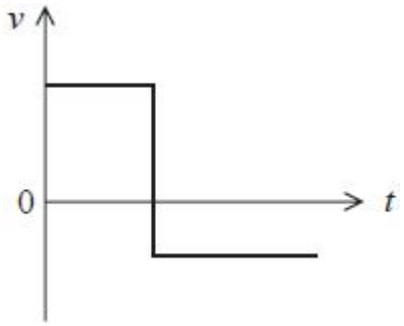
Motion – Time Graphs Questions

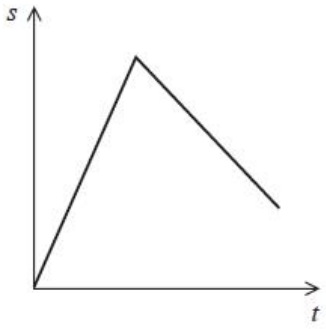
Q1.

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 ☒ .

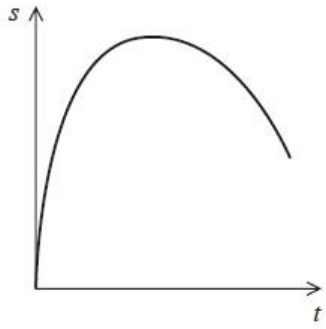
A simplified velocity-time graph for the flight of a drone is shown.



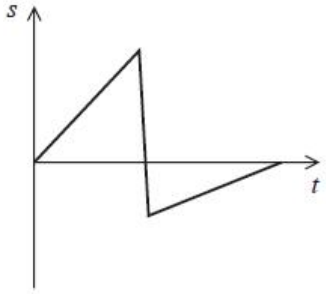
Which of the following is a displacement-time graph for the same flight?



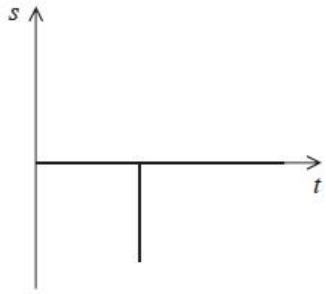
A



B



C



D

☐ **A**

☐ **B**

☐ **C**

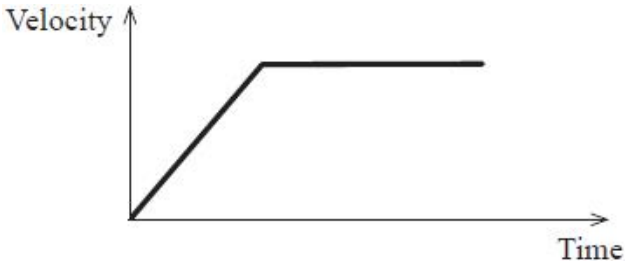
☐ **D**

(Total for question = 1 mark)

Q2.

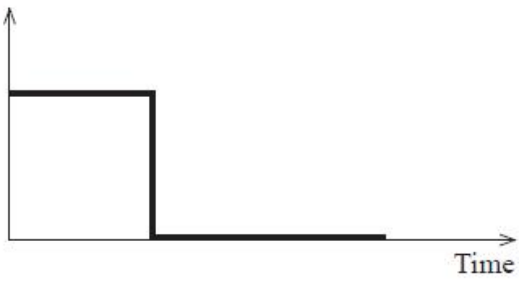
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

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

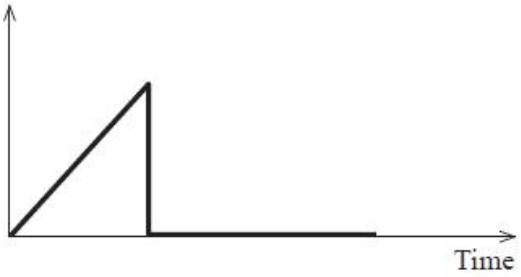


Which of the following graphs shows how the displacement varies with time for this object?

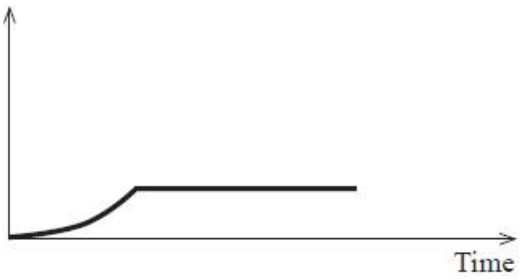
☒ **A**



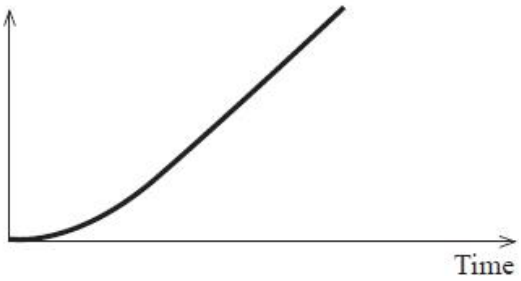
☒ **B**



☒ **C**



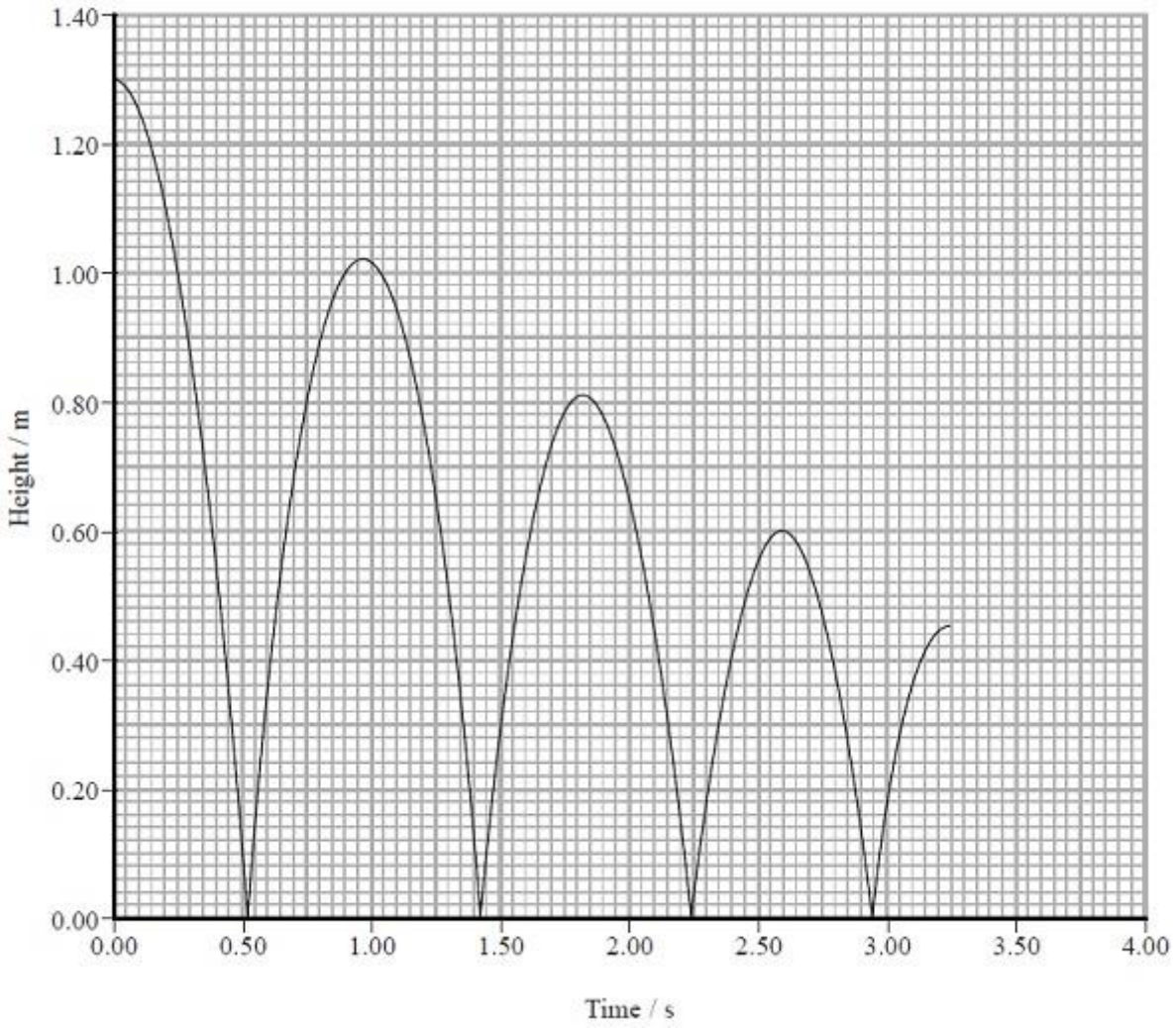
☒ **D**



(Total for question = 1 mark)

Q3.

A ball is dropped from a height of 1.3 m. The graph shows how the height above the ground varies with time for several bounces.



