a = 0 \text{ m s}^{-2}$

$W - T = 4(0)$

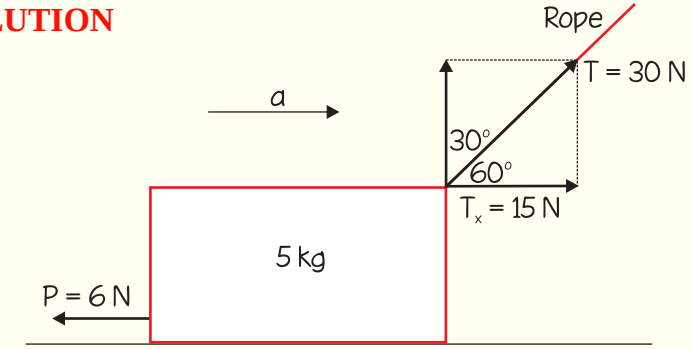
$39.2 - T = 0$

$T = 39.2 \text{ N}$

EXAMPLE 2: A rope pulls a box along a rough floor. The tension in the rope is 30 N. The frictional resistance force is 6 N. Find the net horizontal force and the acceleration across the floor.

Take $g = 9.8 \text{ m s}^{-2}$.

SOLUTION



$F_{\text{Net}} = ma$

MATHEMATICAL CALCULATIONS

HORIZONTAL:

$T\cos 60^\circ = 30(\tfrac{1}{2}) = 15 \text{ N}$

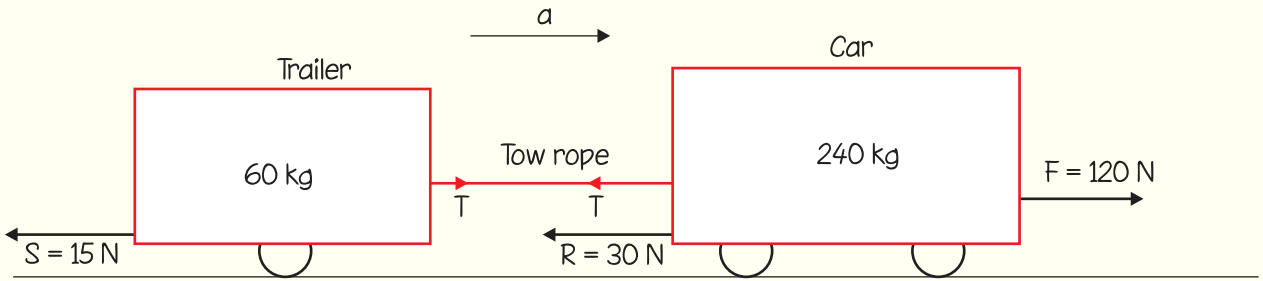
$T\cos 60^\circ - P = 5a$

$15 - 6 = 5a$

$9 = 5a \Rightarrow a = \tfrac{9}{5} = 1.8 \text{ m s}^{-2}$

EXAMPLE 3: A car of mass 250 kg pulls a trailer of mass 60 kg along a straight horizontal road. If the driving force of the car is 120 N and the resistance to the car is 30 N and the trailer is 15 N, find the common acceleration of the bodies. The resistant forces are horizontal. Find the tension in the tow rope. The tow rope is horizontal.

SOLUTION



You can use either the trailer or the car to work out the tension *T*. I'll use the trailer. Show that you get the same answer for *T* using the car.

WHOLE BODY

$F_{\text{Net}} = ma$

MATHEMATICAL CALCULATIONS

HORIZONTAL:

$F - \cancel{T} + \cancel{T} - R - S = (60 + 240)a$

$120 - 30 - 15 = 300a$

$75 = 300a$

$a = \frac{75}{300} = \frac{1}{4}\ \text{ms}^{-2}$

TRAILER

$F_{\text{Net}} = ma$

MATHEMATICAL CALCULATIONS

HORIZONTAL:

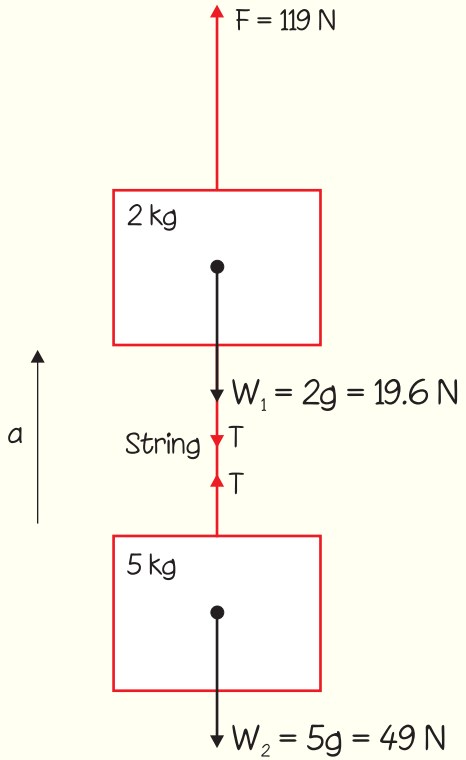
$T - 15 = 60(\frac{1}{4})$

$T - 15 = 15$

$T = 30\ \text{N}$

EXAMPLE 4: A 119 N force in a string pulls up two masses connected by a string as shown. Find the acceleration of each mass and the tension in the connecting string. Take $g = 9.8\ \text{m s}^{-2}$.

SOLUTION



WHOLE BODY

$F_{\text{Net}} = ma$

MATHEMATICAL CALCULATIONS

VERTICAL:

$W_1 = 2g = 2(9.8) = 19.6\ \text{N}$

$W_2 = 5g = 5(9.8) = 49\ \text{N}$

$F - W_1 - \cancel{T} + \cancel{T} - W_2 = (2+5)a$

$119 - 19.6 - 49 = 7a$

$50.4 = 7a$

$a = \frac{50.4}{7} = 7.2\ \text{m s}^{-2}$

You can use either of the masses to work out the tension *T*. I'll use the 2 kg mass. Show that you get the same answer for *T* using the 5 kg mass.

2 kg MASS

$F_{\text{Net}} = ma$

MATHEMATICAL CALCULATIONS

$F - W_1 - T = 2(7.2)$

$119 - 19.6 - T = 14.4$

$T = 85\ \text{N}$