1   Fig. 3.1 shows an aeroplane of mass 3.4×10^5 kg accelerating uniformly from rest along a runway.
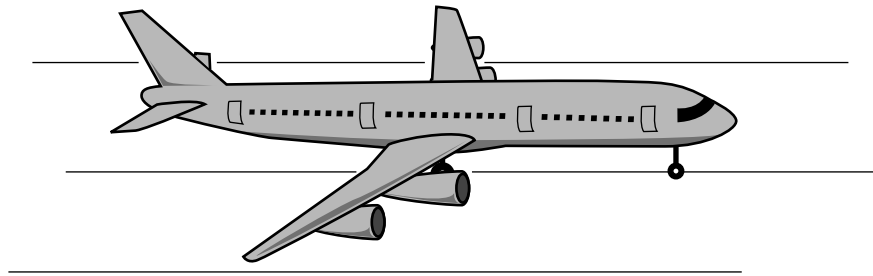

Fig. 3.1

After 26 s it reaches a speed of 65 m/s.

(a) Calculate

   (i) the acceleration of the aeroplane,

   acceleration = ... [2]

   (ii) the resultant force on the aeroplane.

   force = ... [2]

(b) Just after taking off, the aeroplane continues to accelerate as it gains height.

   (i) State **two** forms of energy that increase during this time.

   1. ....

   2. .... [2]

   (ii) State **one** form of energy that decreases during this time.

   .... [1]

(iii) State why the total energy of the aeroplane decreases during this time.

....

.... [1]

(c) When the aeroplane reaches its maximum height, it starts to follow a curved path at a constant speed.

State the direction of the resultant force on the aeroplane.

.... [1]

[Total: 9]

2   An ornamental garden includes a small pond, which contains a pumped system that causes water to go up a pipe and then to run down a heap of rocks.
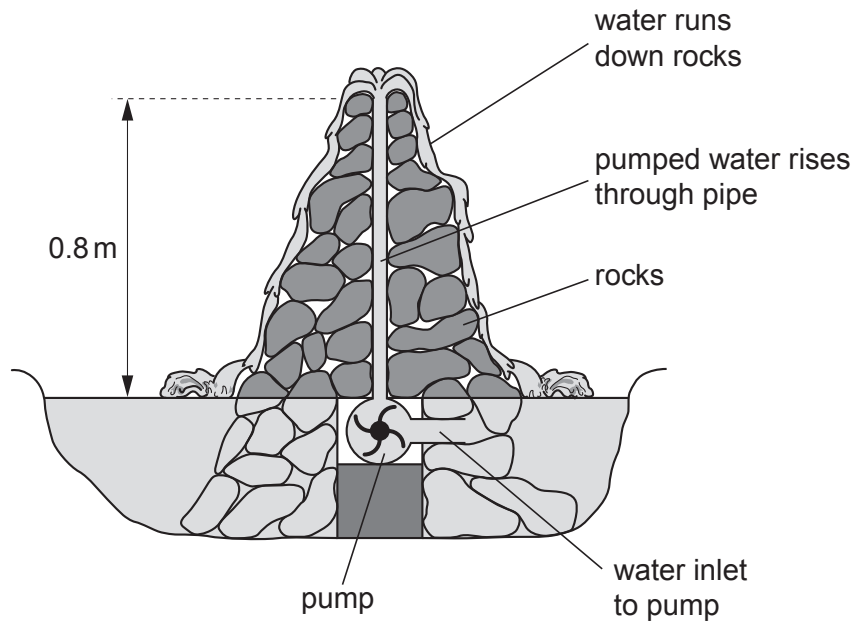
Fig. 3.1 shows a section through this water feature.

Fig. 3.1

The density of water is $1000 \, kg/m^3$. A volume of 1 litre is equal to $0.001 \, m^3$.

(a)   Calculate the mass of 1 litre of water.

mass = ... [2]

(b)   Calculate the work done raising 1 litre of water through a height of 0.8 m.

work = ... [2]

(c) The pump lifts 90 litres of water per minute.

Calculate the minimum power of the pump.

power = ... [2]

(d) The pump is switched off.