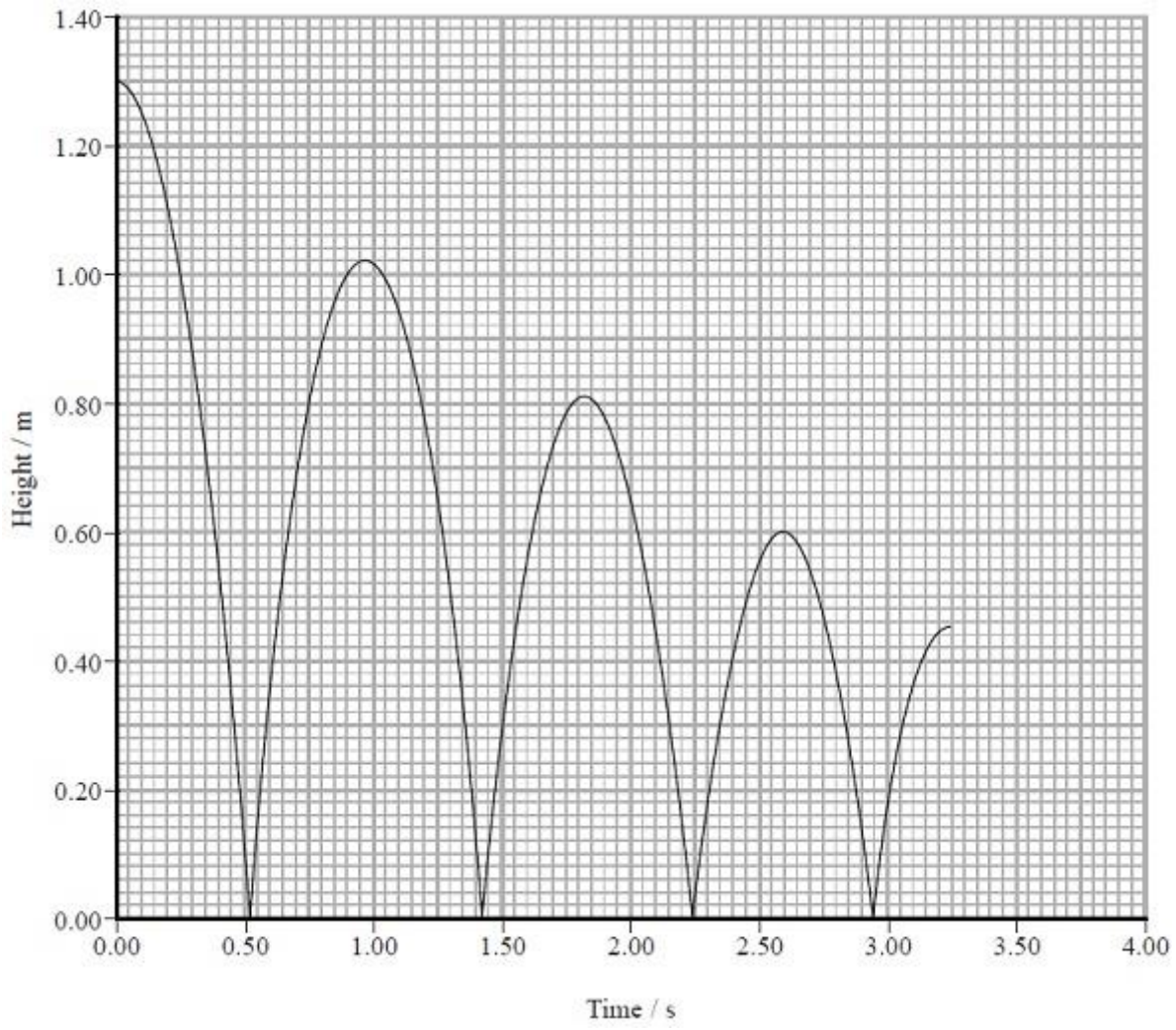
At 2.6 s the magnitude of the displacement from the starting position is

- **A** 0.20 m
- **B** 0.60 m
- **C** 0.70 m
- **D** 1.30 m

(Total for Question = 1 mark)

Q4.

A ball is dropped from a height of 1.3 m. The graph shows how the height above the ground varies with time for several bounces.



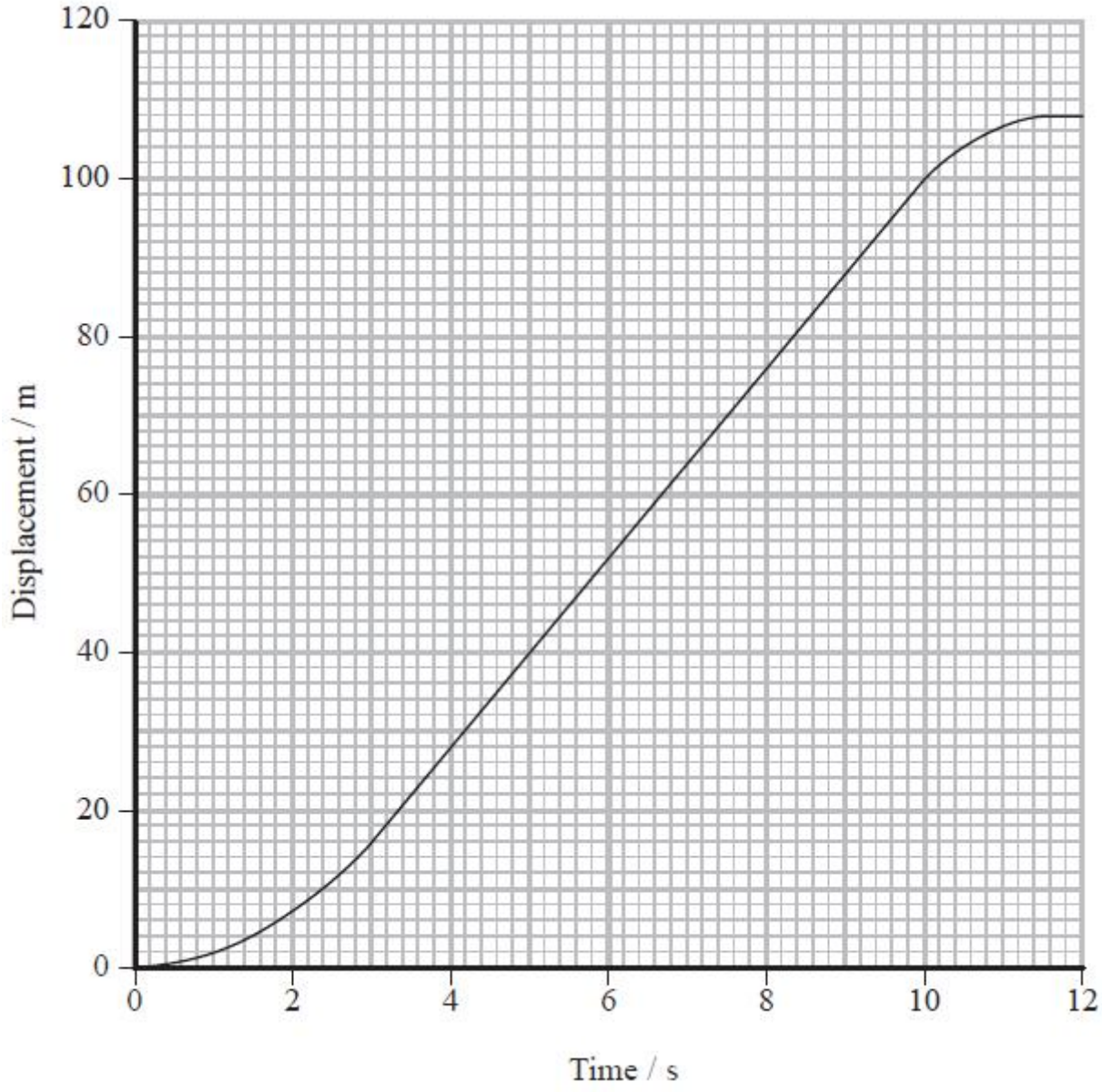
How can the velocity of the ball at time t = 2.5 s be determined from the graph?

- ☒ **A** Calculate the area between the graph and the time axis up to t = 2.5 s.
- ☒ **B** Divide the displacement at t = 2.5 s by 2.5 s.
- ☒ **C** Divide the height at t = 2.5 s by 2.5 s.
- ☒ **D** Draw a tangent to the graph at t = 2.5 s and calculate its gradient.

(Total for Question = 1 mark)

Q5.

The graph is a displacement-time graph for a runner.



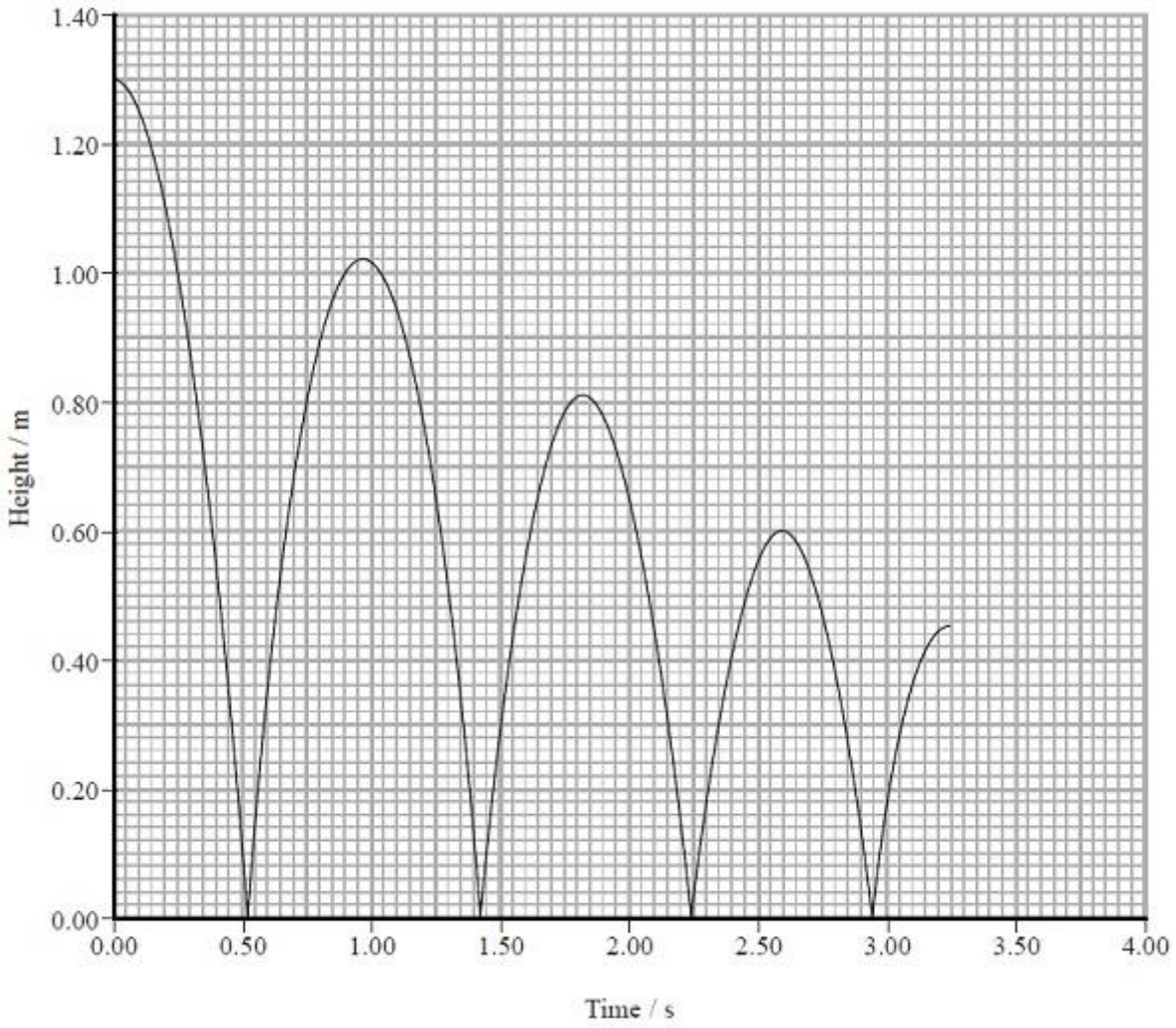
The velocity of the runner at 5 s is approximately

- ☒ **A** 8 m s^{-1}
- ☒ **B** 9 m s^{-1}
- ☒ **C** 12 m s^{-1}
- ☒ **D** 40 m s^{-1}

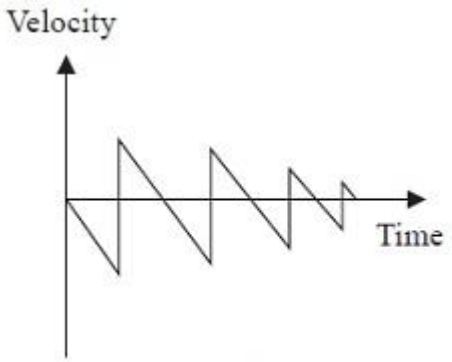
(Total for question = 1 mark)

Q6.

