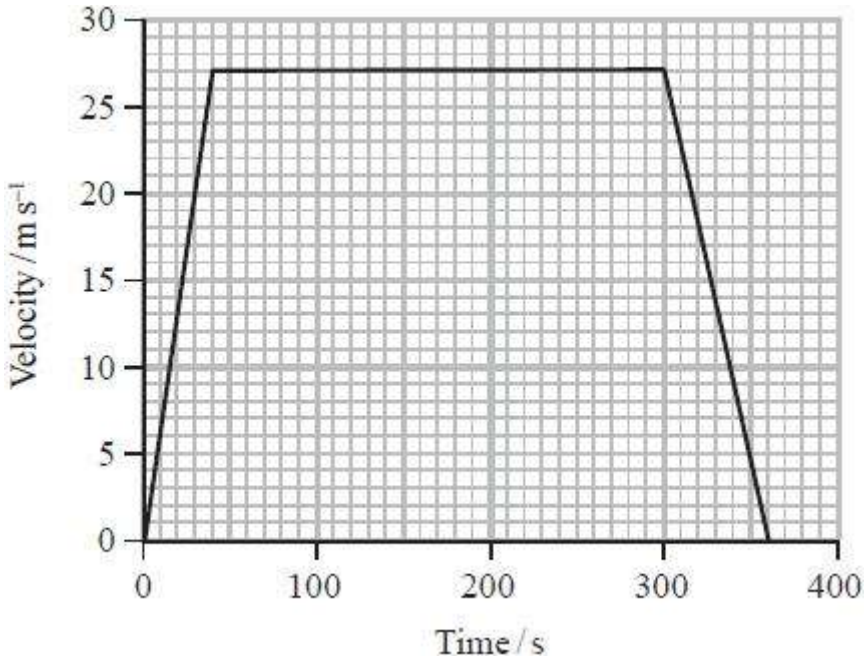
Q1.

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)

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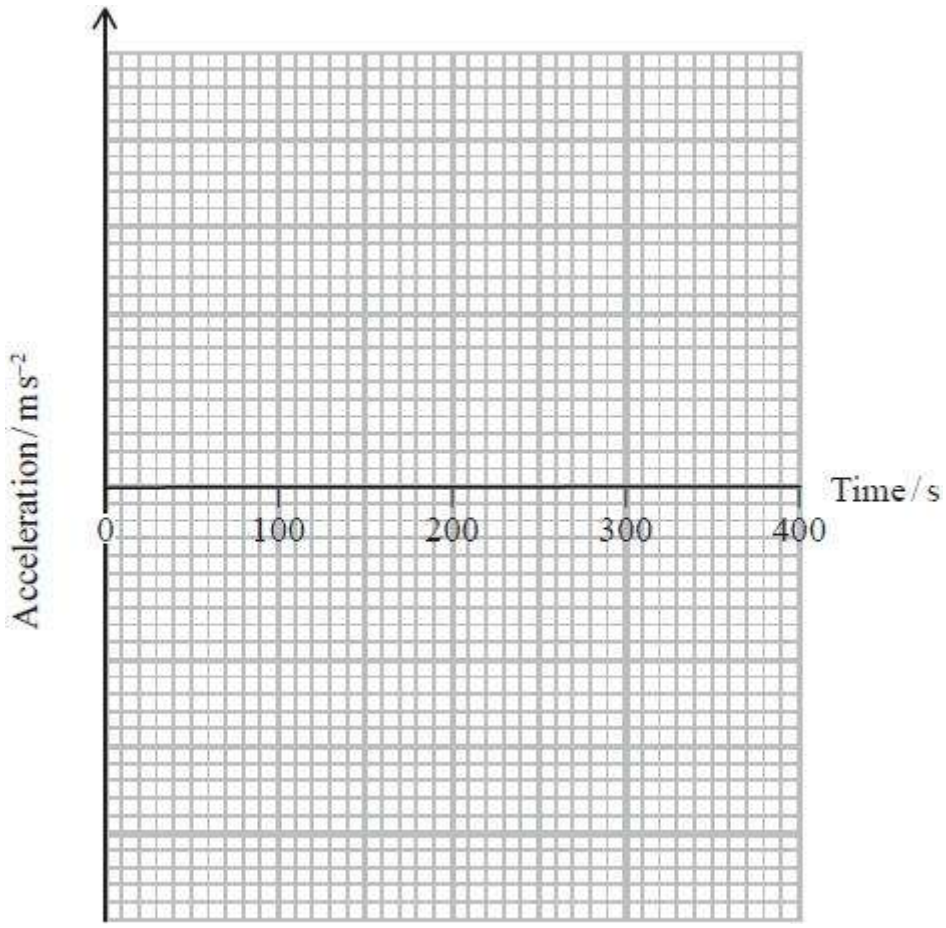

(b) While the train is moving at a constant speed, a passenger throws a ball horizontally out of a window, as shown in Figure 1.