Immediately after the pump is switched off, what is the value of the water pressure at the bottom of the 0.8 m pipe, due to the water in the pipe?

pressure = ... [2]

[Total: 8]

3 Fig. 2.1 shows a rock that is falling from the top of a cliff into the river below.
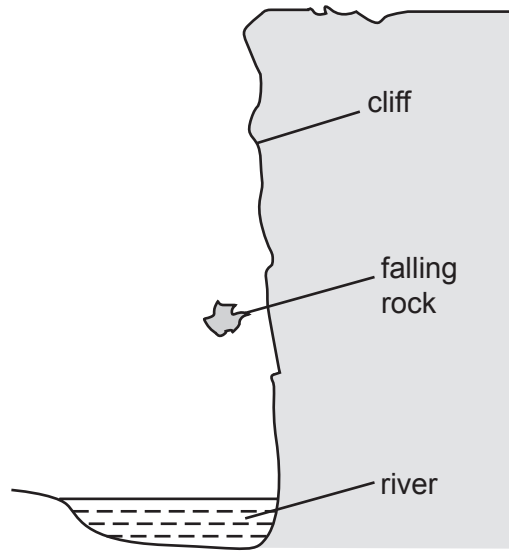

Fig. 2.1

(a) The mass of the rock is 75 kg. The acceleration of free fall is 10 m/s^2.
Calculate the weight of the rock.

weight = …………………[1]

(b) The rock falls from rest through a distance of 15 m before it hits the water.
Calculate its kinetic energy just before hitting the water. Show your working.

kinetic energy = …………………[3]

(c) The rock hits the water. Suggest what happens to the kinetic energy of the rock during
the impact.

....

....

....[3]

[Total : 7]

4   Fig. 3.1 shows the arm of a crane when it is lifting a heavy box.

Fig. 3.1

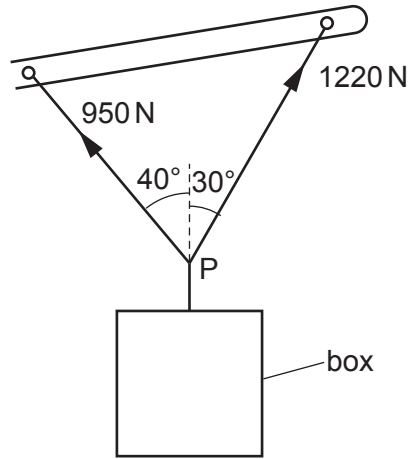**(a)** By the use of a scale diagram (**not** calculation) of the forces acting at P, find the weight of the box.   [5]

(b) Another box of weight 1500 N is raised vertically by 3.0 m.

    (i) Calculate the work done on the box.

work done = ...

    (ii) The crane takes 2.5 s to raise this box 3.0 m. Calculate the power output of the crane.

power = ...

[4]

[Total : 9]

5 Fig. 1.1 shows a smooth metal block about to slide down BD, along DE and up EF.
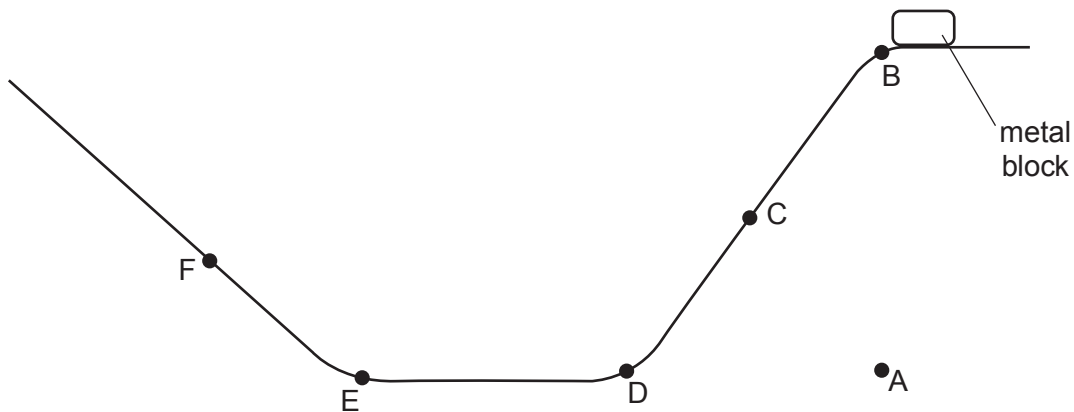BD and DE are friction-free surfaces, but EF is rough. The block stops at F.

Fig. 1.1

(a) On Fig. 1.2, sketch the speed-time graph for the journey from B to F.
Label D, E and F on your graph.   [3]

Fig. 1.2

(b) The mass of the block is 0.2 kg. The vertical height of B above A is 0.6 m.
The acceleration due to gravity is 10 m/s^2.

(i) Calculate the work done in lifting the block from A to B.

work done = ...

(ii) At C, the block is moving at a speed of 2.5 m/s. Calculate its kinetic energy at C.

kinetic energy = ...
[5]

(c) As it passes D, the speed of the block remains almost constant but the velocity changes. Using the terms *vector* and *scalar*, explain this statement.

....

....

....[2]

(d) F is the point where the kinetic energy of the block is zero. In terms of energy changes, explain why F is lower than B.

....

....

....

....[3]

[Total : 13]