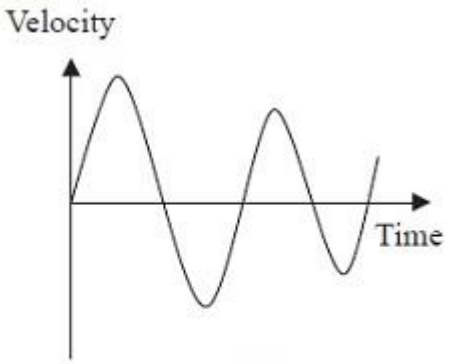
A ball is dropped from a height of 1.3 m. The graph shows how the height above the ground varies with time for several bounces.



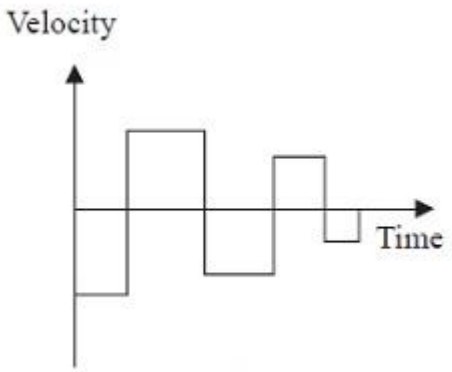
Which of the following graphs could be the velocity-time graph for the ball?



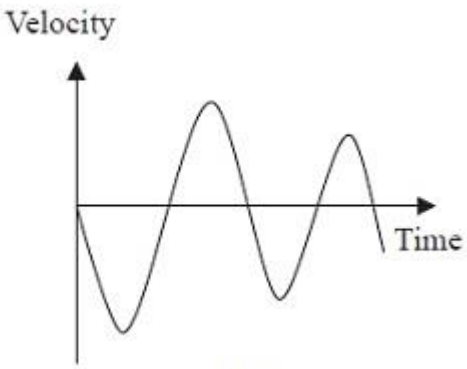
A



B



C



D

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

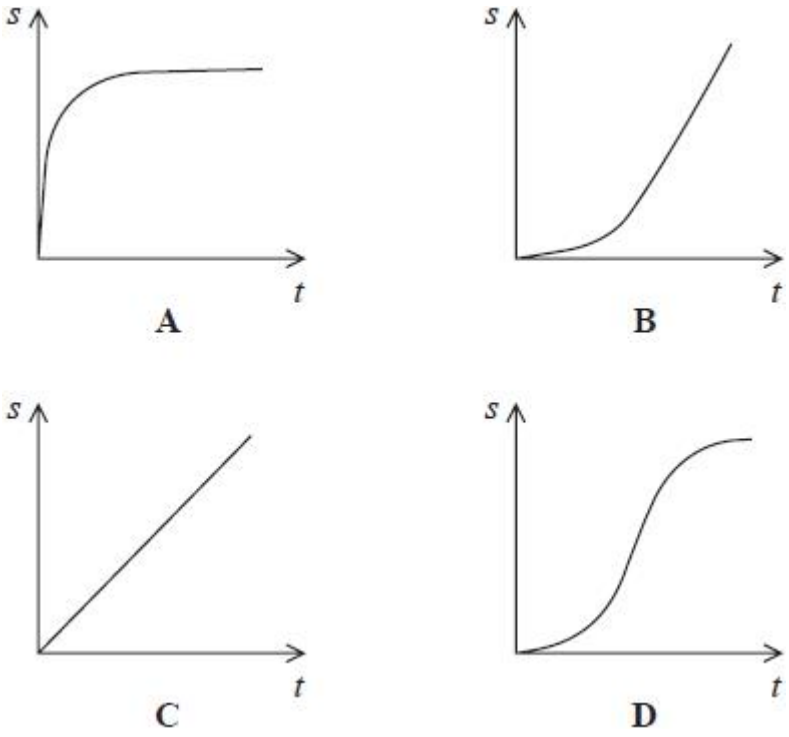
(Total for Question = 1 mark)

Q7.

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 falls from rest through glycerine and reaches terminal velocity.

Which of the following graphs shows how displacement *s* varies with time *t* for the ball?



☐ **A**

☐ **B**

☐ **C**

☐ **D**

(Total for question = 1 mark)

Q8.

Which of the following can be used to determine the magnitude of velocity?

(1)

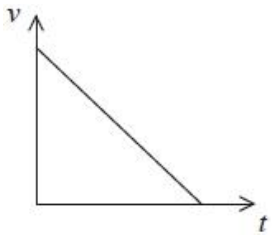
- ☒ **A** area under an acceleration-time graph
- ☒ **B** area under a velocity-time graph
- ☒ **C** gradient of an acceleration-time graph
- ☒ **D** gradient of a velocity-time graph

(Total for question = 1 mark)

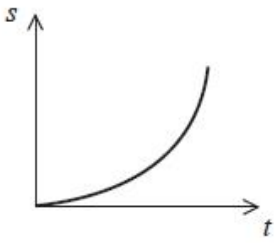
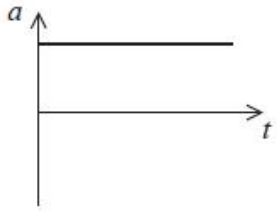
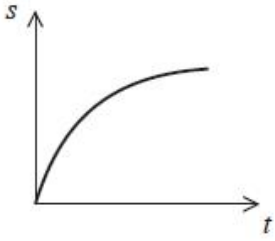
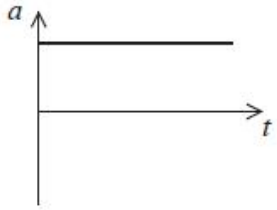
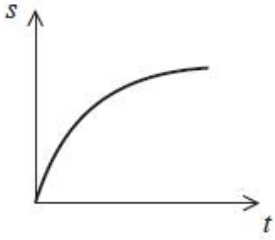
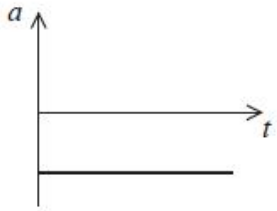
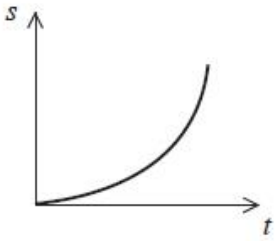
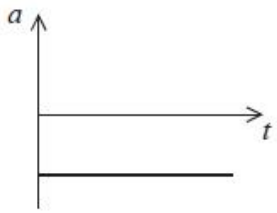
Q9.

A ball is rolled along a horizontal surface. Frictional forces slow the ball to rest.

The velocity-time graph for the ball is shown.



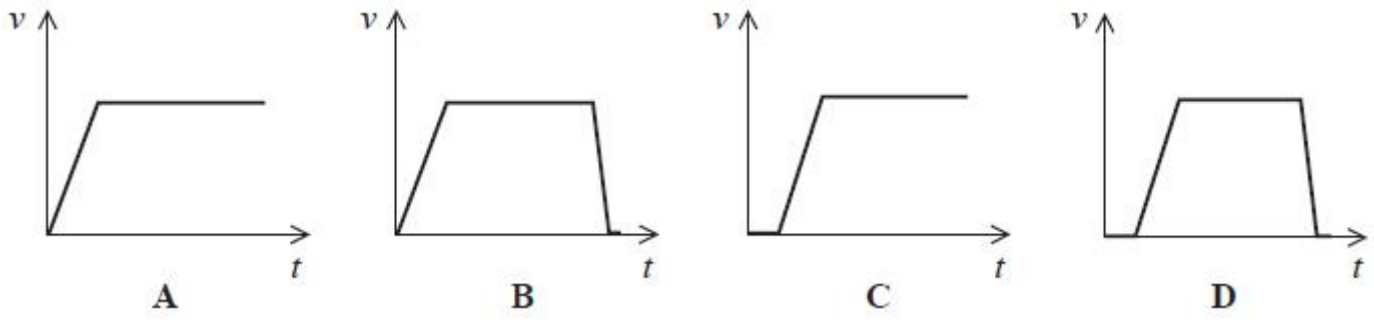
Select the row of the table that correctly gives the corresponding displacement-time and acceleration-time graphs for the ball.

	Displacement-time graph	Acceleration-time graph
☒ A		
☒ B		
☒ C		
☒ D		

(Total for question = 1 mark)

Q10.

The velocity-time graph for the runner over the full 12 s is

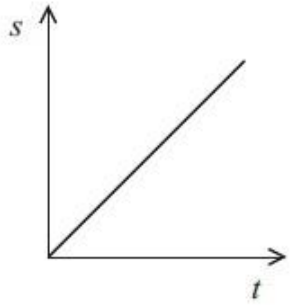
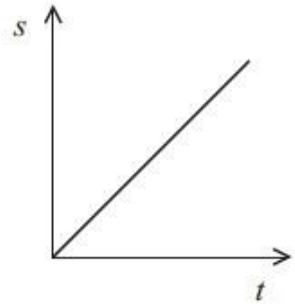
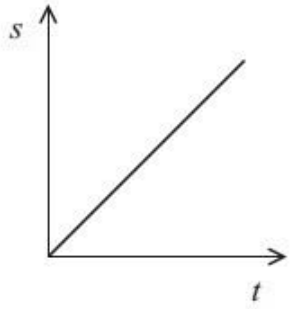
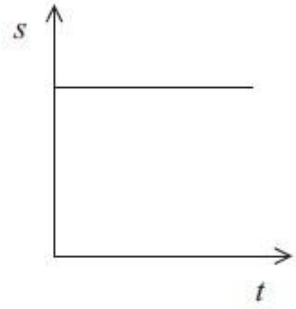
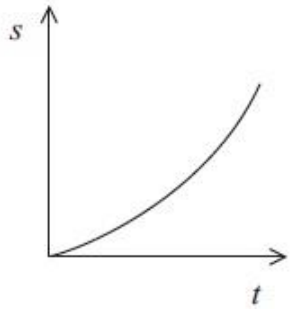
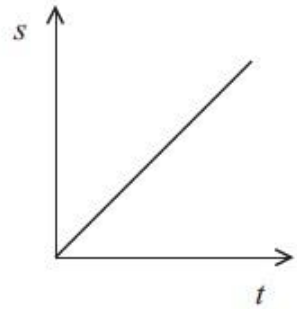
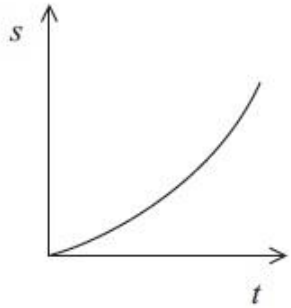
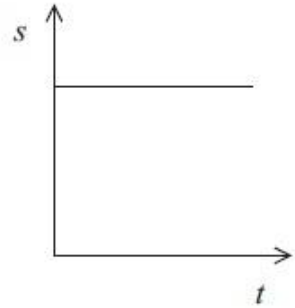


- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(Total for question = 1 mark)

Q11.