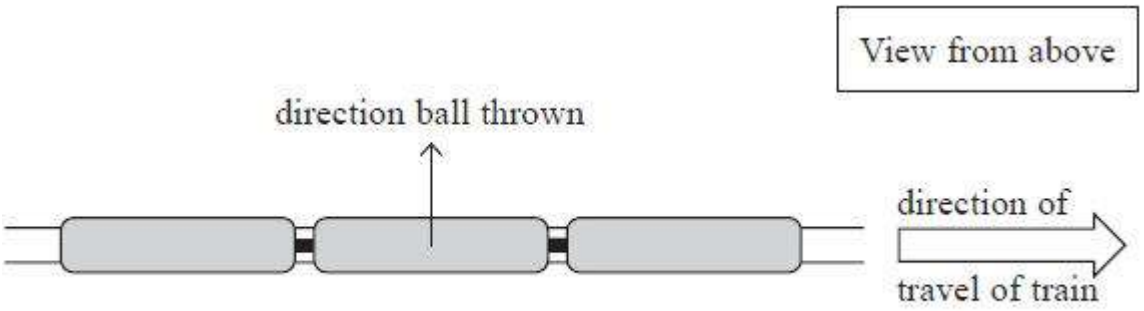

Figure 1

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

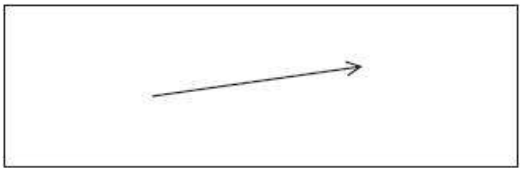

Figure 2

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.

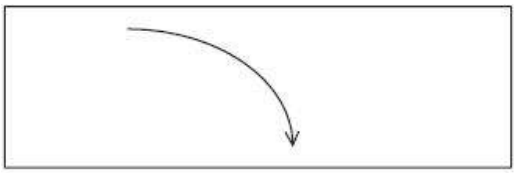

Figure 3

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)

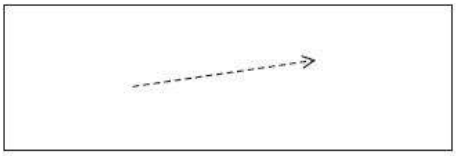


Figure 2

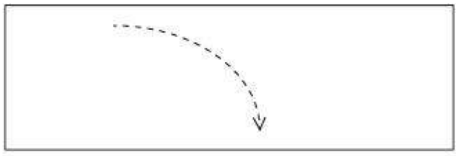


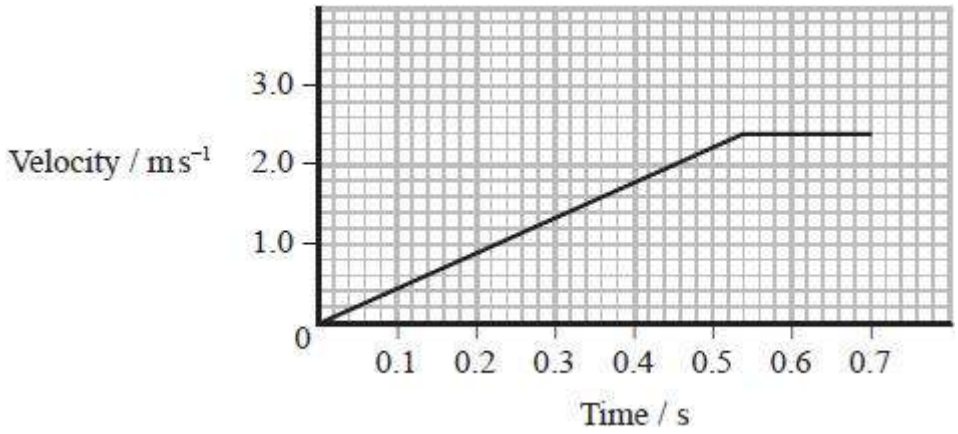
Figure 3

Q2.

A student uses a friction-free trolley and a ramp to investigate motion.

The mass of the trolley is 0.10 kg. The student releases the trolley from rest so it moves down the ramp and then continues along a horizontal surface.

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



(a) Show that the acceleration of the trolley on the ramp is about 4 m s^{-2}.

(2)

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(c) Calculate the time it takes for the trolley to move a distance of 0.74 m.

(3)

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Time = ...

(e) Explain how the acceleration of the trolley down the ramp could be determined experimentally using ICT.

(4)

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Q3.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

The manufacturer of a car claims that the car can accelerate from rest to 30 m s^{-1} in 7.5 s.

What is the average acceleration of the car over this time period?

☐ **A** 0.53 m s^{-2}

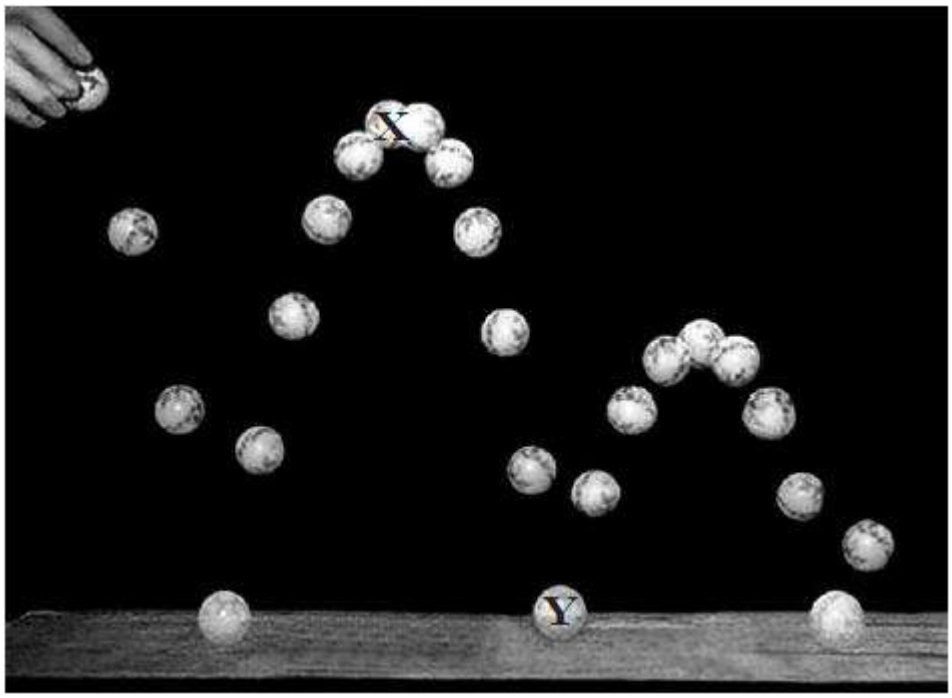
☐ **B** 2.0 m s^{-2}

☐ **C** 4.0 m s^{-2}

☐ **D** 8.0 m s^{-2}

Q4.

