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6 A ball is travelling horizontally at a speed of $7.0\,m\,s^{-1}$. The ball hits a vertical wall and rebounds along its initial path at a speed of $5.0\,m\,s^{-1}$.
The ball has an acceleration of $300\,m\,s^{-2}$ while in contact with the wall.

Which of the following expressions gives the time of contact t between the ball and the wall?

☐ **A** $t = \dfrac{-5-7}{-300}$

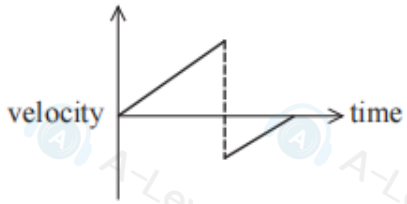
☐ **B** $t = \dfrac{5-7}{-300}$

☐ **C** $t = \dfrac{-5-7}{300}$

☐ **D** $t = \dfrac{5-7}{300}$

(Total for Question 6 = 1 mark)

The velocity-time graph for the motion of a ball is shown.



9 Which of the following correctly describes the motion of the ball?

☐ **A** The ball is dropped and rebounds to its original position.

☐ **B** The ball is dropped and rebounds to a lower position.

☐ **C** The ball is thrown upwards and is caught at its original position.

☐ **D** The ball is thrown upwards and is caught at a higher position.

(Total for Question 9 = 1 mark)

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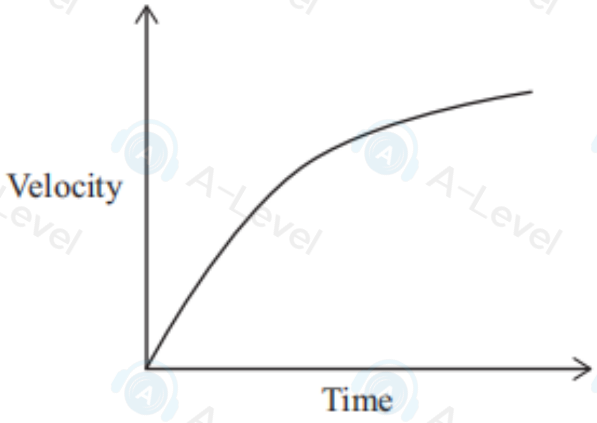
2 The graph shows how the velocity of an object varies with time.



Which of the following describes the motion of the object?

- ☒ **A** constant acceleration
- ☒ **B** constant displacement
- ☒ **C** decreasing acceleration
- ☒ **D** decreasing displacement

(Total for Question 2 = 1 mark)

1 Which of the following quantities has the SI base units $kg\,m^2\,s^{-3}$?

- ☒ **A** force
- ☒ **B** momentum
- ☒ **C** power
- ☒ **D** work done

(Total for Question 1 = 1 mark)

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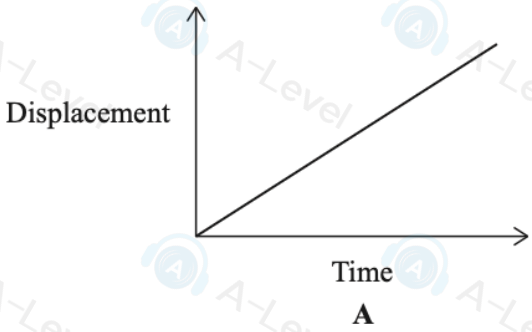
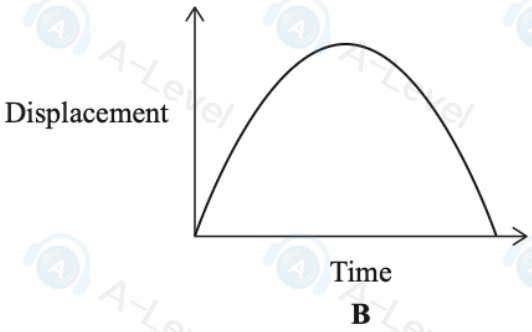
6: An object has a constant non-zero acceleration.

