1 A large plastic ball is dropped from the top of a tall building.

Fig. 1.1 shows the speed-time graph for the falling ball until it hits the ground.
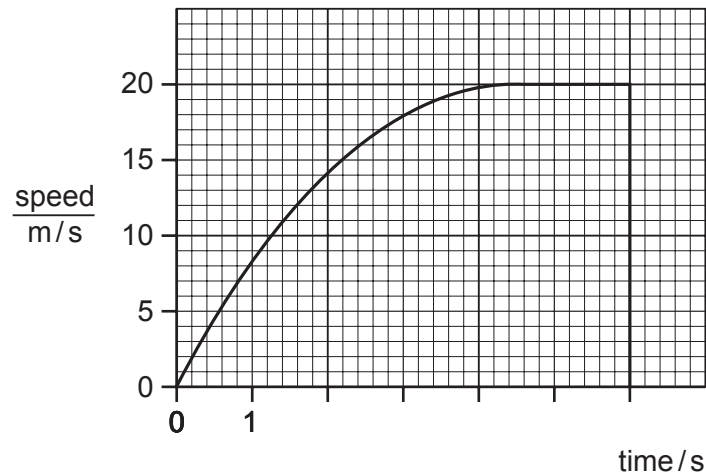

Fig. 1.1

(a) From the graph estimate,

(i) the time during which the ball is travelling with terminal velocity,

time = ... [1]

(ii) the time during which the ball is accelerating,

time = ... [1]

(iii) the distance fallen while the ball is travelling with terminal velocity,

distance = ... [2]

(iv) the height of the building.

height = ... [2]

(b) Explain, in terms of the forces acting on the ball, why

    (i) the acceleration of the ball decreases,

      ....

      ....

      ....

      .... [3]

    (ii) the ball reaches terminal velocity.

      ....

      .... [2]

[Total: 11]

2 A solid plastic sphere falls towards the Earth.

Fig. 1.1 is the speed-time graph of the fall up to the point where the sphere hits the Earth's surface.
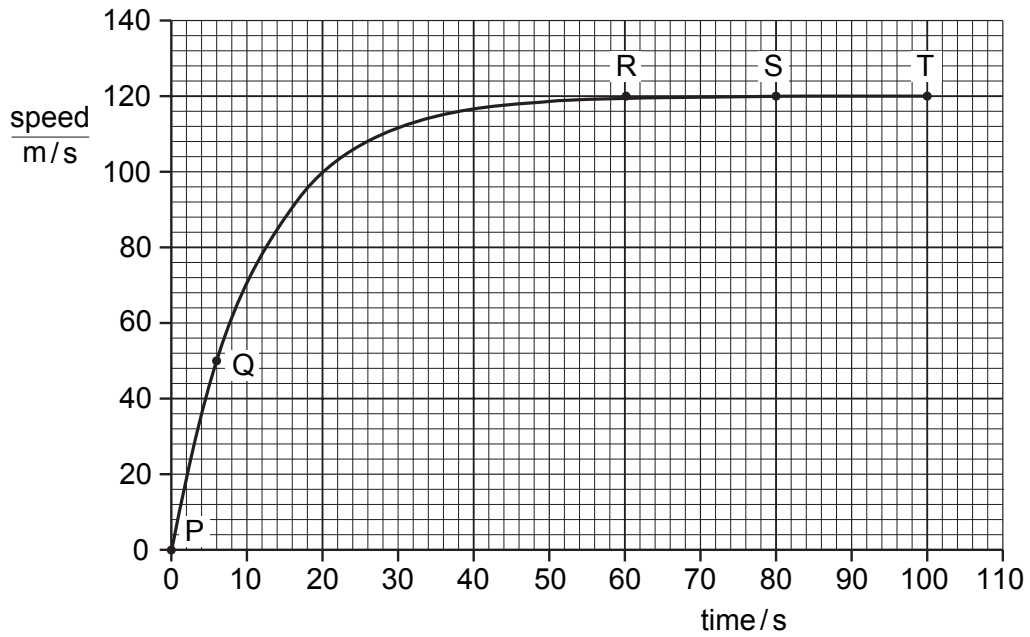

Fig. 1.1

(a) Describe in detail the motion of the sphere shown by the graph.