The photograph shows a sequence of images of a bouncing ball. 20 images were taken per second.



(a) (i) Show that the distance the ball fell between point X and point Y is about 0.4 m.

(3)

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(ii) Use measurements from the photograph to calculate the horizontal velocity of the ball.

(4)

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Horizontal velocity = ...

(b) The vertical position of the ball a short time before a bounce was always higher than the vertical position the same time after a bounce.

Explain the difference in height of the ball before and after each bounce.

(2)

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(c) The ball was released with a small horizontal velocity.

(i) The position of the ball in the first 4 images is shown below.
Draw in the first 4 positions of the ball had it been released with no horizontal velocity.

(2)

(ii) Explain why you have drawn the ball in these positions.

(2)

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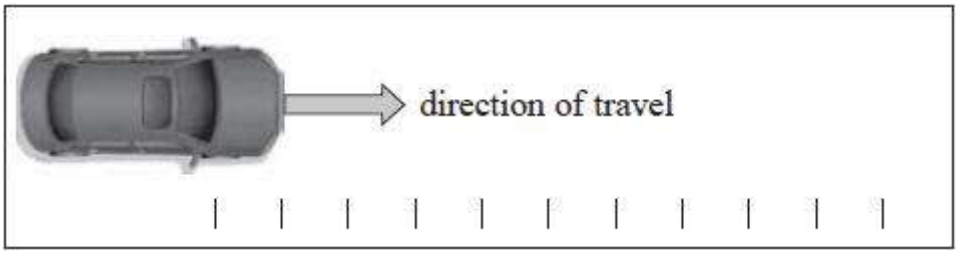
(Total for question = 13 marks)

Q5. A camera may be used to determine if a car is exceeding the speed limit. The camera takes two photographs, at a time interval of 0.50 s, as the car travels over a set of equally spaced road markings as shown.



Measurements from the photographs enable the speed of the car to be calculated.

(a) Explain why the speed calculated is an average speed.

(2)

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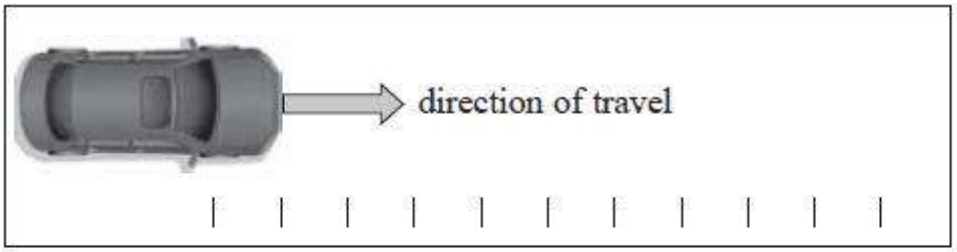
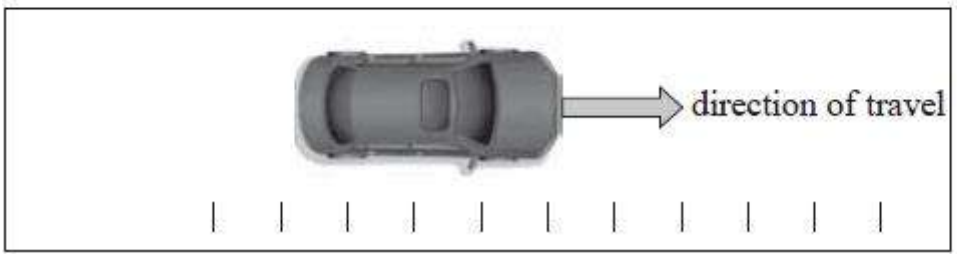
(b) The diagrams below show the positions of a car at a time interval of 0.50 s.

The markings are painted on the road at intervals of 1.52 m.



$t = 0$ s



$t = 0.50$ s

The speed limit is 50 km per hour.

Determine, using information from the diagrams, whether the car was exceeding the speed limit.

(4)

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(c) The position of the camera may result in an error in the calculated speed. Suggest why.

(1)

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Q6.

A car travels at a speed of 20 m s^{-1} due east and then turns around and travels at a speed of 40 m s^{-1} due west.

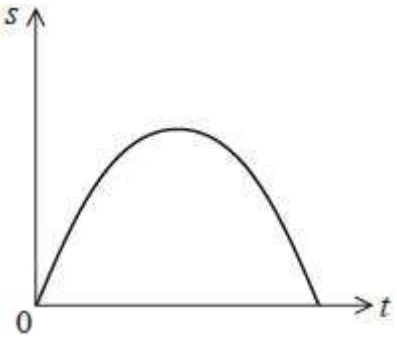
Taking the direction of due east as positive, select the correct row from the table.