An object is thrown horizontally from the roof of a building.
Which pair of displacement-time graphs correctly shows the vertical and horizontal components of displacement for the object until it lands? Assume that there is no air resistance.

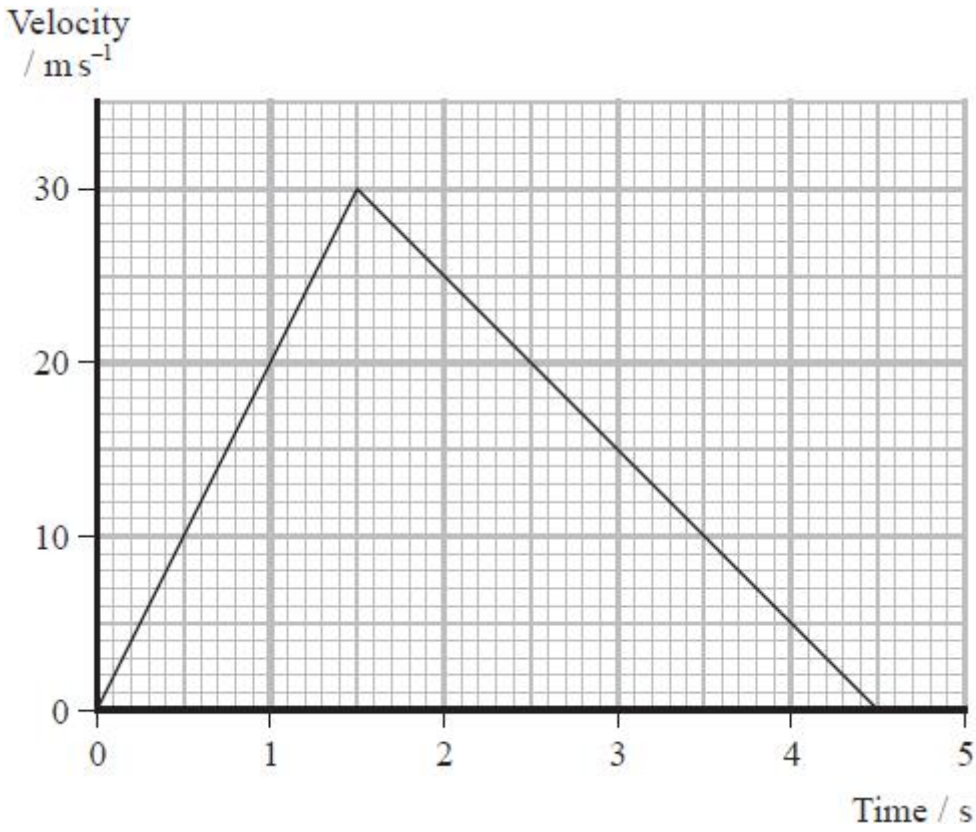
	Vertical	Horizontal
☒ A		
☒ B		
☒ C		
☒ D		

(Total for question = 1 marks)

Q12.

A model rocket accelerates vertically upwards then decelerates due to gravity until it reaches a maximum height.

A velocity-time graph for the rocket until it reaches maximum height is shown.



Show that the rocket reaches a maximum height of about 68 m.

(2)

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(Total for question = 2 marks)

Q13.

A model rocket accelerates vertically upwards then decelerates due to gravity until it reaches a maximum height.

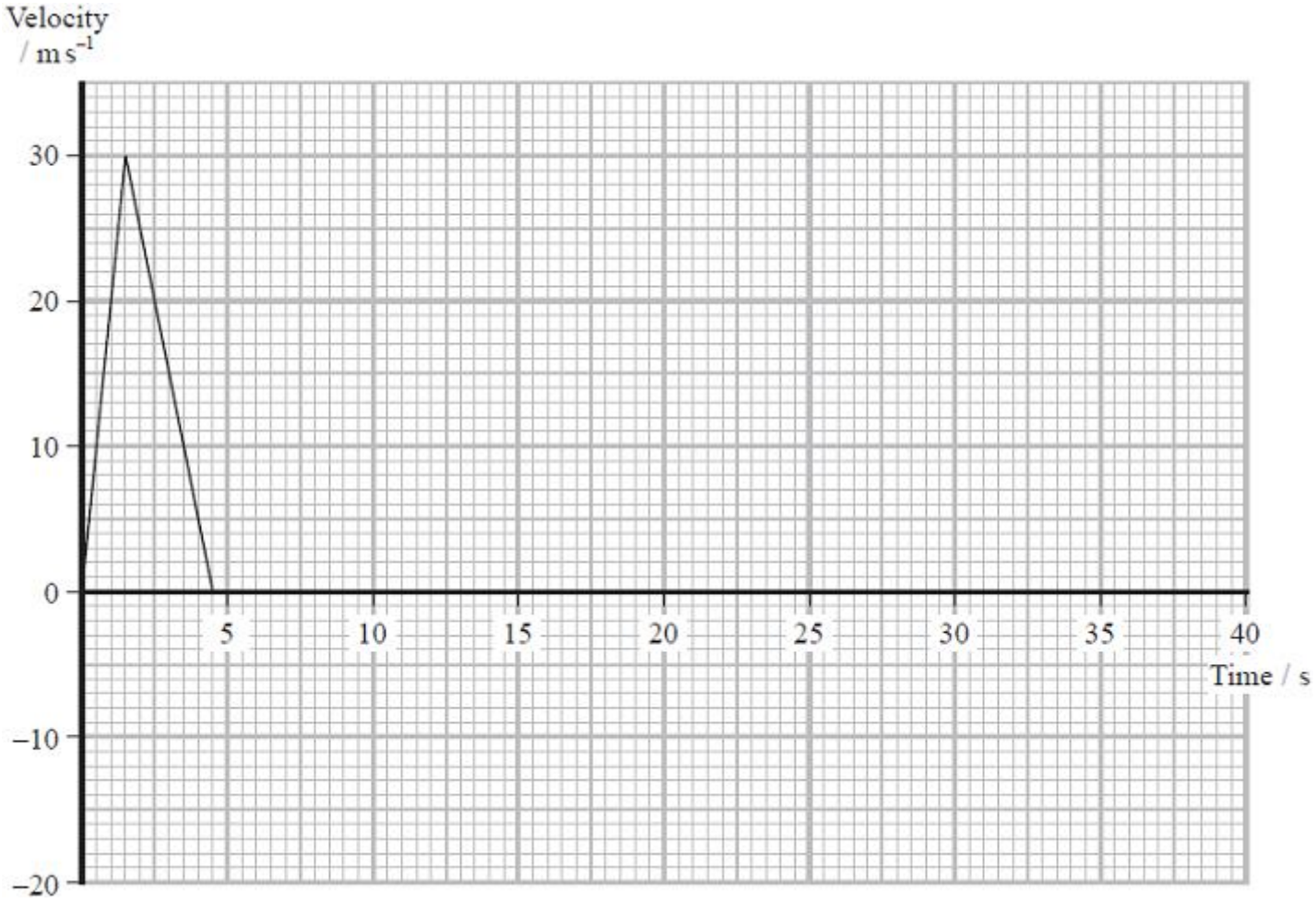
When the rocket reaches the maximum height of 68 m, a parachute opens. Almost instantly, the rocket reaches a terminal velocity of 2.0 m s^{-1}.

Complete the velocity-time graph below for the motion of the rocket until it reaches the ground.

(2)

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(Total for question = 2 marks)

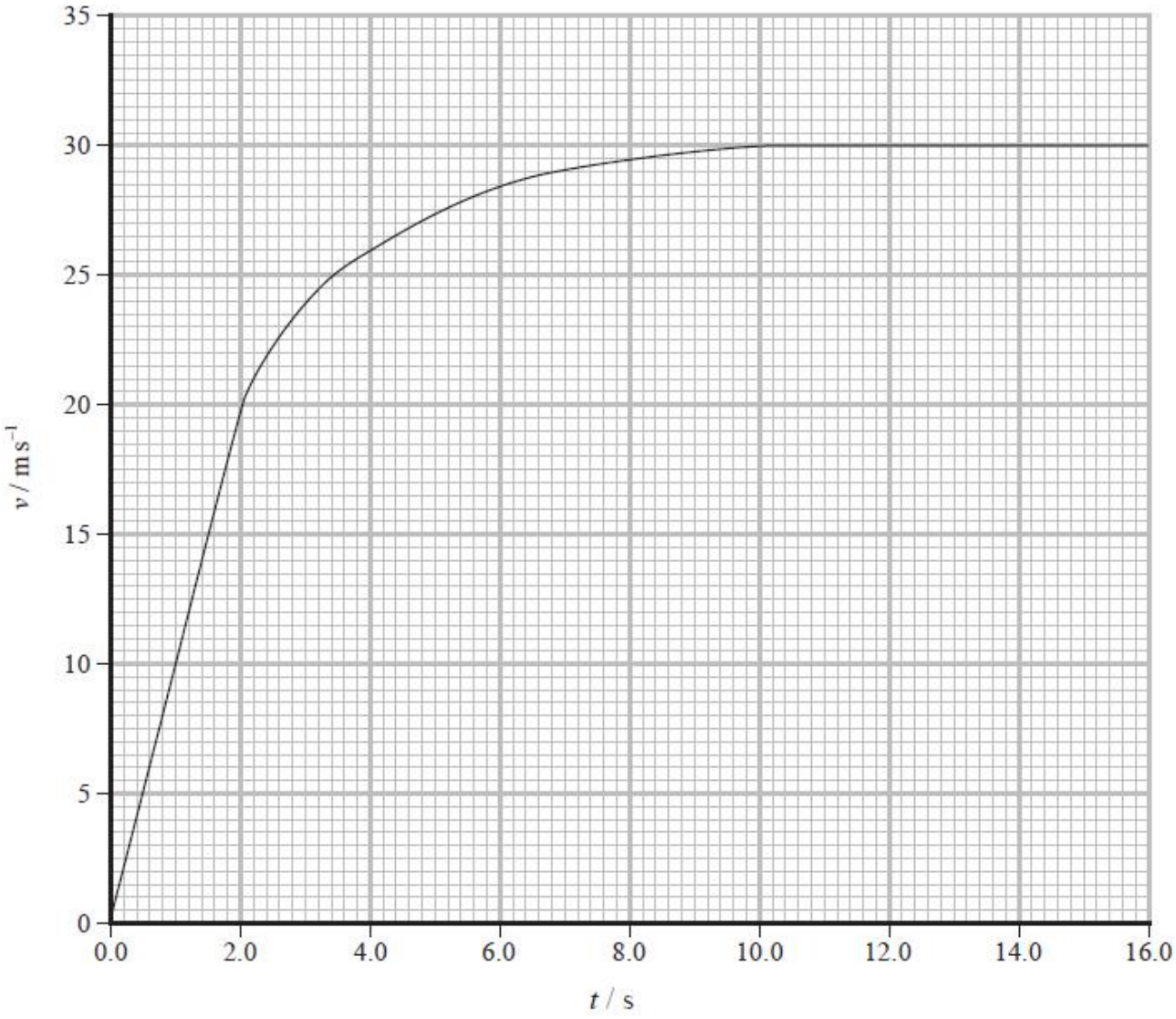
Q14.

