Motion Graphs

Question paper 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Kinematics
Sub Topic	Motion Graphs
Paper Type	Theory
Booklet	Question paper 2

Time Allowed: **84 minutes**

Score: **/70**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Define *force*.

..... [1]

(b) A resultant force F acts on an object of mass 2.4 kg. The variation with time t of F is shown in Fig. 2.1.

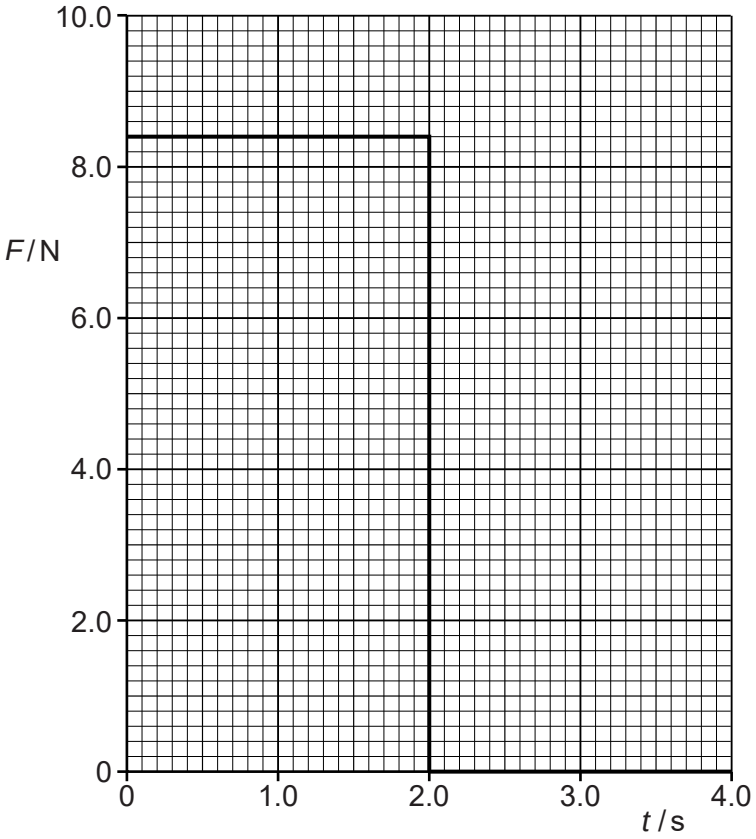


Fig. 2.1

The object starts from rest.

(i) On Fig. 2.2, show quantitatively the variation with t of the acceleration a of the object. Include appropriate values on the y-axis.

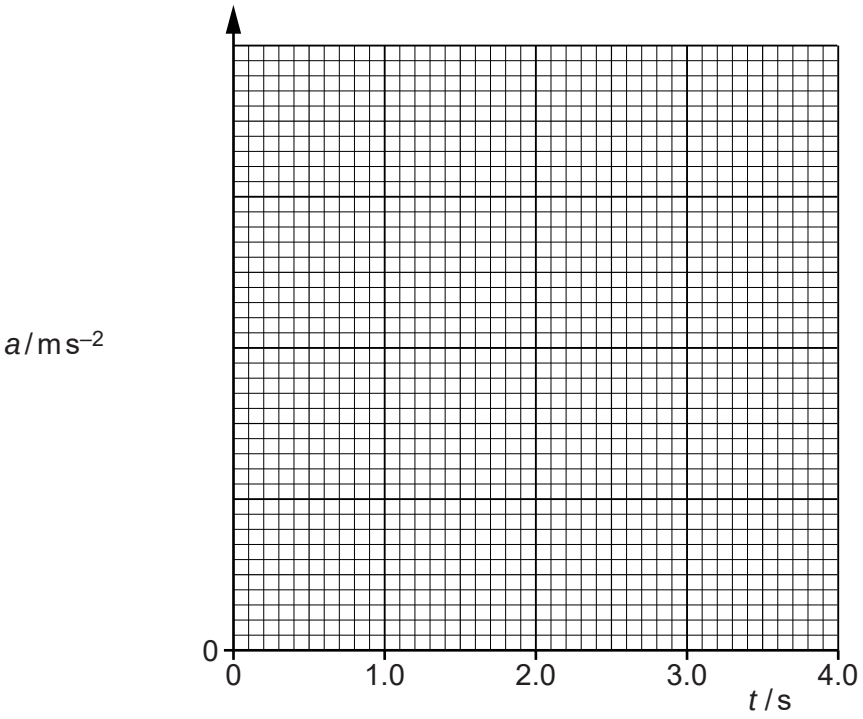


Fig. 2.2

[4]