	Change in speed / m s^{-1}	Change in velocity / m s^{-1}
☒ **A**	20	−60
☒ **B**	20	60
☒ **C**	60	−60
☒ **D**	60	60

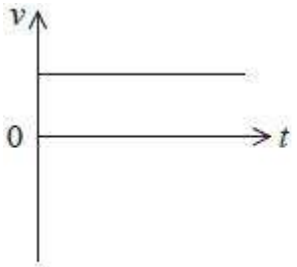
(Total for question = 1 mark)

Q7.

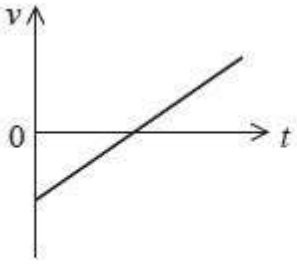
The displacement-time graph for an object is shown.



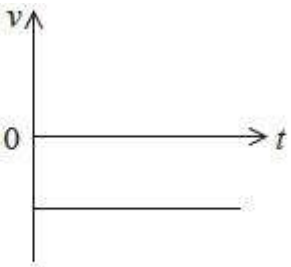
Which of the following is the corresponding velocity-time graph?



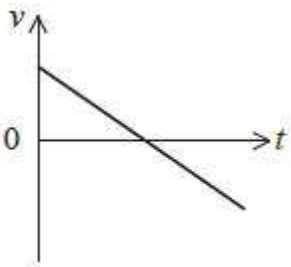
A



B



C



D

☒ **A**

☒ **B**

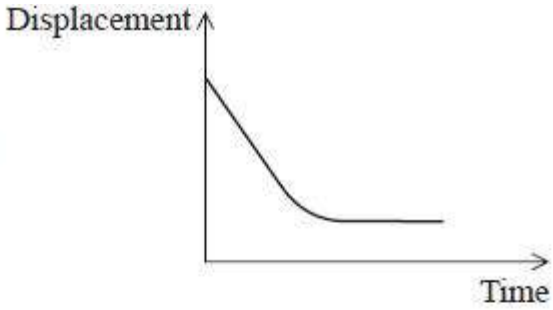
☒ **C**

☒ **D**

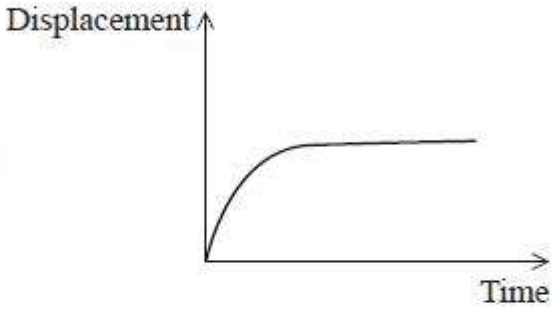
Q8.

Which of the following displacement-time graphs shows a particle starting from rest and reaching terminal velocity?

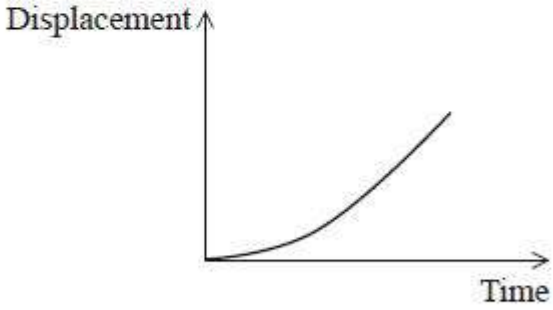
☐ **A**



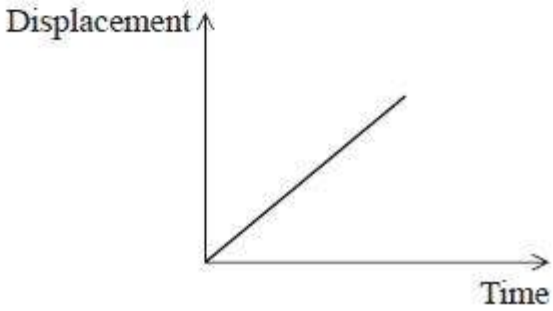
☐ **B**



☐ **C**



☐ **D**



(Total for question = 1 mark)

Q9.

Two students carry out experiments to measure the acceleration of free fall. In each experiment a ball bearing is dropped through a known distance and the time taken is measured.

Student A drops the ball bearing and starts a stopwatch. He stops the stopwatch when he sees the ball bearing reach the ground. The stopwatch measures to the nearest 0.01 s.

Student B uses an electronic system that releases the ball bearing and simultaneously starts a timer. The timer stops automatically when the ball bearing reaches a sensor. The timer measures to the nearest 0.001 s.

State and explain two reasons why the method used by Student B is better for this experiment.

(4)

