

Velocity Time Graphs

Mark Scheme



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1. A velocity time graph is a visual record of an object's motion, showing exactly how its speed increases, decreases, or stays constant over time. Out of the two types of motion graphs these ones are the much more likely to come up in the GCSE as these are considered more difficult.

For each of the following questions **circle** the letter of the correct answer.

- a) The graph below shows the motion of a cyclist. They accelerate steadily from rest to 12.0 m/s in 6.0 s.

How far does the cyclist travel in the last four seconds?

D – is the only correct answer.	1 mark
	Total: 1 mark

- b) The velocity time graph for a drone is shown below.

During which regions of the graph is the drone **accelerating or decelerating**?

C – is the only correct answer.	1 mark
	Total: 1 mark

- c) The velocity-time graph shows a car pulling away from a set of traffic lights.

What is the acceleration of the car?

B – is the only correct answer.	1 mark
	Total: 1 mark

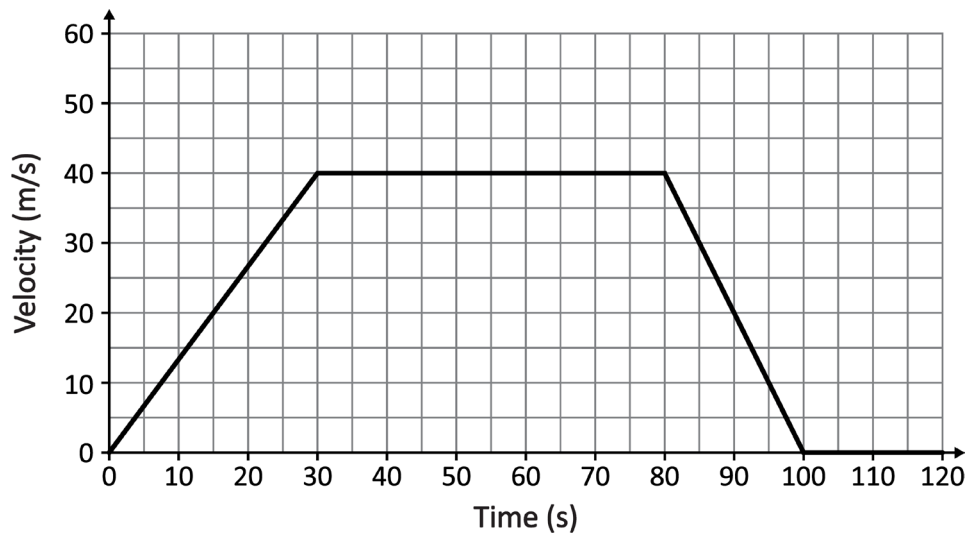
- d) The velocity-time graph shows a cyclist traveling at a constant speed before applying the brakes.

What is the total distance travelled by the cyclist over the 8 seconds shown?

C – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 4 marks)

2. The figure below shows the velocity time graph for a train travelling between two stations.



a) State the total time the train spends travelling at a constant top speed.

50 (s)	1 mark
	Total: 1 mark

b) Calculate the acceleration of the train as it leaves the first station.

Acceleration = gradient	
Gradient = $40 \div 30$	1 mark
Acceleration = 1.33	1 mark
Unit: m/s²	1 mark
	Total: 3 marks

c) Calculate the total distance travelled by the train while it is decelerating.