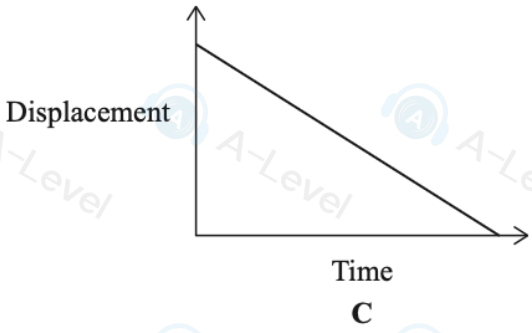
Which of the following displacement-time graphs could represent the motion of the object?



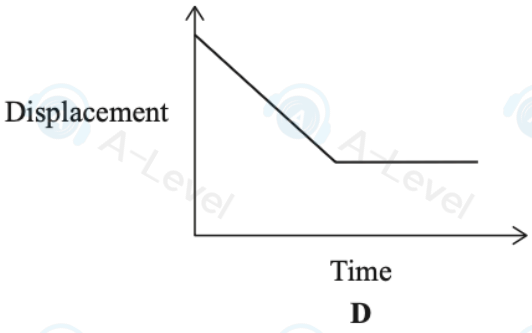
A



B



C



D

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 6 = 1 mark)

1 Which of the following units is only used with vector quantities?

☒ **A** J

☒ **B** m

☒ **C** N

☒ **D** W

(Total for Question 1 = 1 mark)

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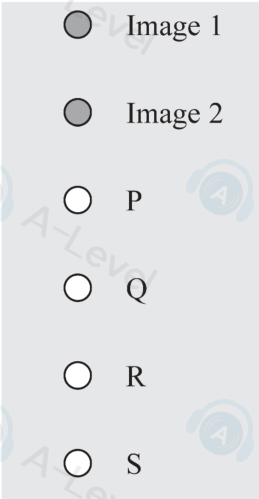
9 A student used a falling sphere to determine the acceleration of free fall.

A camera produced images of the sphere at constant time intervals as it fell.

The positions of the sphere in the first two images are shown. Image 1 shows the sphere's position at the instant it was released.



Which of the positions P, Q, R or S will the sphere be at in Image 3?

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(Total for Question 9 = 1 mark)

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7 A ball bearing falls vertically from rest through a distance of 50 cm in a time of 0.32 s.

Which expression gives the acceleration of the ball bearing in $m\,s^{-2}$?

☒ **A** $1 \div 0.32^2$

☒ **B** $0.5 \div 0.32$

☒ **C** $100 \div 0.32^2$

☒ **D** $50 \div 0.32$

(Total for Question 7 = 1 mark)

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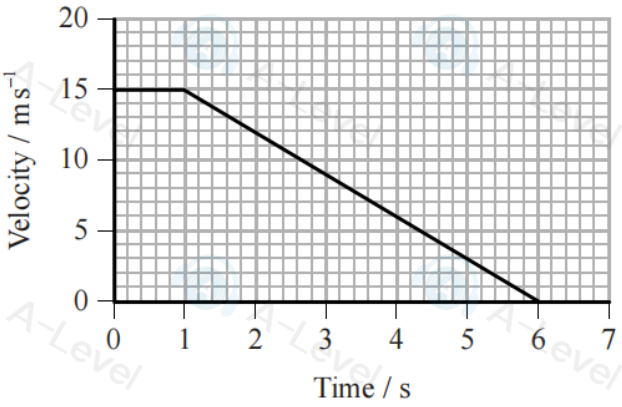
3 A car is moving at a constant velocity of $15\,m\,s^{-1}$. The driver applies the brakes and the car decelerates to rest at a constant rate.

The velocity-time graph for the final six seconds of the car's journey is shown.

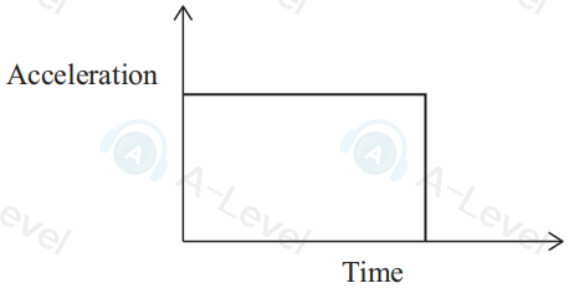


The distance the car travels while braking is

- ☒ **A** 38 m
- ☒ **B** 45 m
- ☒ **C** 53 m
- ☒ **D** 75 m

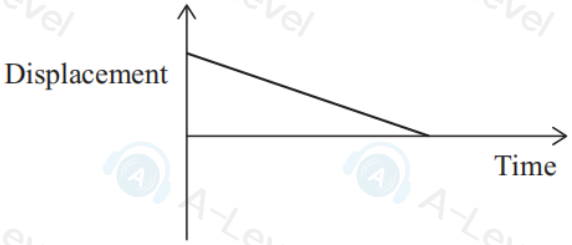
(Total for Question 3 = 1 mark)