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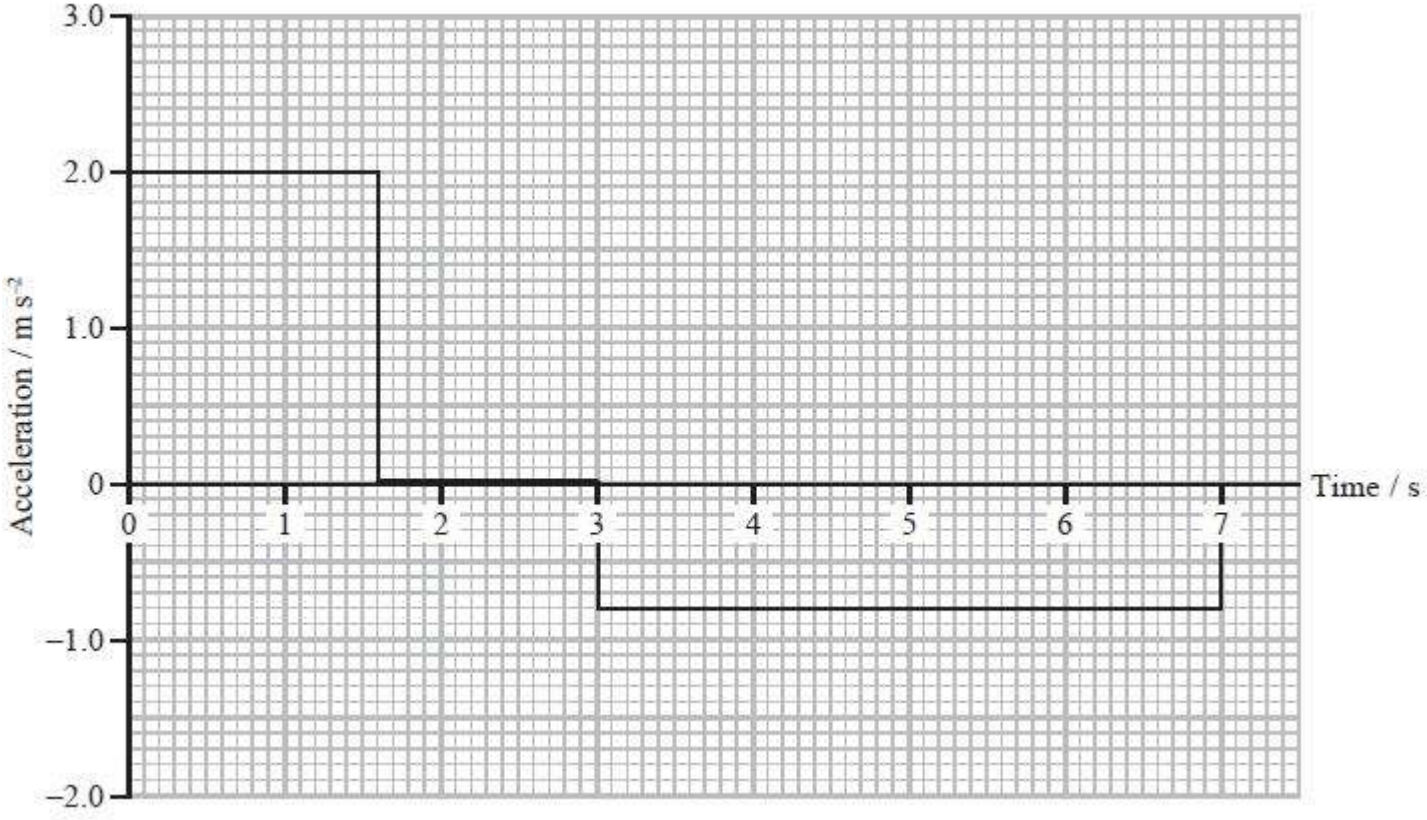
(Total for question = 4 marks)

Q10.

The toy aeroplane in the photograph has a spring mechanism connected to the wheels. When the aeroplane is pulled backwards, the wheels rotate backwards and a spring is compressed. When the aeroplane is released, the force from the spring propels the aeroplane forwards.

The aeroplane is pulled backwards, released and then moves forward in a straight line along a flat surface. The simplified acceleration–time graph for the forward motion of the aeroplane is shown.



(a) Show that the maximum velocity of the aeroplane is about 3 m s^{-1}.

(2)

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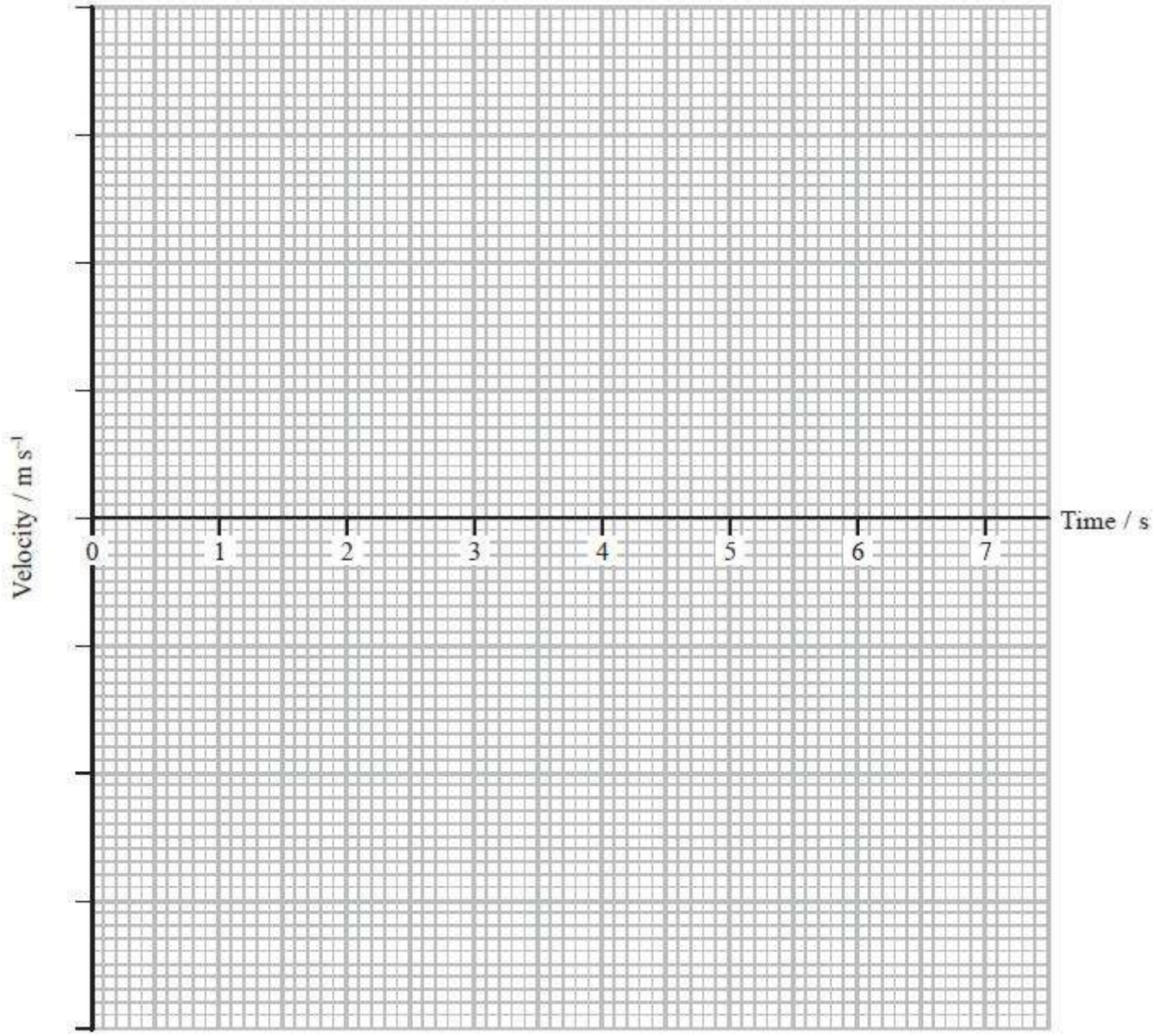
(b) On the axes below draw the corresponding velocity–time graph for the aeroplane.