A skydiver made a skydive from a plane.



(Source: © Sky Antonio/Shutterstock)

The graph shows how the velocity *v* of the skydiver varied with time *t*, from the instant she left the plane to the instant just before the parachute opened.



Determine the acceleration of the skydiver when t = 4.0 s.

(3)

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Acceleration of skydiver = ...

Determine an approximate value for the displacement of the skydiver over the first 16.0 s of the skydive.

(3)

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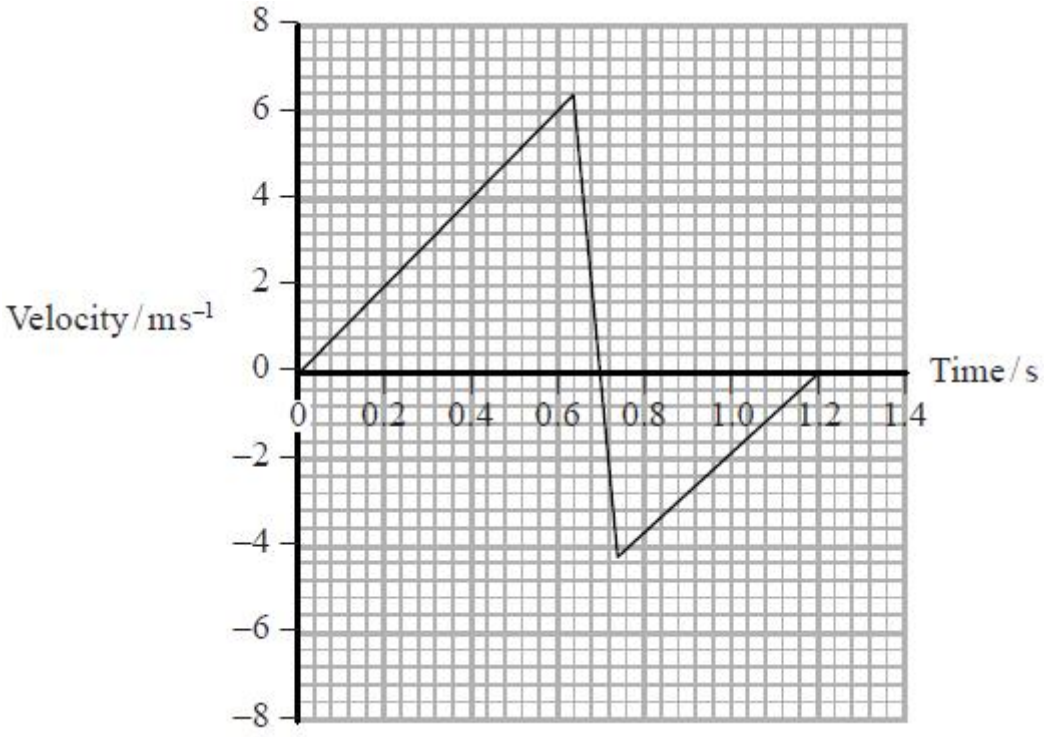
Displacement of skydiver = ...

(Total for question = 6 marks)

Q15.

A stationary ball is released from a height of 2.0 m onto a hard surface.

The simplified velocity-time graph shows the motion of the ball as it falls and bounces back to its maximum height.



(a) Calculate the maximum height reached by the ball after bouncing.

(2)

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Maximum height = ...

(d) The ball is replaced with one that is softer. It is released from a height of 2.0 m onto the same surface as before. A velocity-time graph is drawn to show the motion of the new ball.

Describe the similarities and differences between the two graphs.

(3)

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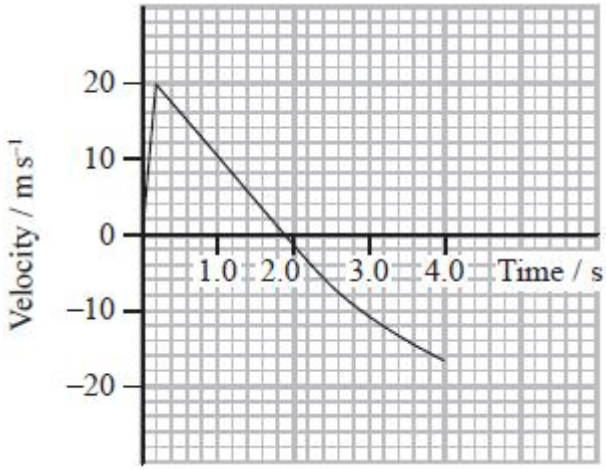
(Total for question = 5 marks)

Q17.

A physics class made a toy rocket. A drinks bottle was partially filled with water and inverted over a valve. An air pump delivered air to the bottle until the pressure forced the bottle from the valve and the water was ejected from the bottle at high speed.



A velocity-time graph for the bottle for the first 4 s after take-off is shown.



Determine the height to which the rocket travelled.

(2)

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Height = ...

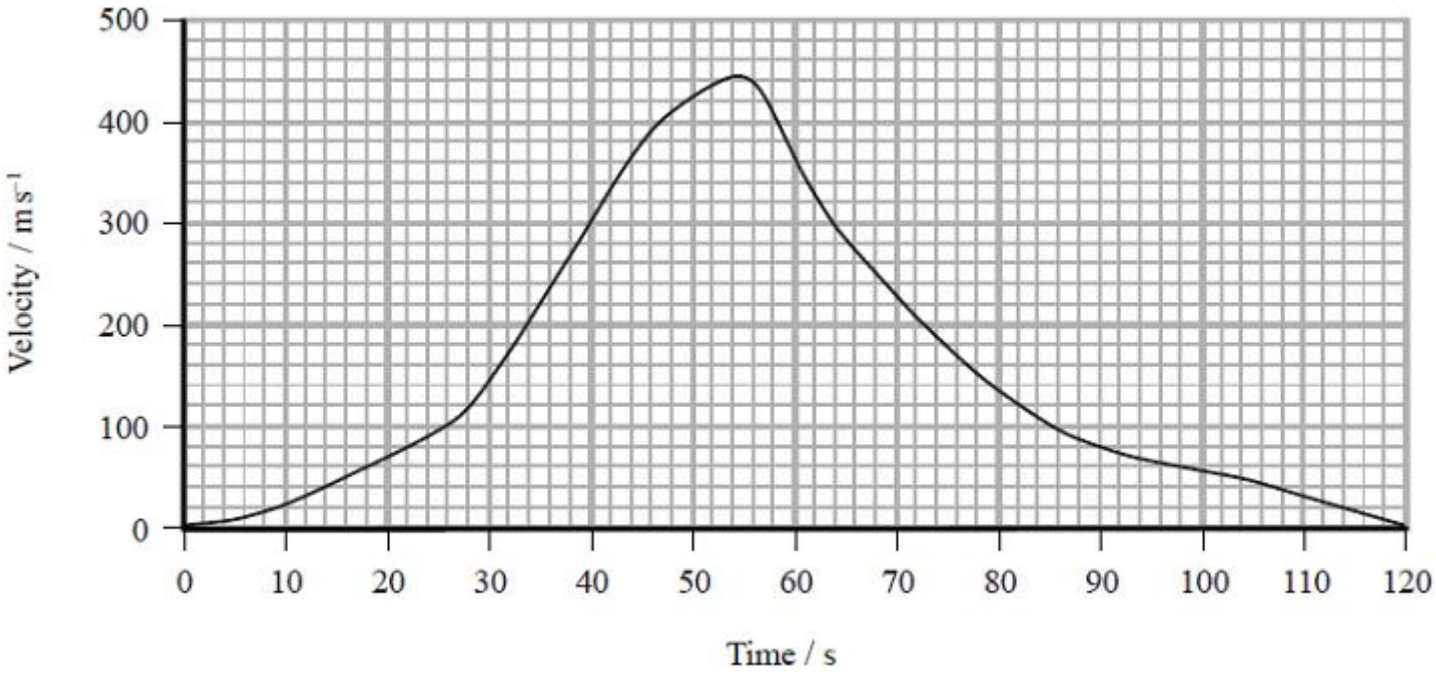
(Total for question = 2 marks)

Q18.

The world land speed record of 341 m s^{-1} was set in October 1997. In an attempt to break this record, a new supersonic car has been developed called the Bloodhound.



The developers of the Bloodhound have used computer modelling to produce a velocity-time graph for the predicted motion of the car, on a straight track, during the record attempt.



A track of length 23 km is available for the record attempt.

Determine whether this track is long enough.

(3)

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(Total for question = 3 marks)

Q19.

The photograph shows cars travelling on a straight section of a motorway.

The maximum speed limit on a motorway in the U.K. is $31 ms^{-1}$.