(ii) On Fig. 2.3, show quantitatively the variation with t of the momentum p of the object. Include appropriate values on the y-axis.

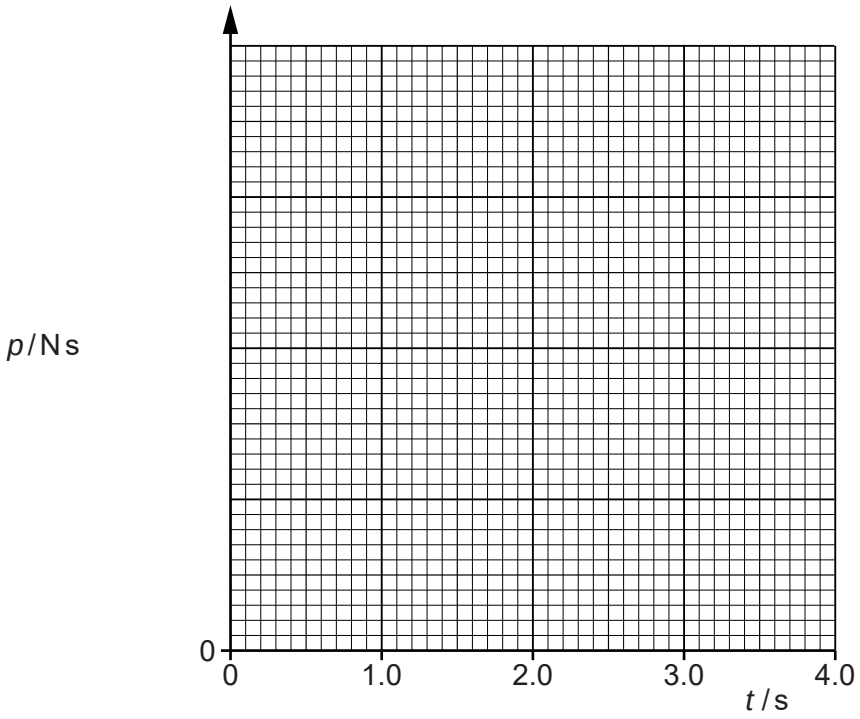


Fig. 2.3

[5]

2 **(a)** A student walks from A to B along the path shown in Fig. 2.1.

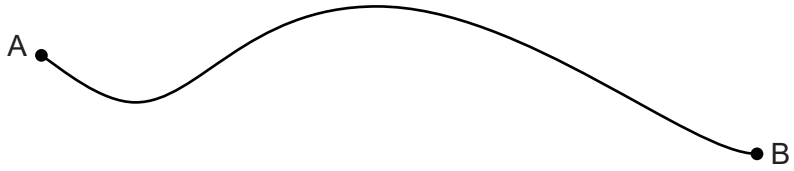


Fig. 2.1

The student takes time *t* to walk from A to B.

(i) State the quantity, apart from *t*, that must be measured in order to determine the average value of

1. speed,

.....

..... [1]

2. velocity.

.....

..... [1]

(ii) Define *acceleration*.

..... [1]

(b) A girl falls vertically onto a trampoline, as shown in Fig. 2.2.