(3)



(c) Calculate the total distance travelled by the aeroplane after release.

(3)

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Total distance travelled = ...

Q11.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A ball is dropped and is caught after the first bounce.

The ball takes 1.6 s to reach the ground.

From what height was the ball dropped?

☐ **A** 7.8 m

☐ **B** 13 m

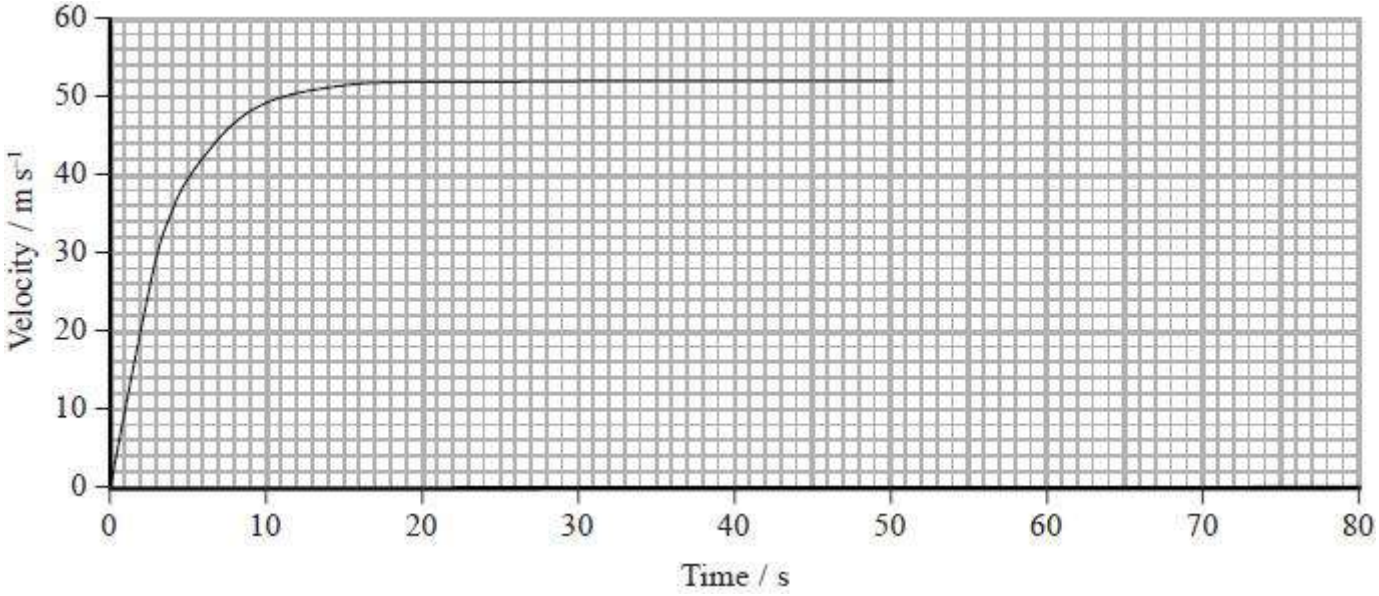
☐ **C** 16 m

☐ **D** 25 m

Q12.

A skydiver jumped out of a plane and fell for 50 s before opening his parachute.

The graph shows how the skydiver's velocity varied with time over the first 50 s of his jump.



*(a) Explain the shape of the graph.

(4)

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(b) Sketch, on the graph above, the motion of the skydiver after he opens his parachute.

(2)

(ii) Explain how the skydiver could decrease this terminal velocity as he falls.

