Exercise 3.1 Work

The questions in this section will help you become more familiar with the concepts of work and energy.

1 **a** Define what a Joule is.

b State the principle of conservation of energy.

c A pupil picks up a book from the floor and places the book on a table.

i Has the book gained energy? Explain your answer.

ii Has the pupil lost energy? Explain your answer.

iii Why is it likely that the energy lost by the pupil is not the same magnitude as the energy gained by the book?

2 A mass of 300 g attached to the end of a light string is made to travel in a circular path of radius 1.2 m by a centripetal force of 4 N.

a Calculate the distance travelled by the mass in one complete circle.

b State the work done on the mass by the centripetal force during one complete circle. Explain your answer.

3 Figure 3.1 shows how the force required to push a thumbtack into a poster board varies with distance (how far it is pushed into the board).

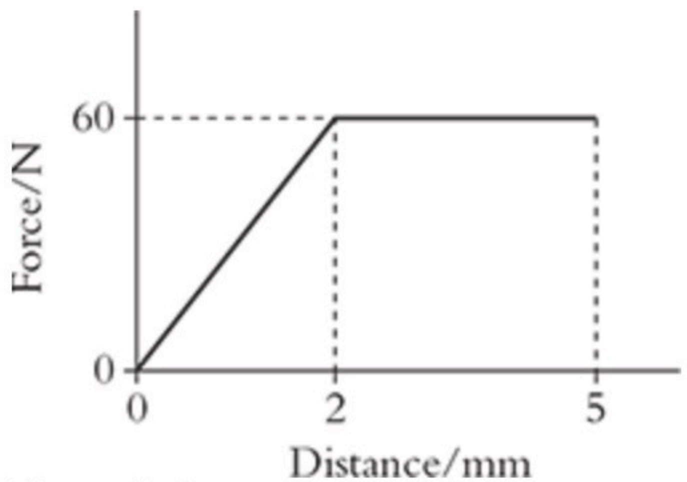

Figure 3.1

Use the graph to calculate the work done when pushing the thumbtack 5 mm into the board.

4 A driver applies the brakes of his 1400 kg car while travelling at 20 ms^{-1}. The car begins to slow down. If the average force of the brakes is 9 kN, calculate how far the car will travel until it comes to a stop.

5 Consider a body of mass m, on which a force, F, is applied for a time, t.

a Suggest **six** ways in which the force could affect the mass, and for each way, give an example.

b How does the principle of conservation of energy apply to this?

TIP

Think about the various different kinds of potential energy into which the work done can be transferred.

6 A net force is applied to a body of mass 25 kg. The body's speed changes from 10 ms^{-1} to 20 ms^{-1}.

- **a** State the work–energy principle.
- **b** Use the work–energy principle to calculate the net work done on the body.
- **c** Suggest why the net work done on the body cannot be calculated using another method; for example, using the equations of kinematics (*SUVAT* equations).

TIP

For questions like this, use the work-energy principle to solve the problem.

7 An electron of mass 9.1×10^{-31} kg is travelling at 4×10^{6} ms^{-1}.

- **a** Calculate the kinetic energy of the electron.
- **b** How much work must be done on the electron to speed it up to double its original speed?

8 A toy train of mass 750 g moving at 1.5 ms^{-1} is brought to rest by a constant force over a distance of 8.0 m.

- **a** Calculate the work done by the force.
- **b** Calculate the size of the force.

9 A box of mass 12 kg is pushed from rest in a straight line along a frictionless surface. The box is pushed with a horizontal constant force of 36 N for 5 s.

- **a** Calculate
  - **i** the acceleration of the box.
  - **ii** the speed of the box after 5 s.
  - **iii** the work done on the box during the 5 s period.
  - **iv** the kinetic energy gained by the box.
- **b** What does the principle of conservation of energy say about your answers to **parts iii** and **iv**?

10 In a game of cricket, a fast bowler releases the ball at 140 $kmhr^{-1}$. The ball has a mass of 160 g. Slow-motion cameras show that the ball loses about 15% of its kinetic energy during the 15 m distance from the bowler to the batsman.

- **a** Determine the speed of the ball at its release in ms^{-1}.
- **b** Calculate how much work is done on the ball by the friction of the air.
- **c** Calculate the average force of air friction acting on the ball.