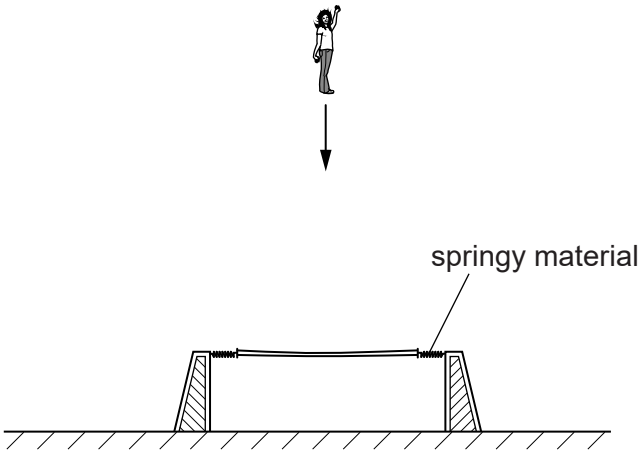


Fig. 2.2

The trampoline consists of a central section supported by springy material. At time t = 0 the girl starts to fall. The girl hits the trampoline and rebounds vertically. The variation with time t of velocity v of the girl is illustrated in Fig. 2.3.

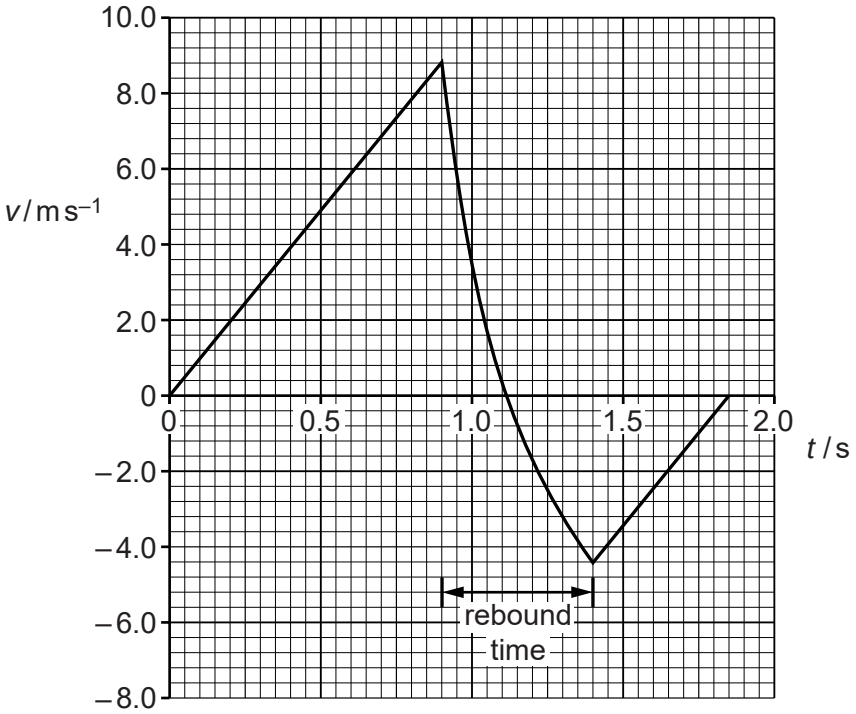


Fig. 2.3

For the motion of the girl, calculate

(i) the distance fallen between time t = 0 and when she hits the trampoline,

distance = ... m [2]

(ii) the average acceleration during the rebound.

acceleration = ... $m\,s^{-2}$ [2]

(c) **(i)** Use Fig. 2.3 to compare, without calculation, the accelerations of the girl before and after the rebound. Explain your answer.

.....

.....

.....[2]

(ii) Use Fig. 2.3 to compare, without calculation, the potential energy of the girl at $t = 0$ and $t = 1.85\,s$. Explain your answer.

.....

.....

.....[2]

3 **(a)** A ball is thrown vertically down towards the ground and rebounds as illustrated in Fig. 2.1.