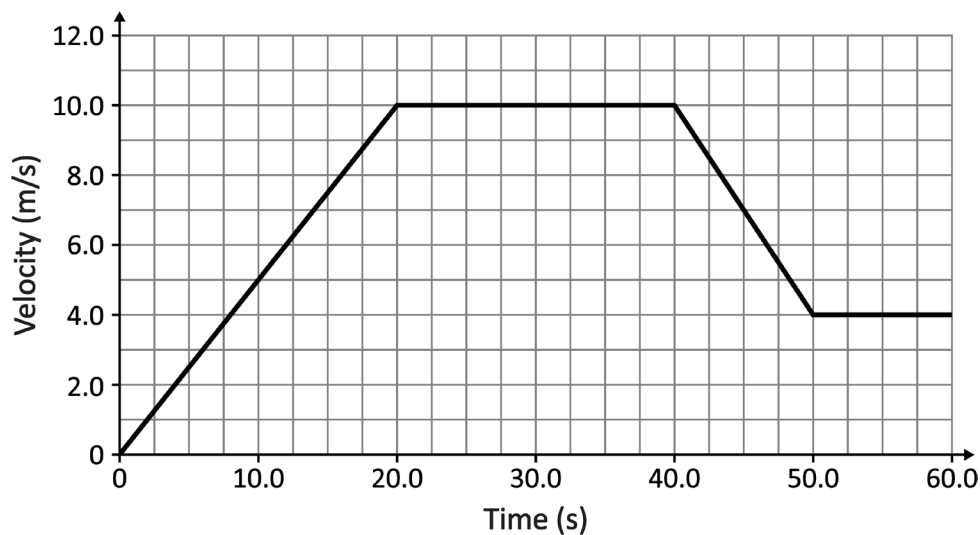
Distance = area under the graph	
Area of deceleration triangle = $\frac{1}{2} \times \text{base} \times \text{height}$	1 mark
Base = $100 - 80 = 20 \text{ s}$	
Distance = 400 (m)	1 mark
	Total: 2 marks

d) Determine the total distance between the two stations. Show your working.

Distance = area under the graph	1 mark
Marking note: this can be done by breaking the shape into three and finding the area of each then adding them up or using the area of a trapezium. Except either as long as the answer is correct.	
Area under the graph = $600 + 2000 + 400 = \mathbf{3000 \text{ m}}$	1 mark
	Total: 2 marks

(Total for Question 2 is 8 marks)

3. The figure below shows the velocity time graph for a cyclist travelling along a road.



The cyclist accelerates to their top speed and travels along a flat road.

They then encounter a steep hill, which causes them to slow down to a lower constant speed.

- a) State the cyclist's maximum velocity.

10.0 (m/s)	1 mark
	Total: 1 mark

- b) Calculate the distance the cyclist travelled while moving at this maximum velocity.

Distance = area under the flat section of the graph	1 mark
Area = base $\times$ height	
Area = $(40 - 20) \times 10$	
Area = $20 \times 10 = 200$ (m)	1 mark
	Total: 2 marks

- c) Determine the total distance the cyclist travelled during the first **50 seconds** of their journey.

Show your working.

Total distance = total area under graph up to 50s	
Area of first triangle: $0.5 \times 20 \times 10 = 100$ m	
Area of the first rectangular section: $10 \times 20 = 200$ m	
Area of second triangle: $0.5 \times 10 \times 6 = 30$ m	
Area of the second rectangular section: $4 \times 10 = 40$ m	1 mark
Total area = 370 m	1 mark
	Total: 2 marks

(Total for Question 3 is 5 marks)

4. A skydiver jumps from a plane.

The velocity time graph below shows their motion during the first 10 seconds of the jump.

- a) During the first 8 seconds, the skydiver's acceleration decreases.

Explain, in terms of the forces acting on the skydiver, why the acceleration decreases.

An explanation to include:	
As speed increases, the upward force of air resistance increases.	1 mark
This reduces the overall downward resultant force, which causes the acceleration to decrease ($a = F \div m$).	1 mark
	Total: 2 marks

- b) The skydiver reaches a terminal velocity of 60 m/s.

Convert this terminal velocity into km/h.

$60 \div 1000 = 0.06 \text{ km/s}$	1 mark
$0.06 \times 3600 = 216 \text{ km/h}$	1 mark
	Total: 2 marks

- c) By estimating the area under the graph, calculate the total distance the skydiver falls during the first 8 seconds. You must show clearly on the graph how you obtained your answer.

