15 In the following examples, is the object's g.p.e. increasing, decreasing or remaining constant?
- **a** An apple falls from a tree.
- **b** An aircraft flies horizontally at a height of 9000 m.
- **c** A sky-rocket is fired into the sky.

16 A girl of weight 500 N climbs on top of a 2 m high wall. By how much does her g.p.e. increase?

17 A stone of weight 1 N falls downwards. Its g.p.e. decreases by 100 J. How far has it fallen?

18 What does v represent in the formula k.e. $= \frac{1}{2}mv^2$?

19 How much k.e. is stored by a 1 kg ball moving at 1 m/s?

20 A runner of mass 80 kg is moving at 8 m/s. Calculate her kinetic energy.

21 Which has more k.e., a 2 g bee flying at 1 m/s, or a 1 g wasp flying at 2 m/s?

8.1 Omar and Ahmed are lifting weights in the gym. Each lifts a weight of 200 N. Omar lifts the weight to a height of 2.0 m, whereas Ahmed lifts it to a height of 2.1 m. Who does more work in lifting the weight? Explain how you know. [2]

8.2 Millie and Lily are identical twins who enjoy swimming. Their arms and legs provide the force needed to move them through the water. Millie can swim 25 m in 50 s. Lily can swim 100 m in 250 s.
- **a** Calculate the swimming speed of each twin. [2]
- **b** Which twin has the greater power when swimming? Explain how you can tell. [2]

8.3 Jim is pulling a load along a ramp, as shown in Figure 8.8. The diagram shows the force with which he pulls and the weight of the load.

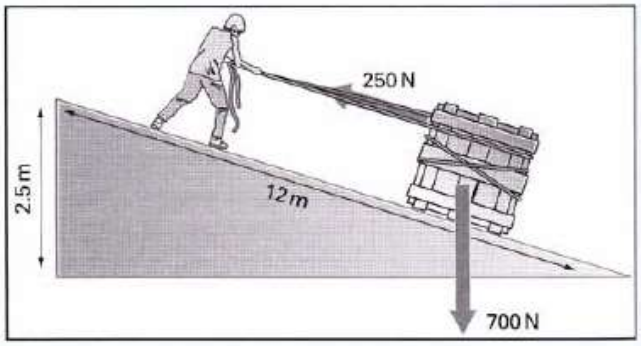

Figure 8.8 Pulling a load up a ramp – for Question 8.3.

- **a** Calculate the work done by Jim's pulling force. [3]
- **b** What is the gain in potential energy of the load? [3]

8.4 Two girls are estimating each other's power. One runs up some steps, and the other times her. Here are their results:

height of one step = 20 cm
number of steps = 36
mass of runner = 45 kg
time taken = 4.2 s

- **a** Calculate the runner's weight. (Acceleration due to gravity $g = 10\,\text{m/s}^2$.) [2]
- **b** Calculate the increase in the girl's gravitational potential energy as she runs up the steps. [3]
- **c** Calculate her power. Give your answer in kilowatts (kW). [4]

8.5 A car of mass 750 kg accelerates away from traffic lights. At the end of the first 100 m it has reached a speed of 12 m/s. During this time, its engine provides an average forward force of 780 N, and the average force of friction on the car is 240 N.

a Calculate the work done on the car by the force of its engine. [3]

b Calculate the work done on the car by the force of friction. [3]

c Using k.e. = $\frac{1}{2}mv^2$, calculate the increase in the car's kinetic energy at the end of the first 100 m. [2]

d Explain whether your answers are consistent with the principle of conservation of energy. [3]

6.4 The girl on the skate ramp (Figure 6.15) roller-skates down one side of the slope and up the opposite side. She cannot quite reach the top of the slope, level with her starting position.

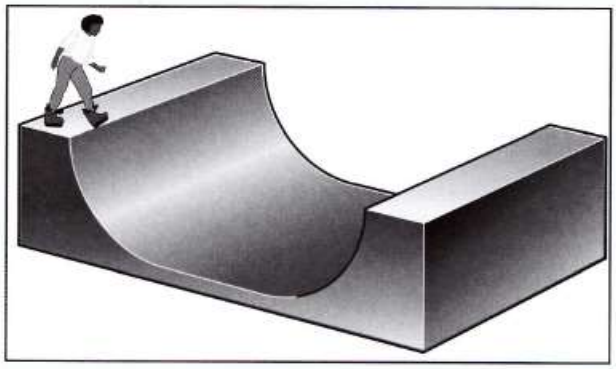

Figure 6.15 For Question 6.4.

a What energy conversion is taking place as the girl moves downwards? [2]

b What energy conversion is taking place as the girl moves back upwards? [2]

c Explain why the girl cannot reach the top of the slope. [2]

d Suggest how the girl could reach the top of the slope. [2]

6.7 Figure 6.17 shows an idea for a perpetual motion machine. The car runs on electricity. As it moves along, the air moving past the car turns the generator on the roof. This generates the electricity needed to power the car.

Figure 6.17 For Question 6.7.

a Explain the energy transformations that are going on here. [2]

b Explain why this idea will not work in practice. [2]

6.8 An astronaut on the Moon has a mass (including his spacesuit and equipment) of 180 kg. The acceleration due to gravity on the Moon's surface is 1.6 m/s^2.

a Calculate the astronaut's weight on the Moon. [3]

The astronaut climbs 100 m to the top of a crater.

b By how much does his gravitational potential energy (g.p.e.) change? [3]

c Does his g.p.e. increase or decrease? [1]

A builder lifts five bricks. Each brick has a mass of 2.4 kg.

a Calculate the weight of five bricks.

b What force is needed to lift five bricks?

c The builder lifts the bricks to the top of a building which is 6.0 m high. Calculate the work done in lifting the bricks.

An electric motor has a power rating of 400 W.

a How much energy does the motor transfer each second?

b The motor provides a force of 50 N to lift a load. It raises a load of sand through a distance of 4.0 m. How much work is done on the sand?

c Because the motor is inefficient, it can transfer just 100 J of energy to a load each second. Calculate the time taken by the motor to raise the sand.