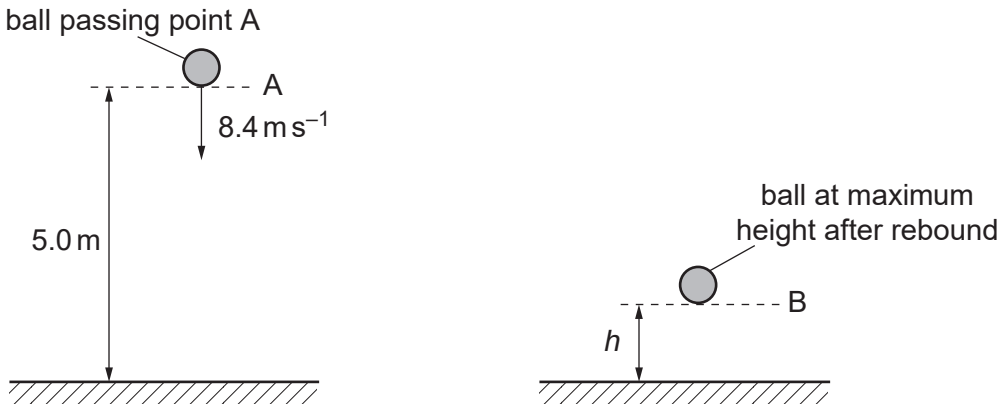


Fig. 2.1

As the ball passes A, it has a speed of 8.4 m s^{-1}. The height of A is 5.0 m above the ground. The ball hits the ground and rebounds to B. Assume that air resistance is negligible.

(i) Calculate the speed of the ball as it hits the ground.

speed = ... m s^{-1} [2]

(ii) Show that the time taken for the ball to reach the ground is 0.47 s.

[1]

(b) The ball rebounds vertically with a speed of $4.2\,m\,s^{-1}$ as it leaves the ground. The time the ball is in contact with the ground is 20 ms. The ball rebounds to a maximum height *h*.

The ball passes A at time $t = 0$. On Fig. 2.2, plot a graph to show the variation with time *t* of the velocity *v* of the ball. Continue the graph until the ball has rebounded from the ground and reaches B.

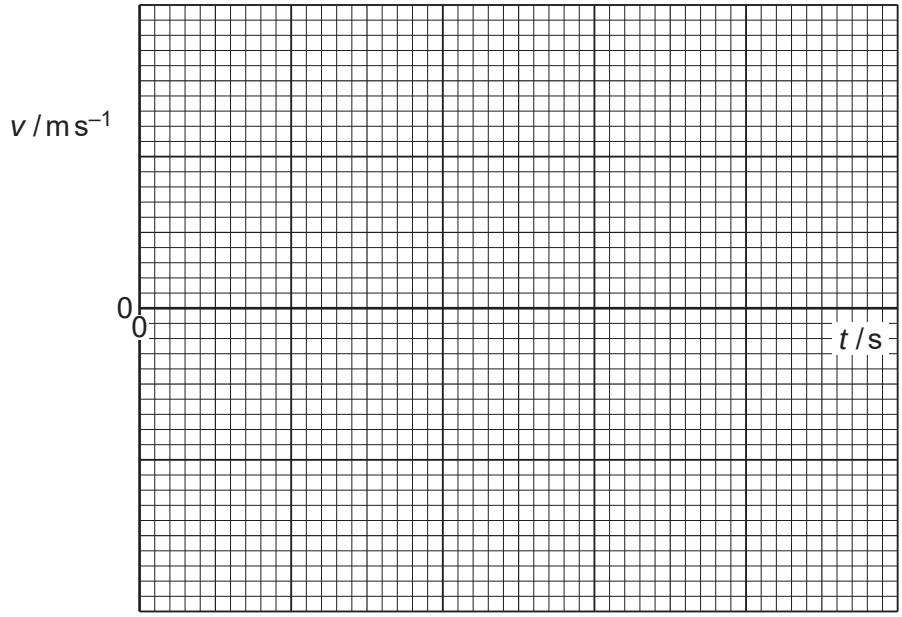


Fig. 2.2 [3]

(c) The ball has a mass of 0.050 kg. It moves from A and reaches B after rebounding.

(i) For this motion, calculate the change in

1. kinetic energy,

change in kinetic energy = ... J [2]

2. gravitational potential energy.

change in potential energy = ... J [3]

(ii) State and explain the total change in energy of the ball for this motion.

.....

.....

.....

