

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

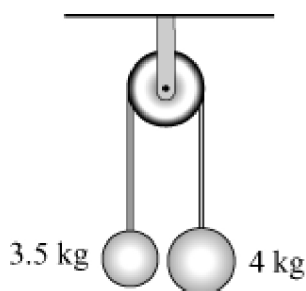
6 Connected particles

Exercise Test yourself, Question 1

Question:

Particles of mass 4 kg and 3.5 kg are attached to the ends of a light, inextensible string, which passes over a smooth pulley. The system is released from rest.

- (a) Find the tension in the string.
- (b) Find the time that it takes for the heavier particle to fall 0.5 m.



Solution:

- (a) Using $F = ma$ for

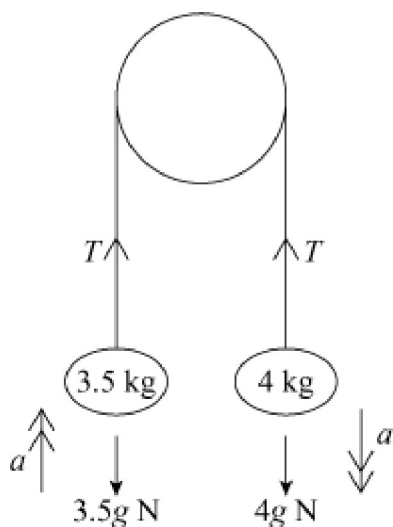
$$4 \text{ kg particle; } 4g - T = 4a \quad [1]$$

$$3 \frac{1}{2} \text{ kg particle; } T - 3.5g = 3.5a$$

$$\text{Adding } 0.5g = 7.5a$$

$$a = \frac{1}{15}g$$

$$= 0.6533 \text{ m s}^{-2}$$



$$\begin{aligned}\text{From [1] } T &= 4g - 4a \\ &= \frac{56}{15}g \text{ or } 36.586\dots\end{aligned}$$

∴ Tension is 36.6 N.

(b) To find the time taken to fall 0.5 m,

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

$$0.5 = \frac{1}{2} \times 0.6533 \times t^2$$

$$t^2 = \frac{1}{0.6533} = 1.5306$$

$$t = 1.2372$$

∴ Time is 1.24 s.

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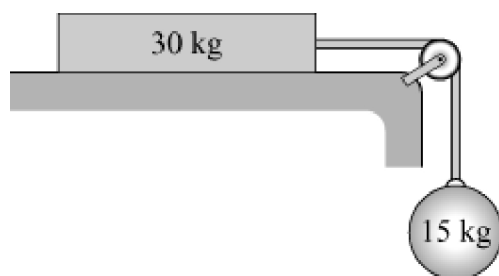
Exercise Test yourself, Question 2

Question:

A block, of mass 30 kg, rests on a rough horizontal surface. The coefficient of friction between the surface and the block is 0.4. A light inextensible rope is attached to the block and passes over a smooth pulley. A particle, of mass 15 kg, hangs from the other end of the rope. The system is released from rest.

(a) Find the acceleration of the block and the tension in the rope.

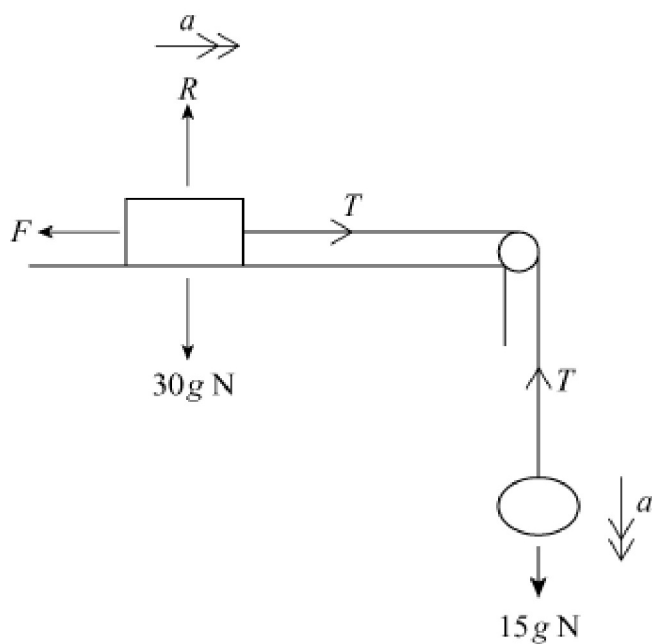
(b) Find the speed of the block when it has travelled 40 cm.



Solution:

(a) For the block; resolving vertically

$$\begin{aligned} R &= 30g \\ \text{using } F &= \mu R \\ F &= 0.4 \times 30g \\ &= 117.6 \end{aligned}$$



$$\begin{array}{rcl}
 \text{Using } F = ma \text{ for 30 kg block horizontally; } T - F & = & 30a \text{ [1]} \\
 \text{for 15 kg particle vertically; } 15g - T & & = 15a \\
 \text{Adding } 15g - F & & = 45a \\
 45a & & = 29.4 \\
 a & & = 0.6533
 \end{array}$$

\therefore Acceleration is 0.653 m s^{-2}

$$\begin{array}{rcl}
 \text{From [1], } T & = & 30a + F \\
 & = & 19.6 + 117.6 \\
 & = & 137.2
 \end{array}$$

\therefore Tension is 137.2 N

(b) To find the speed when it has moved 40 cm, i.e. 0.4 m,

$$\begin{array}{rcl}
 \text{use } v^2 = u^2 + 2as & \Rightarrow & v^2 = 2 \times 0.6533 \times 0.4 \\
 v & & = 0.7227
 \end{array}$$

\therefore speed is 0.723 m s^{-1} .