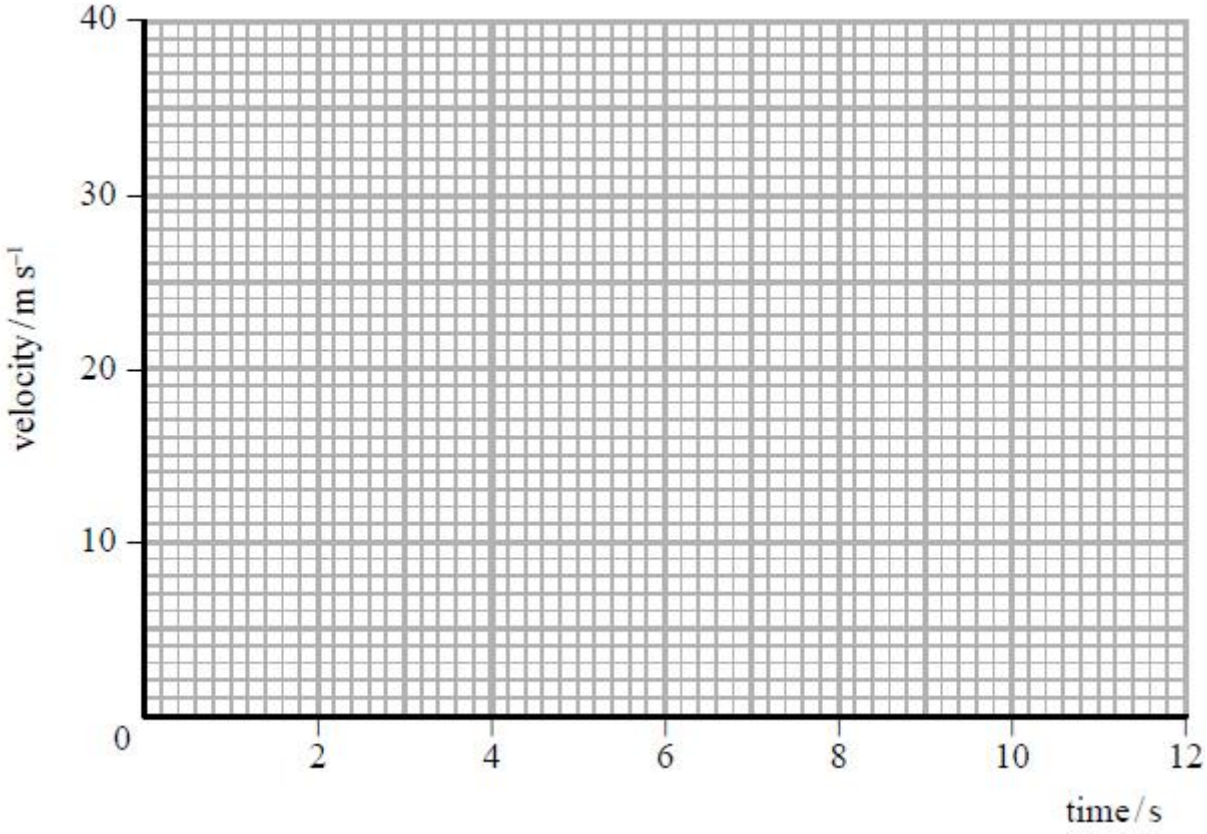


(source: http://tracksideviews.com/tag/motorway/)

A car is travelling along the motorway at $31 ms^{-1}$. The driver sees stationary traffic 180 m ahead. After 0.6 s the driver reacts by applying a constant braking force that stops the car in 10 s.

(i) Draw a velocity-time graph of the car's motion, from the instant the driver sees the stationary traffic until the car stops.

(1)



(ii) Analyse the data to determine whether the car stops without colliding with the stationary traffic.

(2)

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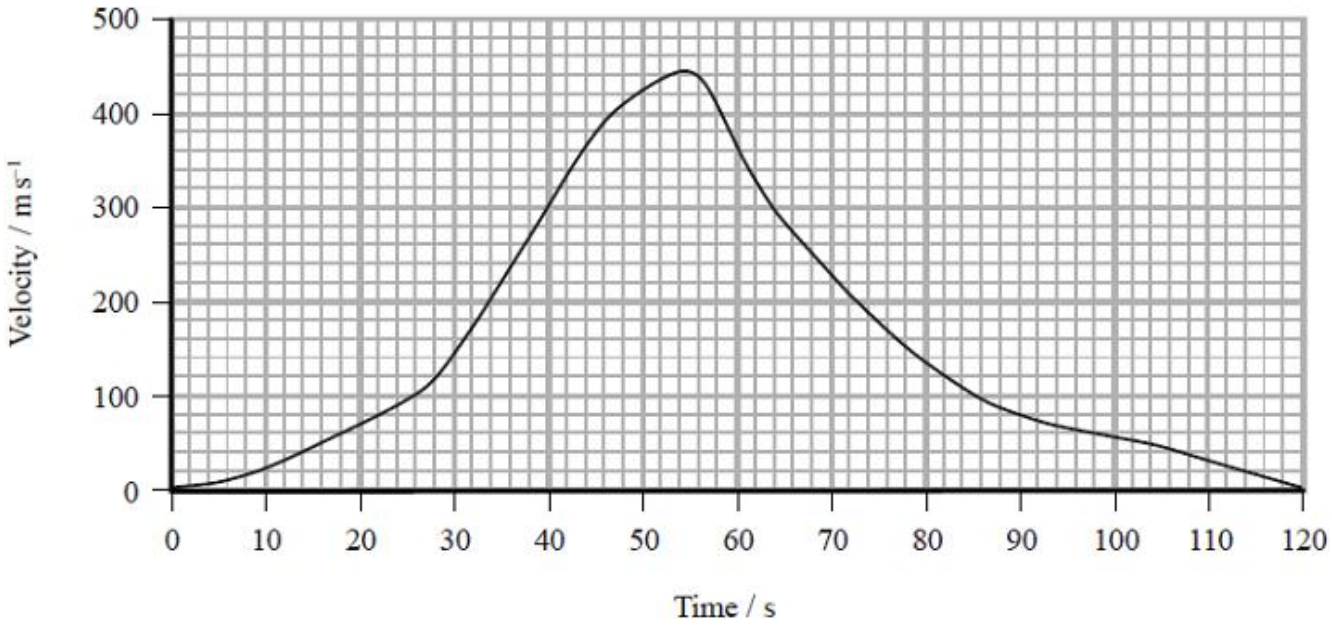
(Total for question = 3 marks)

Q20.

The world land speed record of 341 m s^{-1} was set in October 1997. In an attempt to break this record, a new supersonic car has been developed called the Bloodhound.



The developers of the Bloodhound have used computer modelling to produce a velocity-time graph for the predicted motion of the car, on a straight track, during the record attempt.



The car has two different engines: a jet engine providing a thrust of 89 kN and a rocket engine providing a thrust of 120 kN.

(i) The jet engine runs throughout the car's acceleration stage. The rocket engine runs for only part of that stage.

State the time at which the rocket engine is started during the car's predicted motion.

(1)

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(ii) Use the graph to determine the maximum positive acceleration of the car.

(2)

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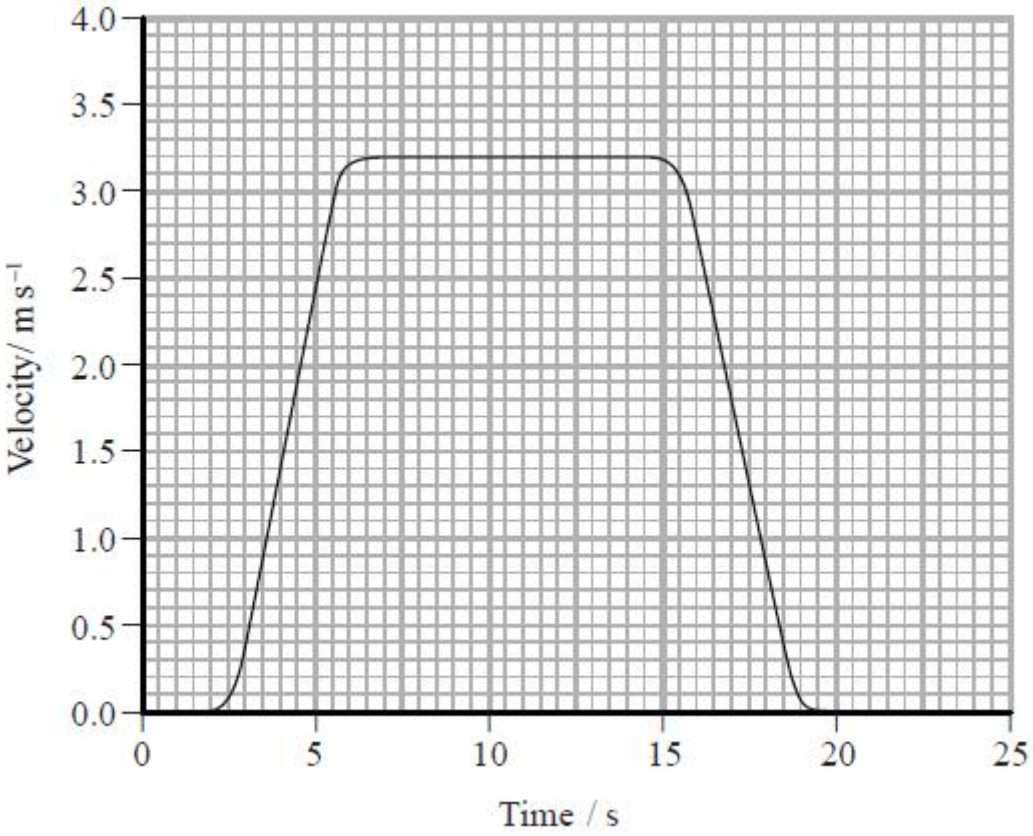
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Maximum positive acceleration of the car = ...

(Total for question = 6 marks)

Q21.

A lift moves upwards from the ground to the tenth floor of a building. The velocity-time graph for the lift is shown.



(i) Calculate the magnitude of the maximum acceleration of the lift.

(2)

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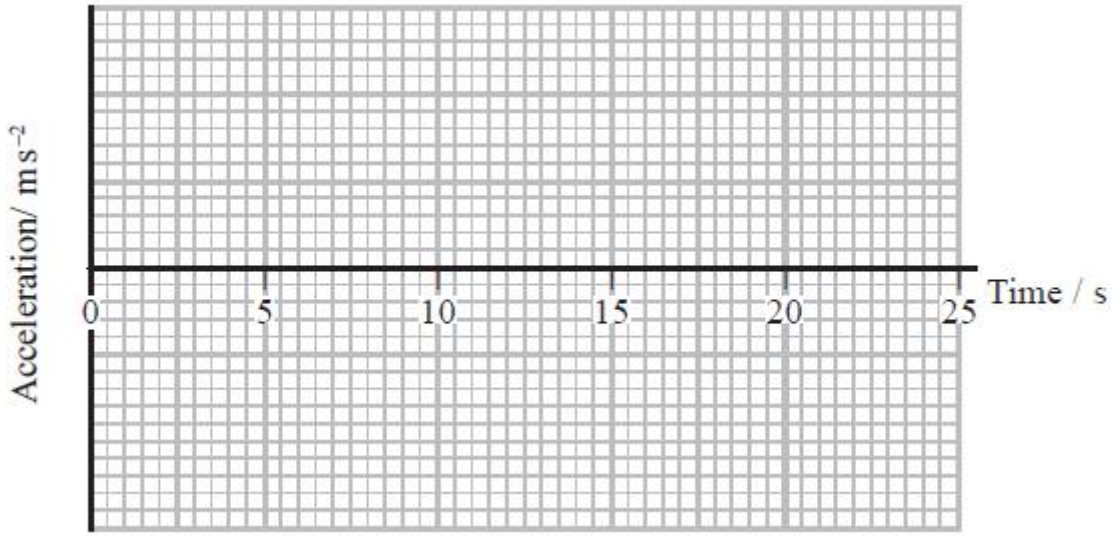
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Maximum acceleration = ...