9 The acceleration-time graph for the motion of an object is shown.

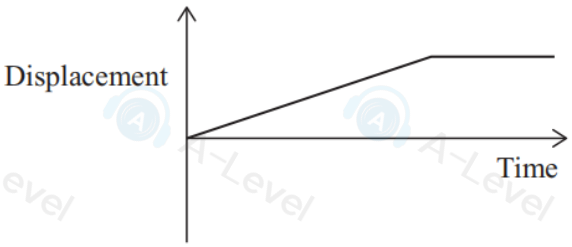


Which of the following could be the displacement-time graph for the motion of the object?

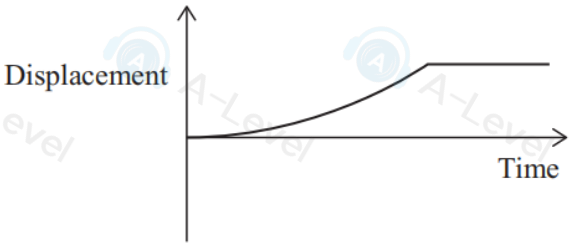
☒ **A**



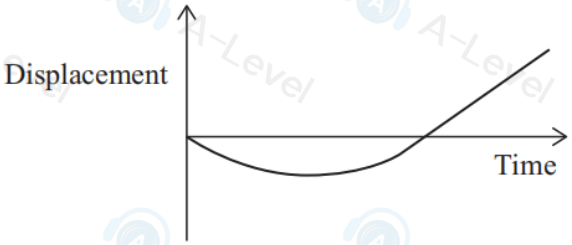
☒ **B**



☒ **C**



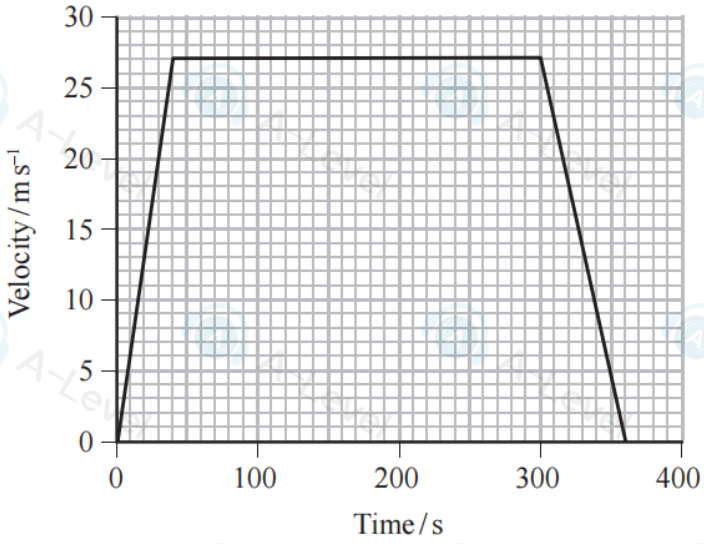
☒ **D**



(Total for Question 9 = 1 mark)