$1 \text{ square} = 1 \text{ s} \times 10 \text{ m/s} = 10 \text{ m}$	1 mark
There are roughly 32 to 34 full squares under the curve.	1 mark
$33 \text{ squares} \times 10 \text{ m}$	1 mark
Total distance: $33 \text{ squares} \times 10 \text{ m} = 330 \text{ m}$	1 mark
	Total: 4 marks

- d) The skydiver has a mass of 85 kg.

Calculate the resultant force acting on the skydiver at exactly $t = 9 \text{ s}$.

Resultant force = 0 (N)	2 marks
	Total: 2 marks

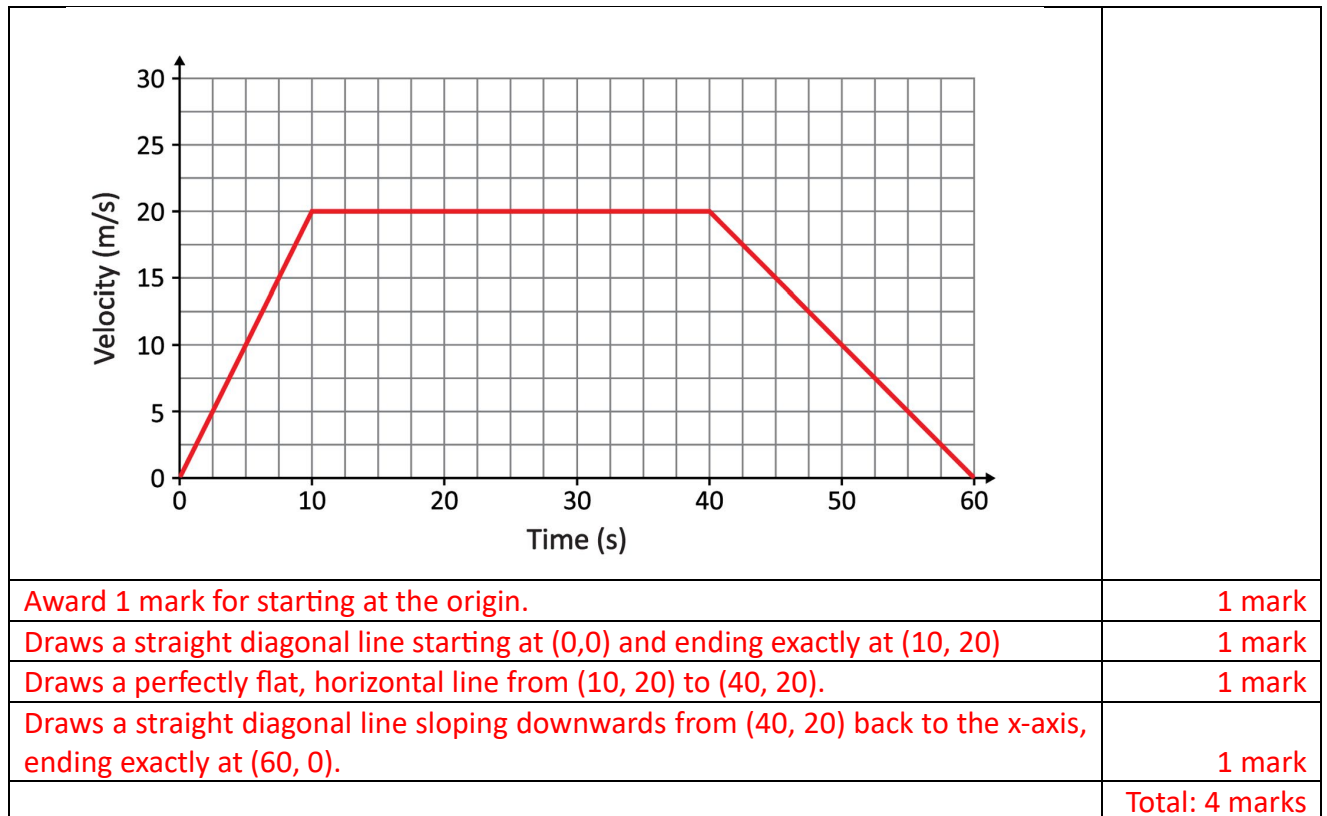
(Total for Question 4 is 10 marks)