(2)

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(d) The skydiver's jump was being filmed by another skydiver. Both skydivers jumped out of the plane at the same time. During the period of filming only the skydiver who was being recorded opened his parachute.

When viewing the recording after the jump, it appeared as though the skydiver being filmed moved upwards as he opened his parachute.
Explain this apparent movement.

(2)

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(Total for question = 12 marks)

Q13. ball is dropped and reaches the ground after 0.42 s. The ball bounces and is caught at the same height from which it was dropped.

Draw, on the graph paper below, the velocity-time graph for the motion of the ball. You may assume that the time the collision with the ground takes and all frictional forces are negligible. Show your working in the space provided.

(5)

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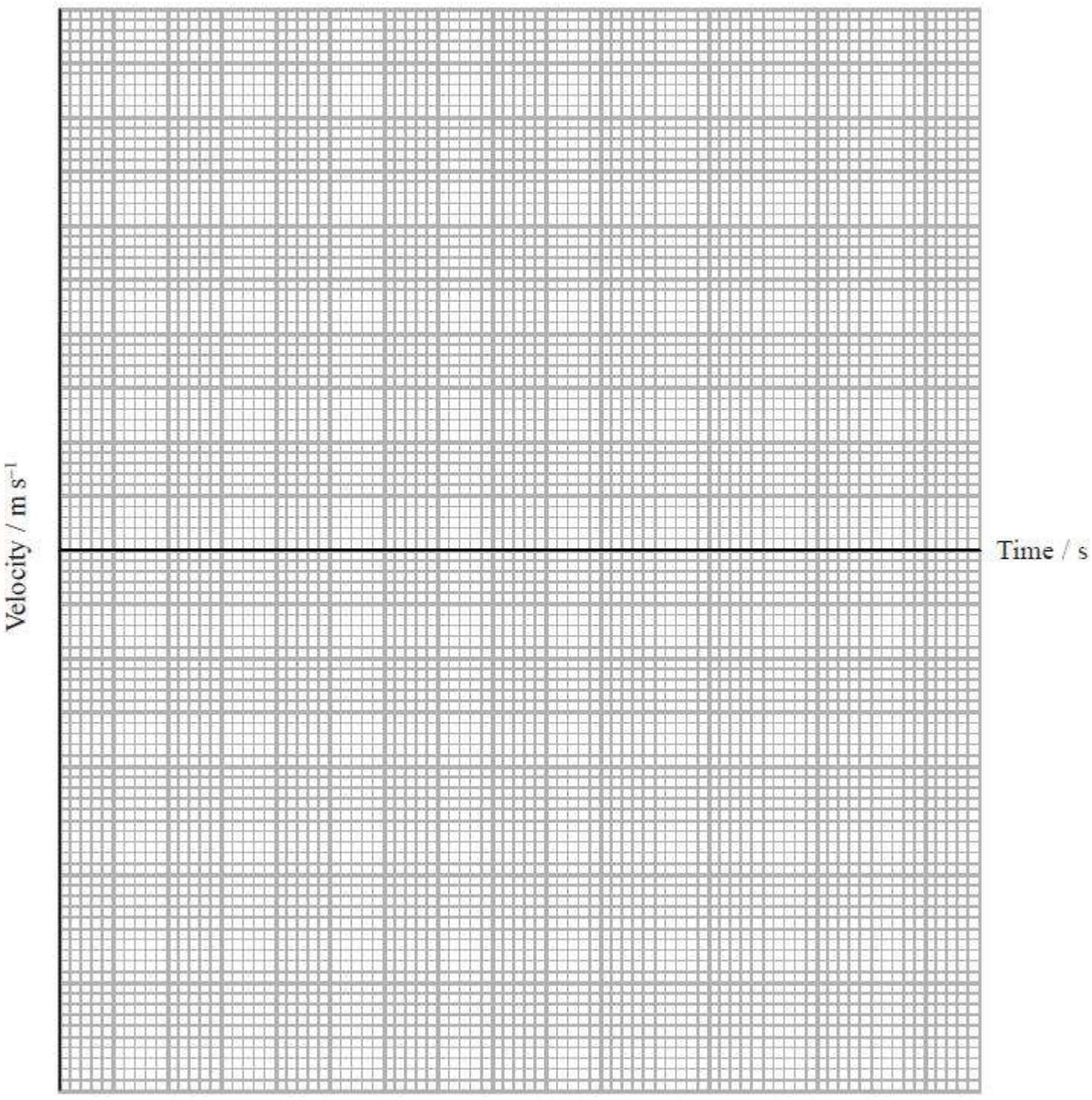
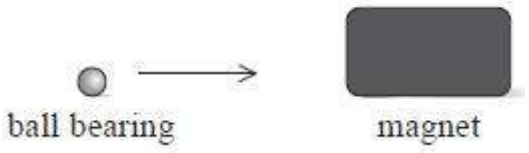
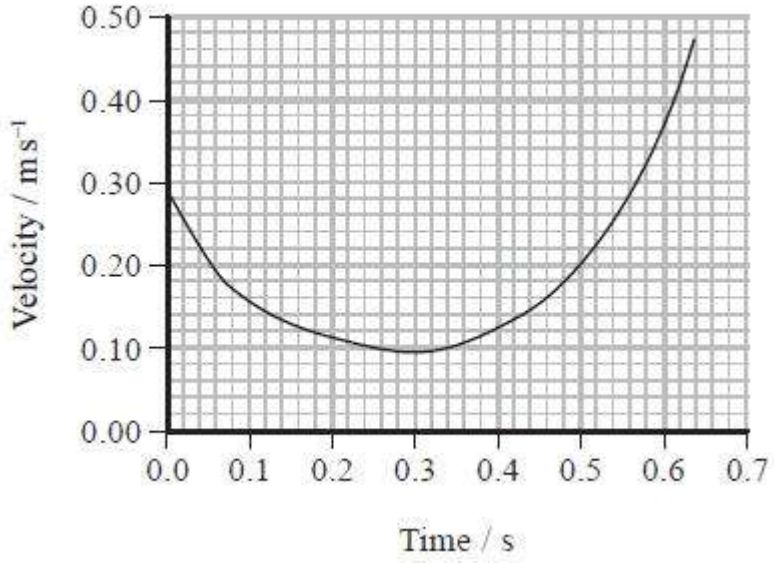


Q14.