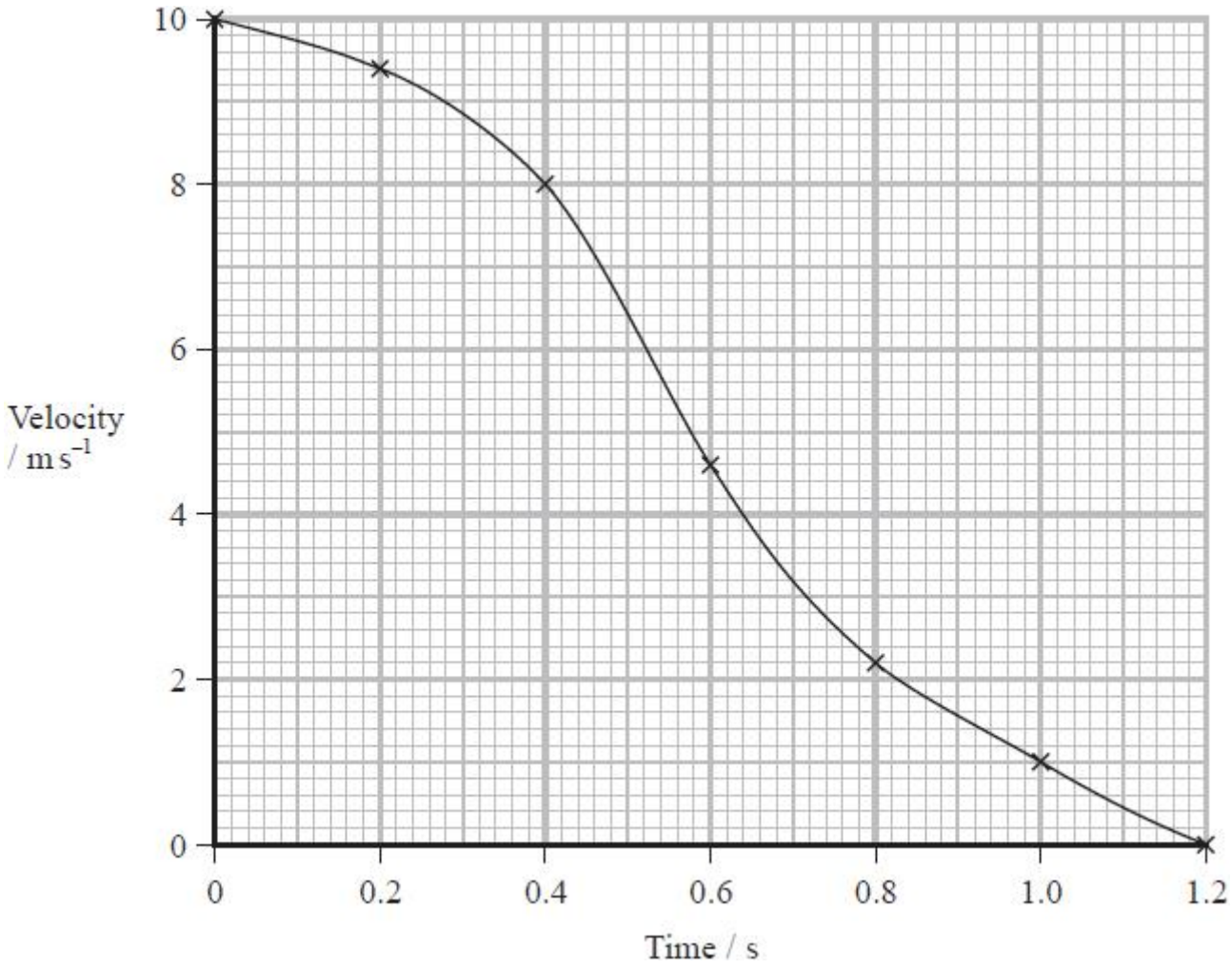
(ii) Sketch the corresponding acceleration-time graph on the axes below.

(3)



Q22.

A sprinter crossed the finish line of a race and then decelerated to rest. The graph shows how the velocity of the sprinter varied with time once the sprinter had crossed the finish line.



Determine the distance travelled by the sprinter whilst decelerating to rest.

(3)

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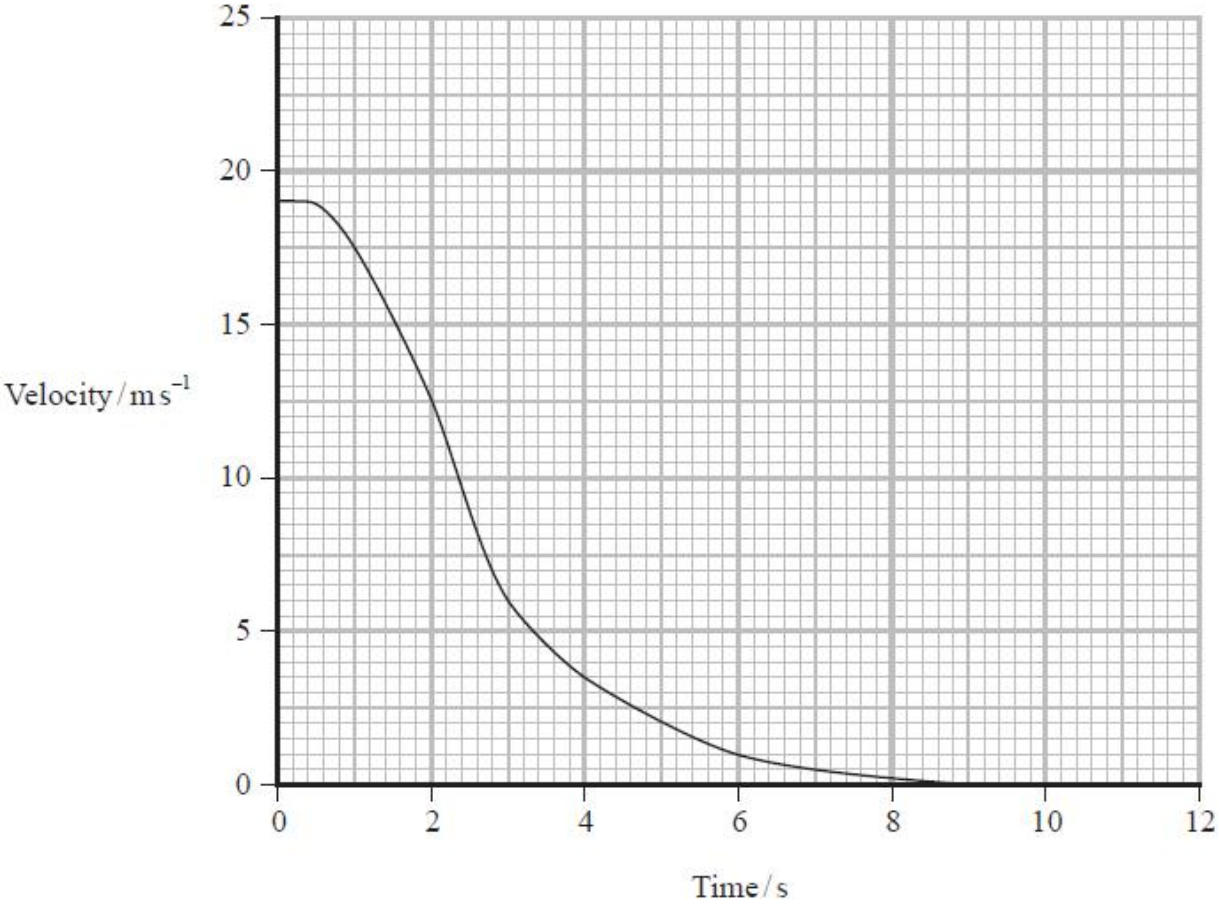
Distance = ... m

(Total for question = 3 marks)

Q23.

A very steep road may have a lane to the side, filled with deep gravel. A vehicle with brake failure can drive onto the lane and will be brought to rest as the vehicle's wheels sink into the gravel.

The graph shows the decrease in velocity of a van as it comes to rest in the gravel.



(i) Calculate the maximum decelerating force on the van.

mass of van = 2400 kg

(4)

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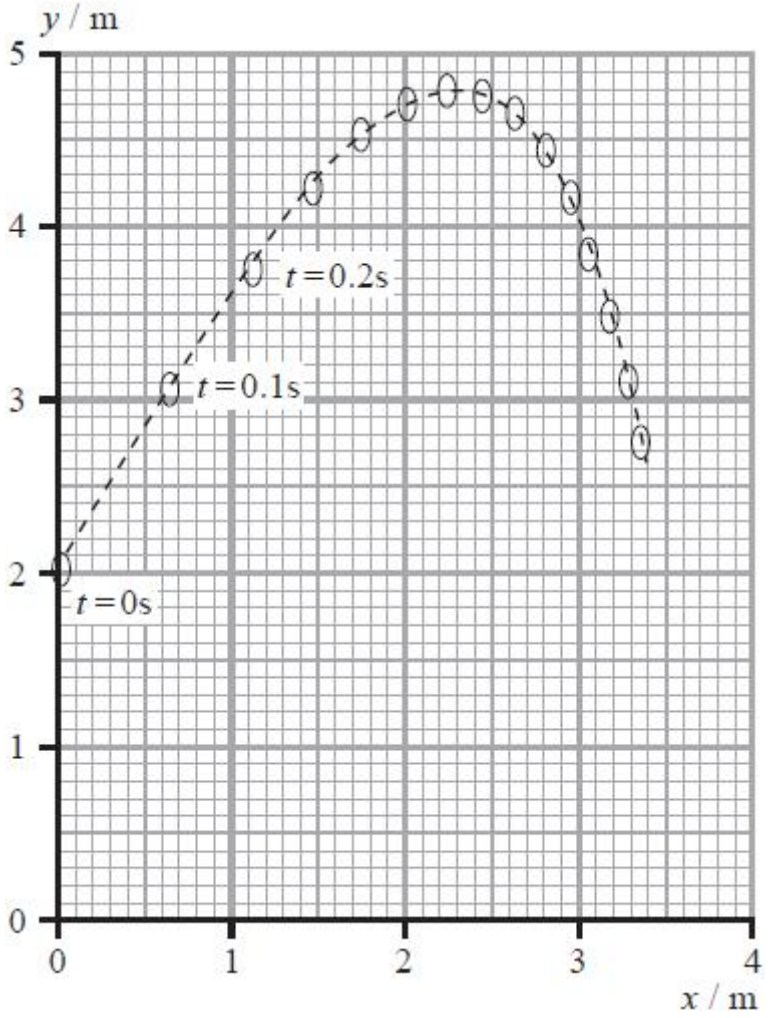
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Maximum decelerating force = ... N