..... [2]

4 The variation with time t of the displacement s for a car is shown in Fig. 1.1.

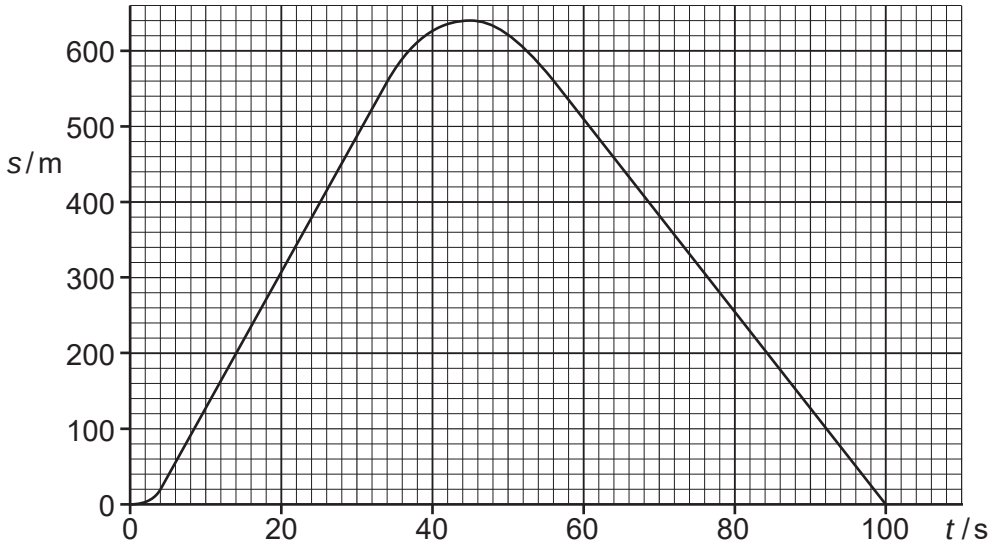


Fig. 1.1

(a) Determine the magnitude of the average velocity between the times 5.0 s and 35.0 s.

average velocity = ... $m\,s^{-1}$ [2]

(b) On Fig. 1.2, sketch the variation with time t of the velocity v for the car.

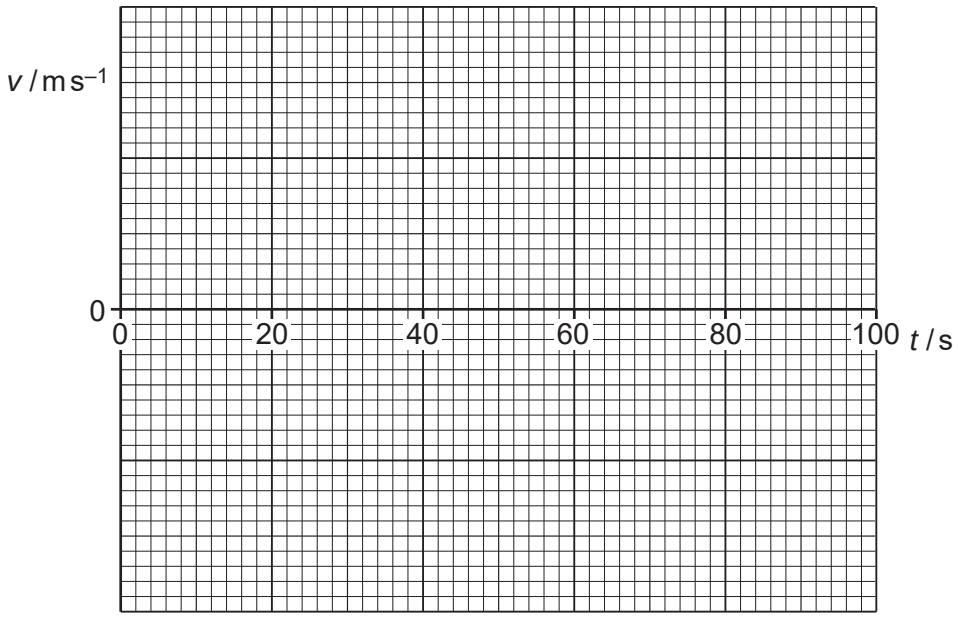


Fig. 1.2

[4]