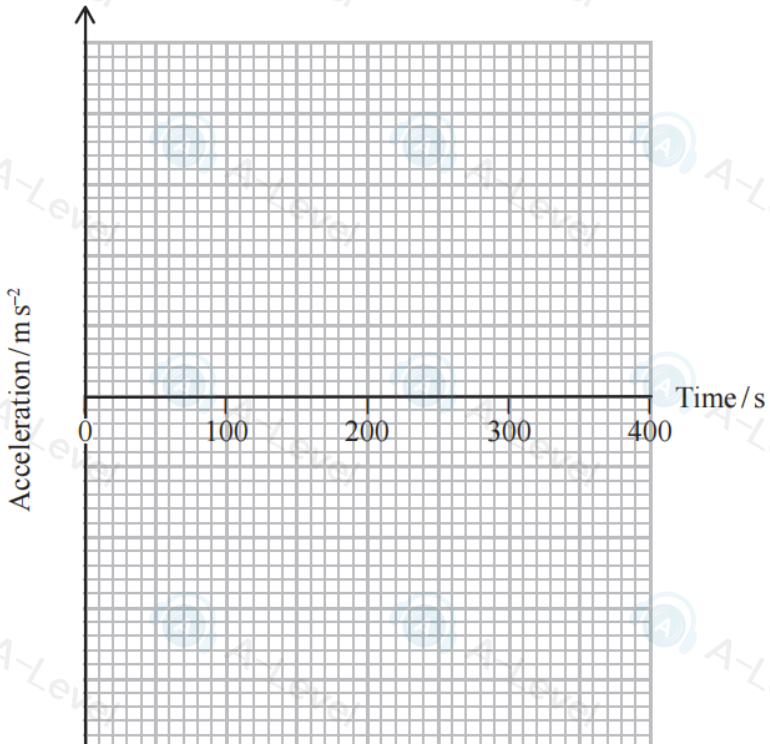
14 A train moves between two stations.

(a) A simplified velocity-time graph for the motion of the train is shown.



Draw a corresponding acceleration-time graph for the motion of the train. Show all working in the space below.

(6)



(b) While the train is moving at a constant speed, a passenger throws a ball horizontally out of a window, as shown in Figure 1.

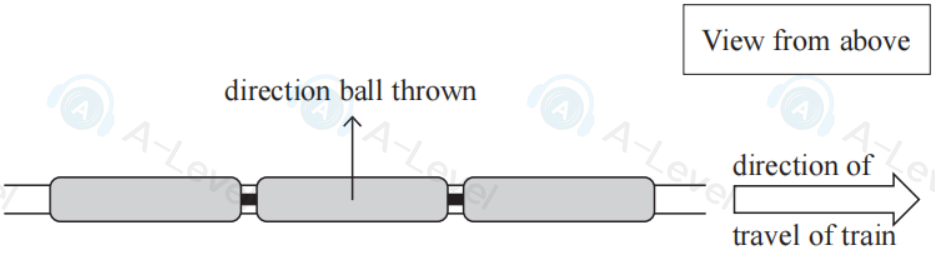


Figure 1

(i) The path of the ball when viewed from above is shown in Figure 2. Any effects of the air have been ignored.

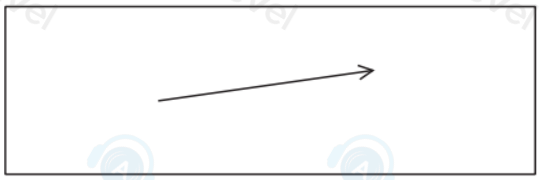


Figure 2

Explain the shape of this path.

(2)

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(ii) The path of the ball when viewed from the side is shown in Figure 3. The effect of air resistance has been ignored.

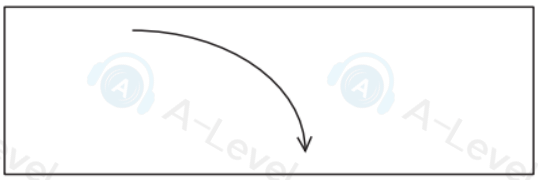

Figure 3

Explain the shape of this path.

(2)

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(iii) Figures 2 and 3 are shown again below. Add to these figures the path of the ball if the effect of air resistance is not ignored.

(2)