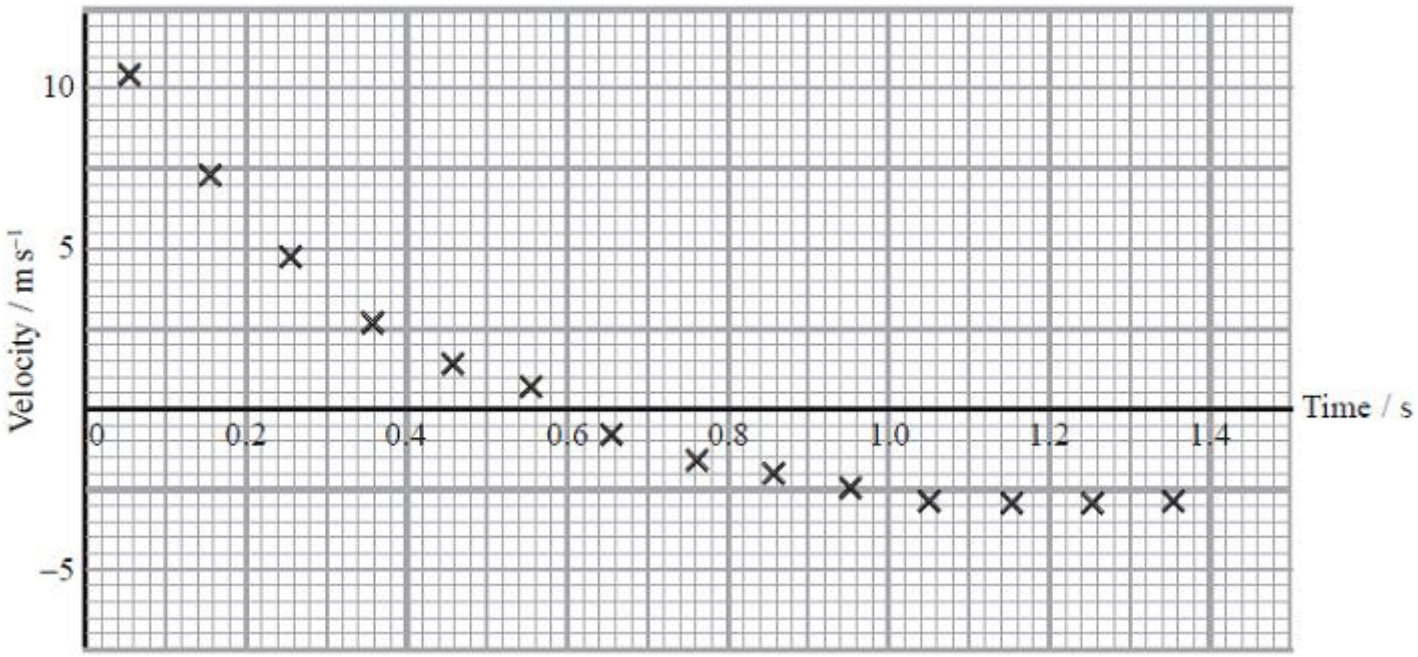
(Total for question = 4 marks)

Q24.

In a game of badminton, a shuttlecock is hit by a racket. The graph shows how the vertical displacement (y) and horizontal displacement (x) of the shuttlecock vary from the moment it leaves the racket. The positions are recorded every 0.10 s.



The graph below shows how the velocity of the shuttlecock in the vertical direction varies with time.



(iv) Show, using the velocity-time graph, that the maximum height gained by the shuttlecock is about 3 m.

(3)

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(Total for question = 9 marks)

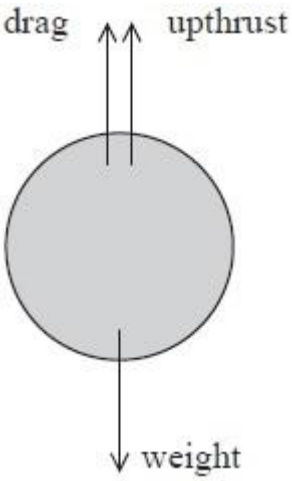
Q25.

The Greek philosopher Aristotle (4th Century BC) stated that heavy objects fall more quickly than lighter objects.

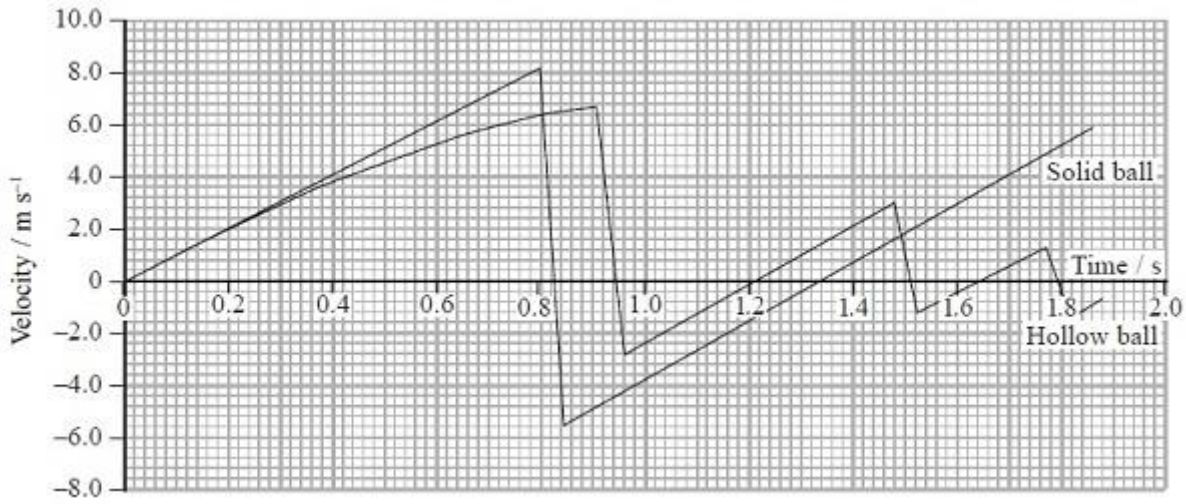
In the 17th Century Galileo reported that a cannon ball and a much smaller musket ball, dropped at the same time, reached the ground together.

A student carries out an experiment, dropping two balls of the same size at the same time. One of the balls is hollow and the other is solid.

The diagram shows the forces acting on each ball as it falls.



The velocity-time graph shows the motion of the two balls from the time they are dropped.



(a) State how the graphs show that neither ball reaches terminal velocity.

(1)

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(b) (i) By drawing a tangent to the graph, show that the acceleration of the hollow ball at time t = 0.60 s is about 7ms^{-2}.

(2)

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(ii) Show that the resultant force on the hollow ball at t = 0.60s is about 0.02 N.

mass of hollow ball = 2.4 g

(2)

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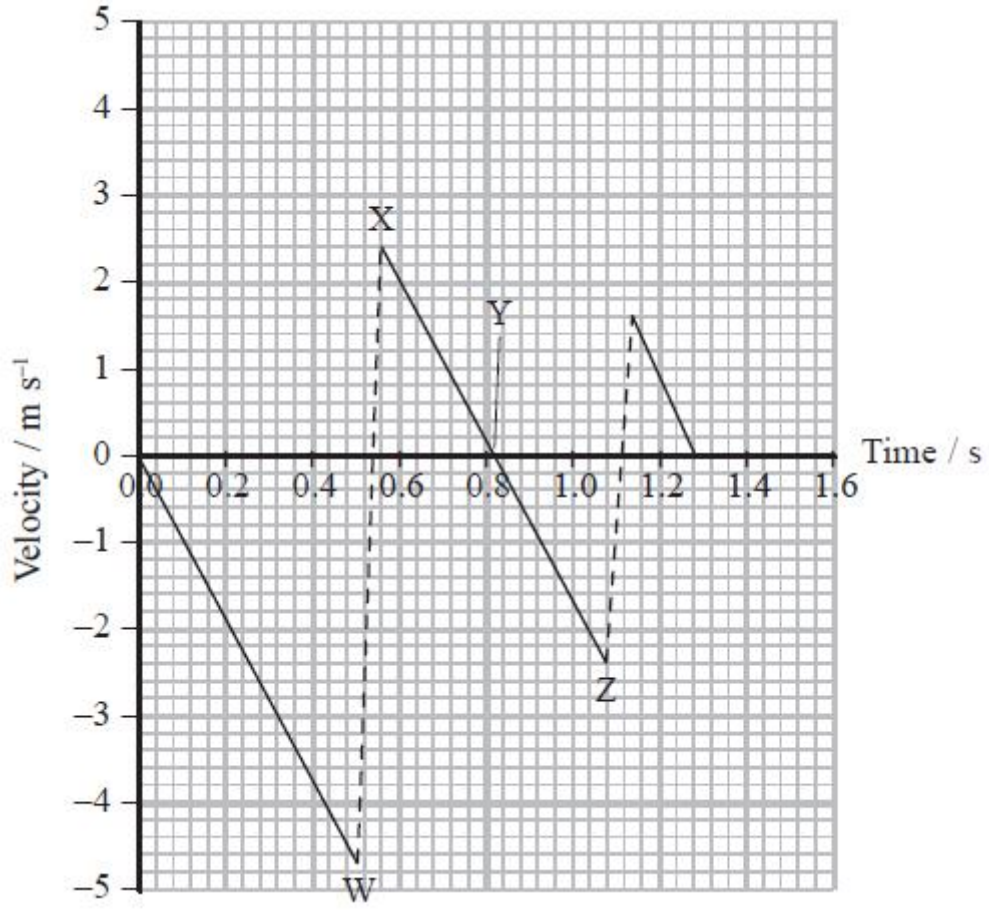
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(Total for Question = 5 marks)

Q26.

A basketball is dropped vertically onto the horizontal ground and bounces twice before being caught. The graph shows how the velocity of the basketball varies with time.



(a) Suggest why the downward sloping lines are all parallel.

(1)

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(b) (i) State the reason for the upwardly sloping dotted lines.

(1)

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(ii) Describe how the gradient of the dotted lines would change if the basketball was not fully inflated.

(1)

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(c) Calculate the initial height through which the basketball fell.

(2)

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Height = ...

(Total for question = 5 marks)