5. A car is waiting at a red traffic light on a straight road. When the light turns green, the car begins its journey.

Here is a description of the car's journey:

- **0 to 10 seconds:** The car accelerates uniformly from rest to a velocity of **20 m/s**.
- **10 to 40 seconds:** The car travels at a constant velocity.
- **40 to 60 seconds:** The driver sees a hazard ahead and applies the brakes. The car decelerates uniformly and comes to a complete stop.

- a) Use the information above to draw a complete velocity time graph of the car's journey.



- b) Calculate the deceleration of the car during the final 20 seconds of the journey.

$\text{deceleration} = \text{change in velocity} \div \text{time}$	1 mark
$\text{deceleration} = (0 - 20) \div 20 = 1 \text{ m/s}^2$	1 mark
	Total: 2 marks

- c) The car has a mass of 1200 kg.

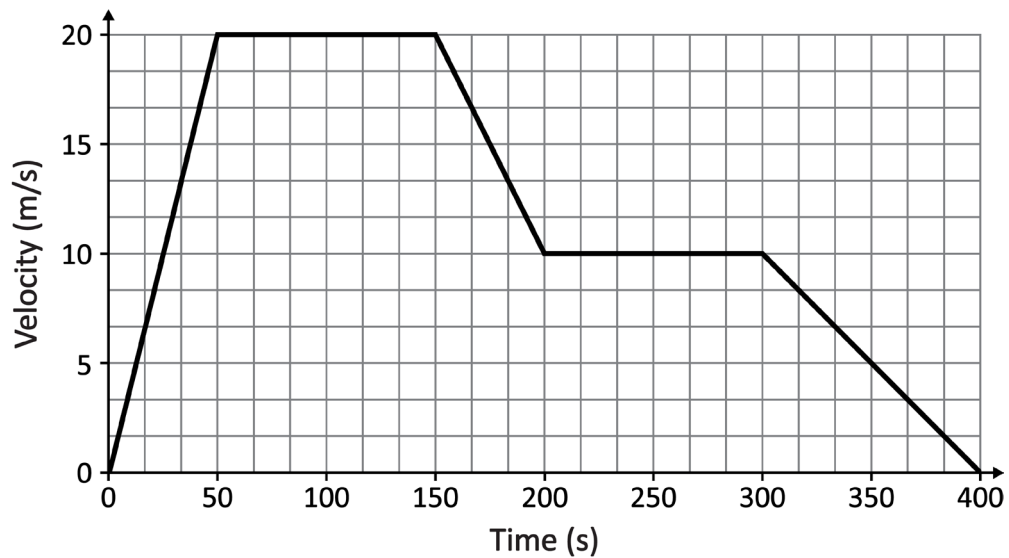
Calculate the resultant braking force required to stop the car during the final 20 seconds.

$\text{Force} = \text{mass} \times \text{acceleration}$	1 mark
$\text{Force} = 1200 \times 1 = 1200 \text{ N}$	1 mark
	Total: 2 marks

(Total for Question 5 is 8 marks)

6. A small passenger ferry travels between two ports.

The velocity time graph below shows the ferry's journey from port to port.