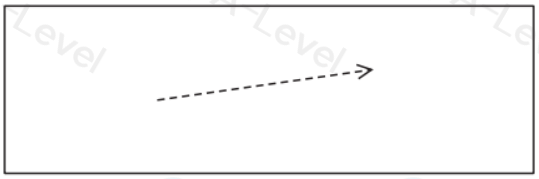


Figure 2

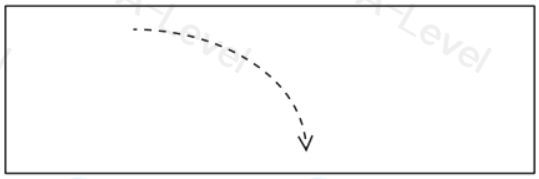
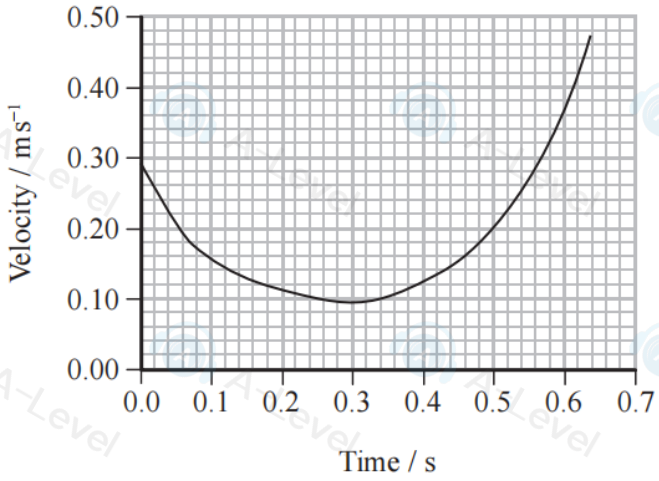


Figure 3

(Total for Question 14 = 12 marks)

13 A ball bearing moves across a horizontal bench towards a magnet as shown.

The velocity-time graph for the horizontal motion of the ball bearing up to the point of contact with the magnet is shown.



(a) Explain the shape of the graph.

(3)

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(b) Calculate the maximum acceleration of the ball bearing.

(3)

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Maximum acceleration = ...

19 A deep-sea diver is a person who swims at great depths below the surface of the sea.

(a) To help a deep-sea diver move downwards quickly, spherical masses are attached to the diver.

During a dive, one mass became unattached and fell to the bottom of the sea.

(i) State the conditions for Stokes' law to apply.

(2)

(ii) The mass accelerated to terminal velocity as it fell to the bottom of the sea.

At terminal velocity, the mass fell 25 m in a time of 0.36 s.

There was a difference of 4.6 N between the weight of the mass and the upthrust on the mass.

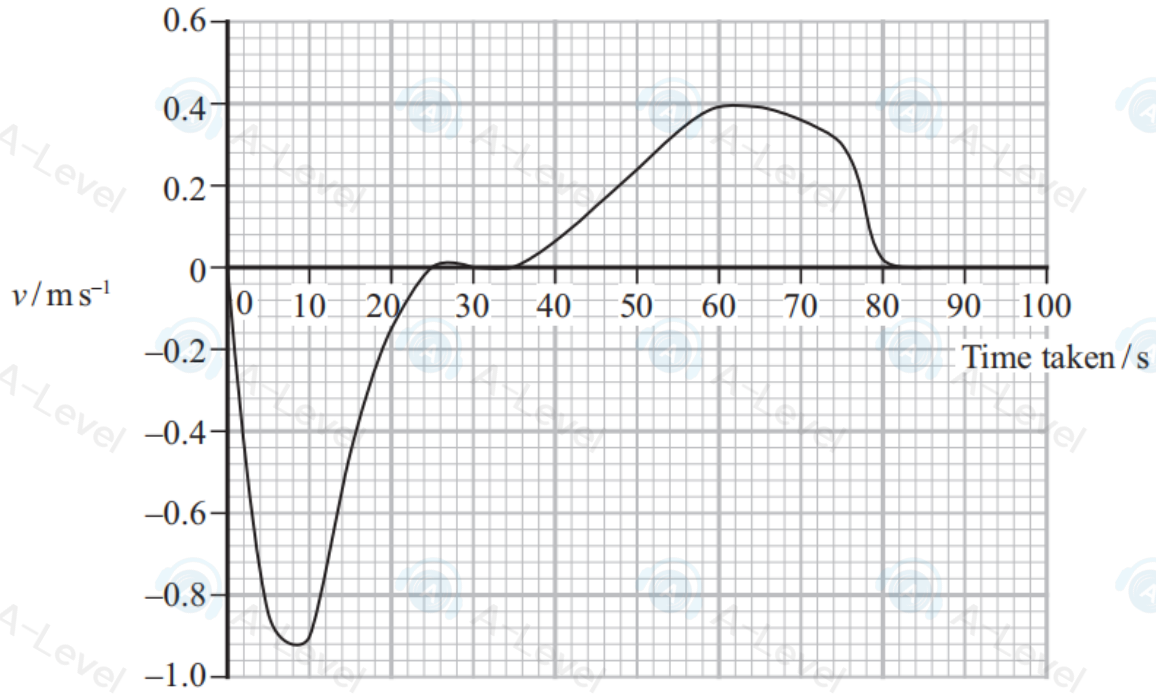
The spherical mass has a volume of 45 cm^3.