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 = ...

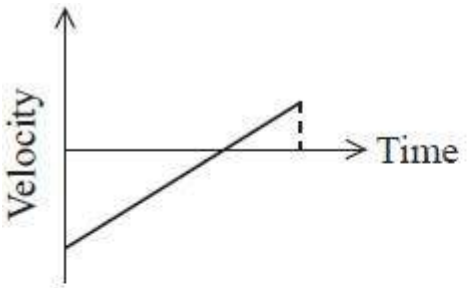
(Total for question = 6 marks)

Q15.

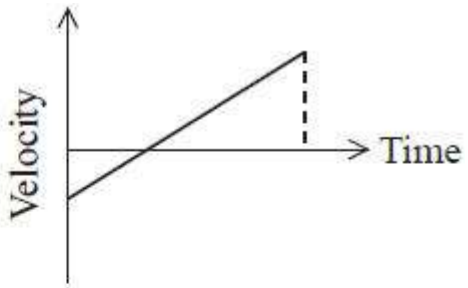
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A ball is dropped and is caught after the first bounce.

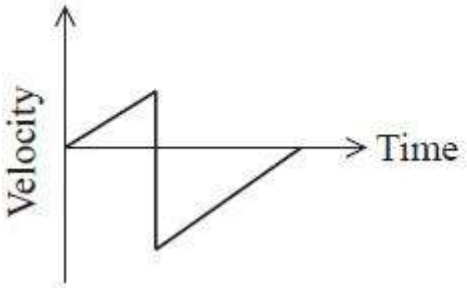
Which of the following is the velocity-time graph for the motion of the ball?



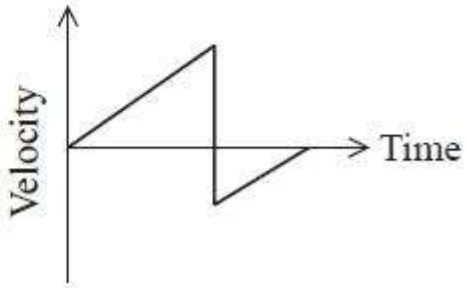
A



B



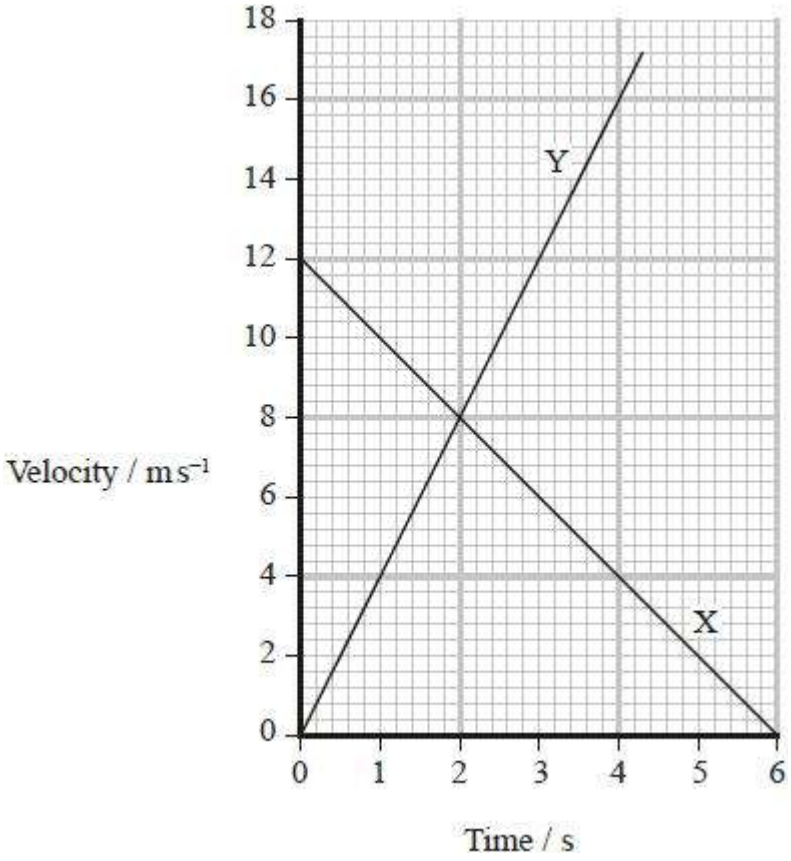
C



D

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**

Q16. The velocity-time graph shows the motion of two vehicles, X and Y, along a track. At time = 0 seconds, the two vehicles are side by side.



(a) Describe the motion of vehicle X between 0 and 6 s.

(3)

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(b) Calculate the time at which vehicle Y overtakes vehicle X.

(4)

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Time = ...

* (c) A video camera is used to film vehicle X.

Explain how a velocity-time graph can be produced from the recording.

(4)

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