

# Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

## 6 Connected particles

### Exercise A, Question 17

#### Question:

Two children are holding the ends of a light, inextensible rope, which passes over a light, smooth pulley. Initially Tom, who has a mass of 40 kg, is standing at ground level and Simon, who has a mass of 60 kg, is on the edge of a fixed platform 2 metres above ground level. Model the two boys as particles, one initially at ground level, and the other initially at a height of 2 metres. The rope is taut.

Simon steps off the platform and as he falls vertically, Tom rises vertically.

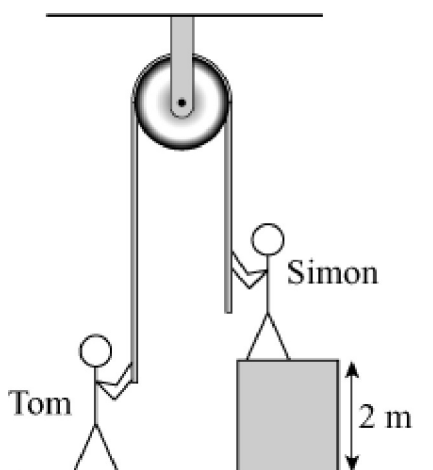
(a) Assume that the rope remains taut while the boys are moving.

(i) Show that the acceleration of each boy is  $1.96 \text{ m s}^{-2}$ .

(ii) Find the tension in the rope.

(b) Find the total distance that Tom travels upwards.

[A]



#### Solution:

(a) (i) Using  $F = ma$  for

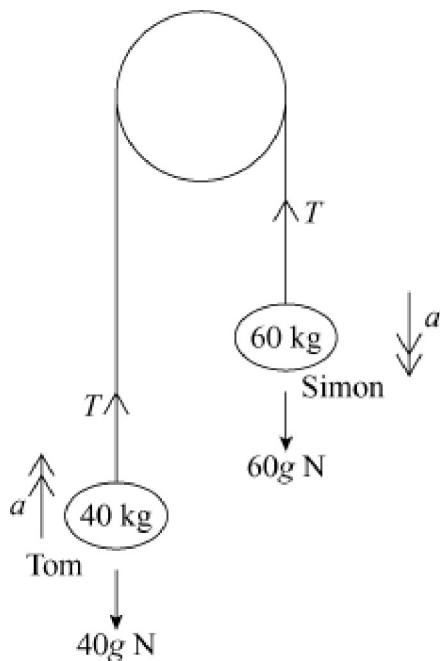
$$\text{Simon; } 60g - T = 60a$$

$$\text{Tom; } T - 40g = 40a \quad [1]$$

$$\text{Adding } 20g = 100a$$

$$a = \frac{g}{5}$$

$\therefore$  Acceleration is  $1.96 \text{ m s}^{-2}$



$$(ii) \text{ From [1] } T = 40g + 40 \times 1.96 \\ = 470.4$$

$\therefore$  Tension in the rope is 470 N

(b) When Simon hits the floor, to find the speed of Tom use  $v^2 = u^2 + 2as$ ,

$$v^2 = 2 \times 1.96 \times 2$$

$$\therefore v = 2.8$$

Tom now moves subject to gravitational force

$$\text{Using } v^2 = u^2 + 2as \text{ with } a = -g$$

$$0 = 2.8^2 - 2gs$$

$$s = \frac{2.8^2}{2g}$$

$$= 0.4$$

$\therefore$  Tom travels 2 m + 0.4 m = 2.4 m .