Deduce whether Stokes' law applied as the mass fell through the water.

$\eta_{water} = 1.2 \times 10^{-3}$ Pa s

(5)

(b) The graph shows how the vertical velocity v of the diver varied during a dive.



(i) The diver was at the surface of the sea at 0 s.

Explain how the graph could be used to show that the diver reached the surface of the sea again at 82 s.

(2)

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(ii) Determine the vertical acceleration of the diver at 70 seconds.

(3)

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.....

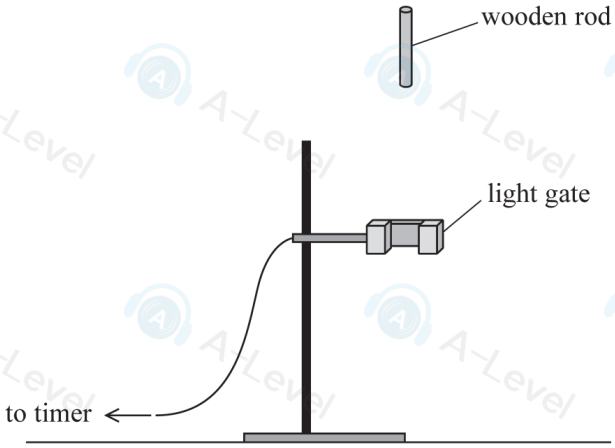
.....

Acceleration = ...

(Total for Question 19 = 12 marks)

12 A student carries out an experiment to determine a value for g, the acceleration of free fall. A short wooden rod is released above a light gate. A timer connected to the light gate is used to measure the time taken for the wooden rod to pass through the light gate.

The experimental arrangement is shown.



The student uses the equation $v^2 = u^2 + 2as$, where $u = 0$, and a graphical method to determine a value for g.

(a) State the additional measurements the student should take.

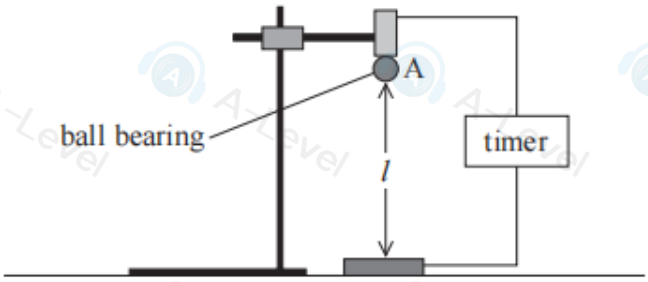
(2)

(b) Describe how the velocity v of the wooden rod as it passes through the light gate can be determined accurately.

(2)

11 A student carried out an experiment to measure the acceleration of free-fall g.

A ball bearing was released from position A. The time t for the ball bearing to fall a distance l was measured. This was repeated for decreasing values of l.



Explain how the measurements obtained can be used to determine a value for g in m s^{-2}. Your answer should include a sketch on the axes below of the graph that the student would expect to obtain.

(5)

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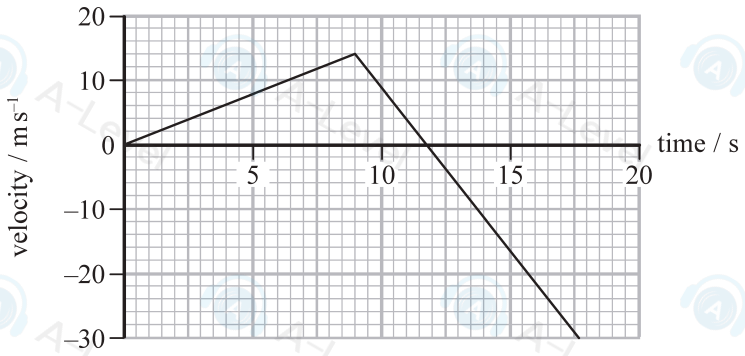
SECTION B

Answer ALL questions in the spaces provided.

11 The graph shows how the velocity of an object varies with time.



Describe how the acceleration of the object varies with time.
Your answer should include calculations.

(3)

(Total for Question 11 = 3 marks)