5 The variation with time t of velocity v of a car is shown in Fig.

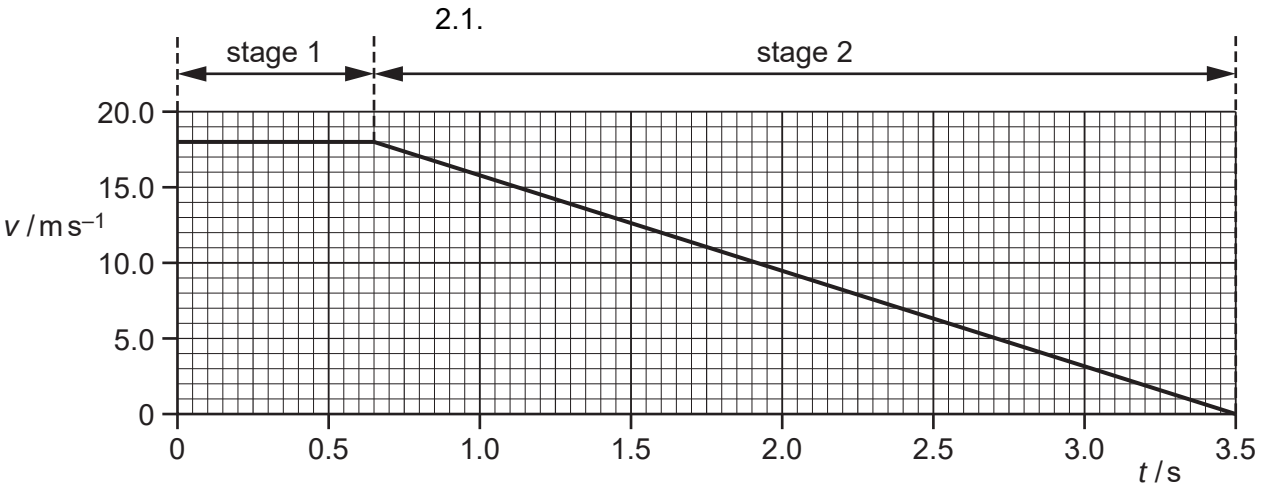


Fig. 2.1

At time t = 0, the driver sees an obstacle in the road. A short time later, the driver applies the brakes. The car travels in two stages, as shown in Fig. 2.1.

(a) Use Fig. 2.1 to describe the velocity of the car in

1. stage 1,

.....

..... [1]

2. stage 2.

.....

..... [1]

(b) **(i)** Calculate the distance travelled by the car from t = 0 to t = 3.5 s.

total distance = ... m [2]

(ii) The car has a total mass of 1250 kg. Determine the total resistive force acting on the car in stage 2.

force = ... N [3]

(c) For safety reasons drivers are asked to travel at lower speeds. For each stage, describe and explain the effect on the distance travelled for the same car and driver travelling at half the initial speed shown in Fig. 2.1.

(i) stage 1:

.....

.....

.....[1]

(ii) stage 2:

.....

.....

.....

.....[2]

6 **(a)** State the relation between force and momentum.

..... [1]

(b) A rigid bar of mass 450 g is held horizontally by two supports A and B, as shown in Fig. 3.1.