....

....

....

....

.... [3]

(b) On Fig. 1.2, draw arrows to show the directions of the forces acting on the sphere when it is at the position shown by point S on the graph. Label your arrows with the names of the forces. [2]
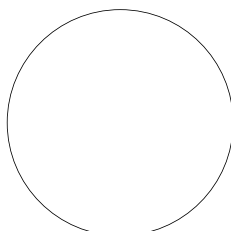
Fig. 1.2

(c) Explain why the sphere is moving with constant speed at S.

....

....

.... [2]

(d) Use the graph to calculate the approximate distance that the sphere falls

    (i) between R and T,

distance = ……………… [2]

    (ii) between P and Q.

distance = ……………… [2]

[Total : 11]

3 Fig. 2.1 shows a simple pendulum that swings backwards and forwards between P and Q.

Fig. 2.1

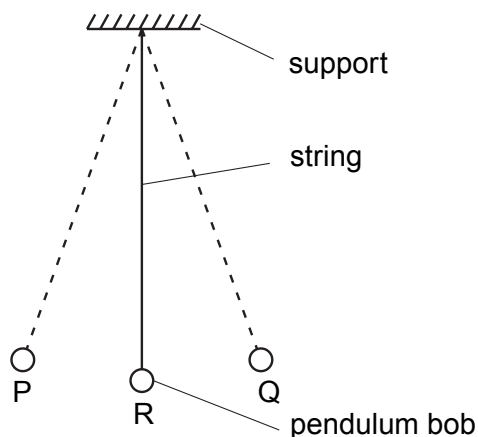**(a)** The time taken for the pendulum to swing from P to Q is approximately 0.5 s.

Describe how you would determine this time as accurately as possible.

....

....

.... [2]

(b) (i) State the two vertical forces acting on the pendulum bob when it is at position R.

1. ....

2. .... [1]

(ii) The pendulum bob moves along the arc of a circle. State the direction of the resultant of the two forces in **(i)**.

.... [1]

(c) The mass of the bob is 0.2 kg. During the swing it moves so that P is 0.05 m higher than R.

Calculate the increase in potential energy of the pendulum bob between R and P.

potential energy = ……………… [2]

[Total : 6]

4 **(a)** State what is meant by the terms

    (i) *weight,* ....

    .... [1]

    (ii) *density.* ....

    .... [1]

(b) A student is given a spring balance that has a scale in newtons. The student is told that the acceleration of free-fall is $10 \, \text{m/s}^2$.

    (i) Describe how the student could find the mass of an irregular solid object.

    ....

    ....

    .... [2]

    (ii) Describe how the student could go on to find the density of the object.

    ....

    ....

    ....

    .... [2]

(c) Fig. 1.1 shows three forces acting on an object of mass 0.5 kg. All three forces act through the centre of mass of the object.
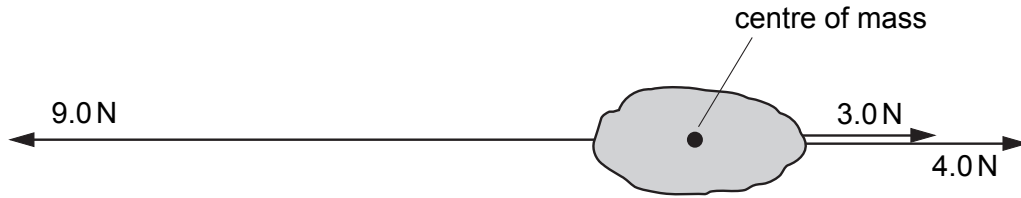

centre of mass

9.0 N

3.0 N

4.0 N

Fig. 1.1

Calculate

(i) the magnitude and direction of the resultant force on the object,

magnitude = ……………   direction .... [2]