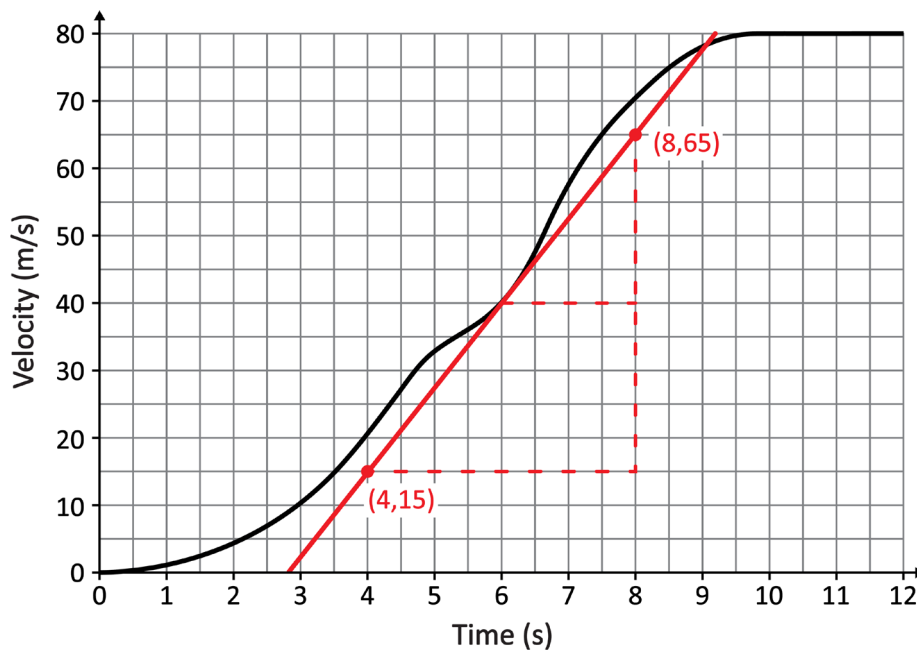
Calculate the total distance travelled by the ferry during the entire journey.

You **must** show all of your working. You may add lines to the graph to help you.

Total distance = total area under graph up to 50s	
Area of first triangle: $0.5 \times 50 \times 20 = 500 \text{ m}$	
Area of the first rectangular section: $100 \times 20 = 2000 \text{ m}$	
Area of second triangle: $0.5 \times 50 \times 10 = 250 \text{ m}$	
Area of the second rectangular section: $50 \times 10 = 500 \text{ m}$	
Area of the third rectangular section: $100 \times 10 = 1000 \text{ m}$	
Area of third triangle: $0.5 \times 100 \times 10 = 500 \text{ m}$	5 marks
Total area = 4750 m	1 mark
	Total: 6 marks

(Total for Question 6 is 6 marks)

7. A prototype electric hypercar is being tested on a test track.



a) The car has a mass of 1850 kg. Determine the acceleration of the hypercar at exactly $t = 6$ s.

You **must** show clearly on the graph how you obtained your answer.

Student draws a straight line touching the curve exactly at $t = 6$ s.	1 mark
Gradient = change in $y \div$ change in x	1 mark
Gradient = $50 \div 4$	1 mark
Acceleration = $12.5 \text{ (m/s}^2\text{)}$	1 mark
Accept a reasonable range of answers, e.g., 11.0 to 14.0 m/s^2	
	Total: 4 marks

b) Use your answer to part (a) to calculate the resultant force acting on the hypercar at $t = 6$ s.

$F = m \times a$	1 mark
$F = 1850 \times 12.5$ Force = 23,125 (N)	1 mark
	Total: 2 marks

c) By estimating the area under the curve, calculate the total distance the hypercar travels during the first 8 seconds of the test.

Determine the value of one grid square:	
1 square = $1 \text{ s} \times 10 \text{ m/s} = 10 \text{ m}$	1 mark
Count the squares under the curve between 0 s and 8 s:	
There are roughly 26 to 28 full squares under the curve up to the 8s line.	1 mark
Calculate total distance: 27 squares $\times 10 \text{ m} = 270 \text{ m}$ Accept between 260 – 280	2 marks
	Total: 4 marks

(Total for Question 7 is 10 marks)