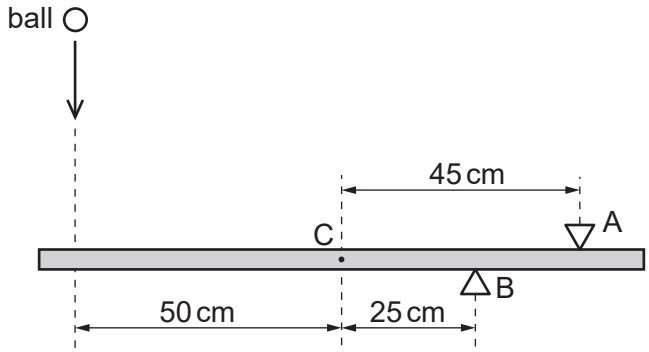
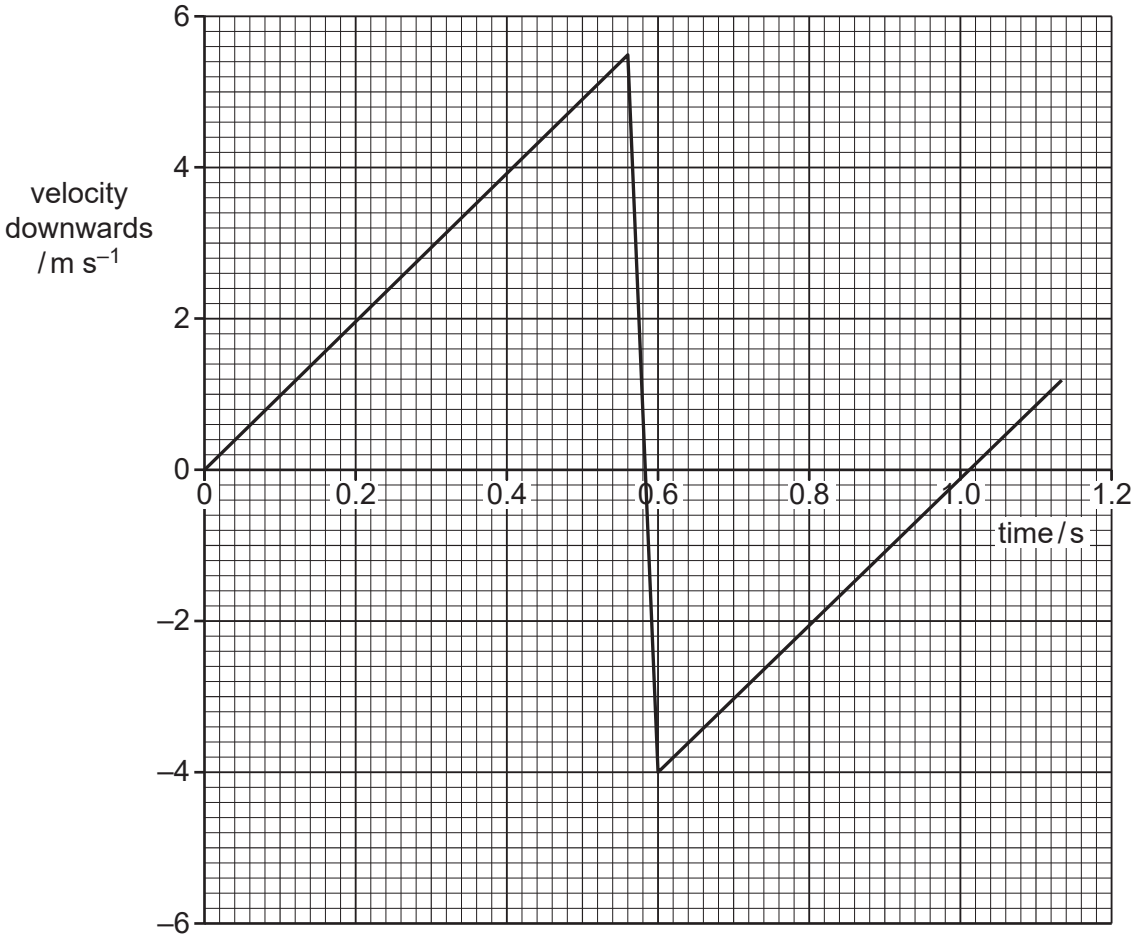


Fig. 3.1

The support A is 45 cm from the centre of gravity C of the bar and support B is 25 cm from C.

A ball of mass 140 g falls vertically onto the bar such that it hits the bar at a distance of 50 cm from C, as shown in Fig. 3.1.
The variation with time t of the velocity v of the ball before, during and after hitting the bar is shown in Fig. 3.2.



For the time that the ball is in contact with the bar, use Fig. 3.2

(i) to determine the change in momentum of the ball,

change = ... $kg\,m\,s^{-1}$ [2]

(ii) to show that the force exerted by the ball on the bar is 33 N.