(ii) the magnitude of the acceleration of the object.

acceleration =…………………… [2]

[Total : 10]

5 Fig. 1.1 shows the speed-time graph for a bus during tests.
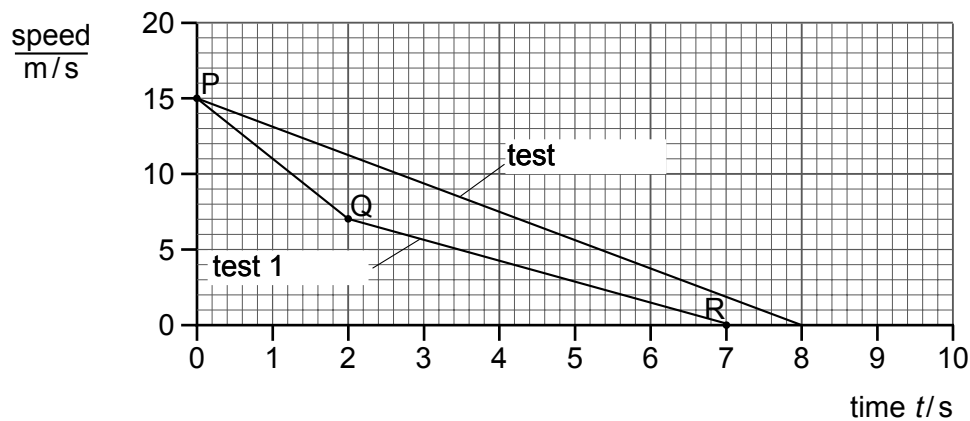
At time t = 0, the driver starts to brake.

Fig. 1.1

(a) For test 1,

(i) determine how long the bus takes to stop,

....

(ii) state which part of the graph shows the greatest deceleration,

....

(iii) use the graph to determine how far the bus travels in the first 2 seconds.

distance = ...
[4]

(b) For test 2, a device was fitted to the bus. The device changed the deceleration.

(i) State two ways in which the deceleration during test 2 is different from that during test 1.

1 ....

2 ....

(ii) Calculate the value of the deceleration in test 2.

deceleration = ...

[4]

(c) Fig. 1.2 shows a sketch graph of the magnitude of the acceleration for the bus when it is travelling around a circular track at constant speed.
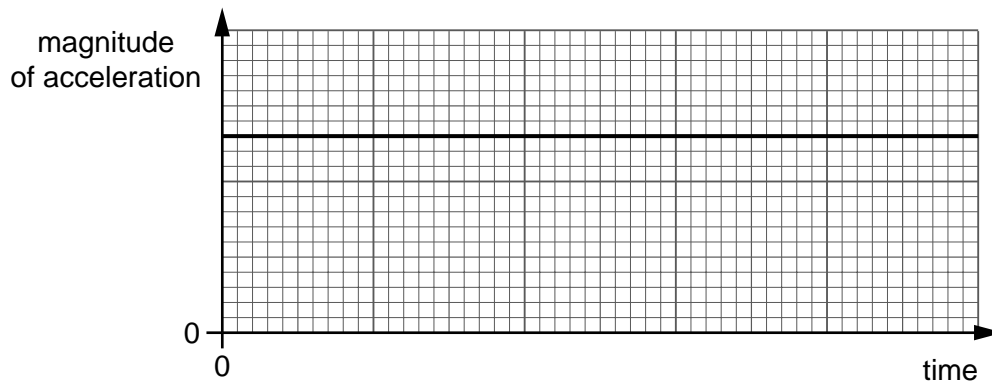

Fig. 1.2

(i) Use the graph to show that there is a force of constant magnitude acting on the bus.

....

....

(ii) State the direction of this force.

....

[3]

[Total : 11]