[1]

(c) For the time that the ball is in contact with the bar, use data from Fig. 3.1 and **(b)(ii)** to calculate the force exerted on the bar by

(i) the support A,

force = ... N [3]

(ii) the support B.

force = ... N [2]

7 **(a)** Complete Fig. 2.1 to show whether each of the quantities listed is a vector or a scalar.

	vector / scalar
distance moved	.....
speed	.....
acceleration	.....

Fig. 2.1

[3]

(b) A ball falls vertically in air from rest. The variation with time *t* of the distance *d* moved by the ball is shown in Fig. 2.2.

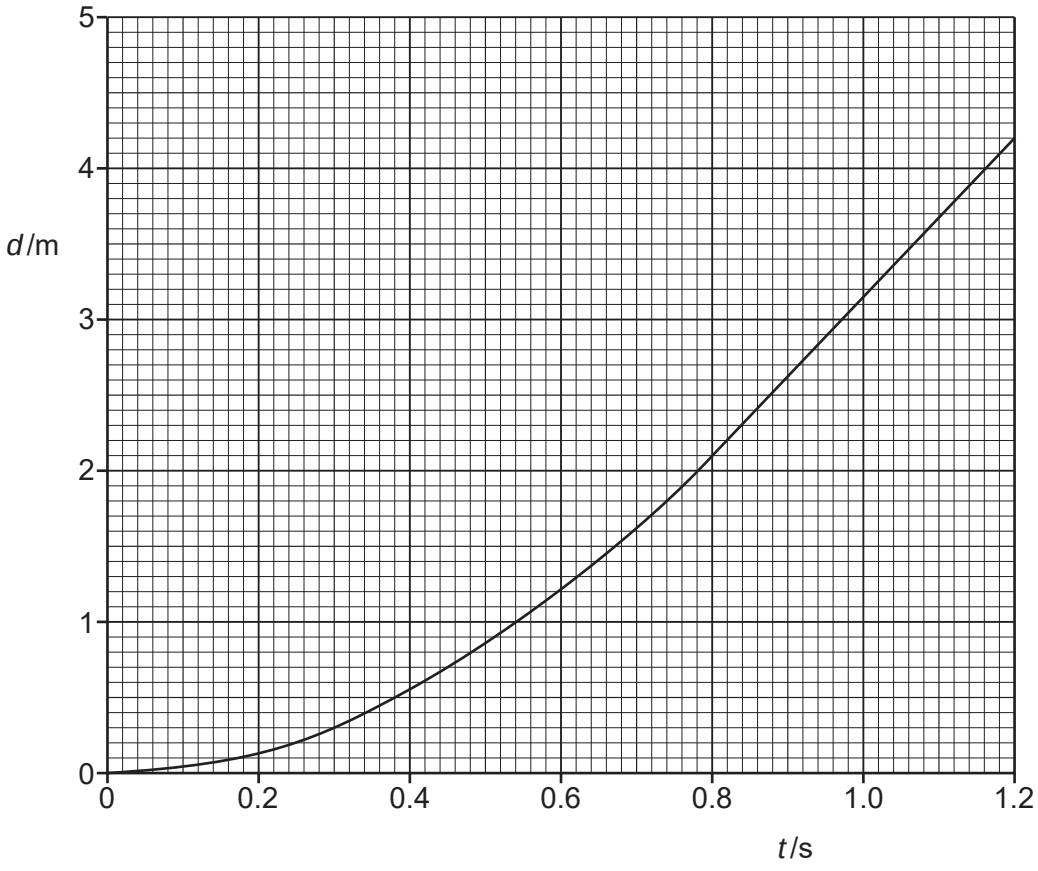


Fig. 2.2

(i) By reference to Fig. 2.2, explain how it can be deduced that

1. the ball is initially at rest,

.....

.....

..... [2]

2. air resistance is not negligible.

.....

..... [1]

(ii) Use Fig. 2.2 to determine the speed of the ball at a time of 0.40 s after it has been released.

speed = ... m s^{-1} [2]

(iii) On Fig. 2.2, sketch a graph to show the variation with time *t* of the distance *d* moved by the ball for negligible air resistance. You are not expected to carry out any further calculations. [3]