

Real-Life and Distance-Time Graphs - Higher

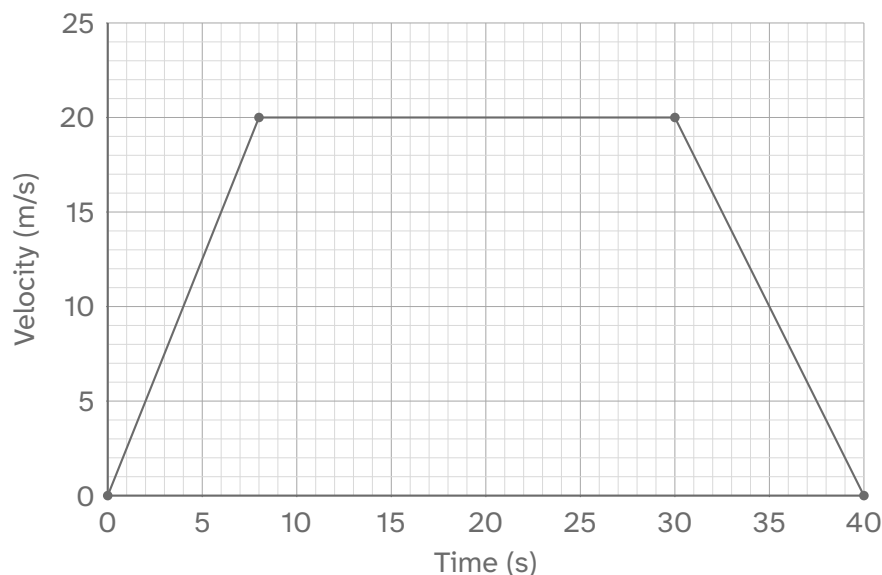
Solutions

For AQA GCSE Mathematics (8300) • Higher tier

Each question is shown in grey, followed by the working, one step per line. The final answer is in a box. *Marks* shows how the marks are usually given in the exam, and **Tip** points out a common mistake.

1 (9 marks)

The velocity-time graph shows a car journey of 40 seconds.



(a) Describe the motion of the car between 8 seconds and 30 seconds.

Between 8 and 30 seconds the graph is a horizontal line at 20 m/s.

A horizontal line on a velocity-time graph means the velocity is not changing.

Answer: Constant velocity of 20 m/s

Tip: Horizontal on a **velocity**-time graph means moving at a steady speed. It only means “stopped” on a **distance**-time graph.

- (b) Work out the acceleration during the first 8 seconds.

Acceleration is the gradient of a velocity-time graph.

The velocity goes up from 0 to 20 m/s in 8 seconds.

$$\text{Gradient} = 20 \div 8$$

$$= 2.5$$

Answer: 2.5 m/s²

Marks: 1 mark for $20 \div 8$. 1 mark for 2.5.

- (c) Work out the deceleration during the last 10 seconds.

The velocity falls from 20 m/s to 0 between 30 and 40 seconds.

$$\text{Deceleration} = 20 \div 10$$

$$= 2$$

Answer: 2 m/s²

- (d) Work out the total distance travelled.

The distance travelled is the area under a velocity-time graph.

The shape under the graph is a trapezium.

Its parallel sides are 40 s (the bottom) and $30 - 8 = 22$ s (the top).

Its height is 20 m/s.

$$\text{Area} = \frac{1}{2}(22 + 40) \times 20$$

$$= 620$$

Or split it into a triangle, a rectangle and a triangle:

$$\frac{1}{2} \times 8 \times 20 + 22 \times 20 + \frac{1}{2} \times 10 \times 20$$

$$= 80 + 440 + 100 = 620$$

Answer: 620 m

Tip: Remember to halve for a triangle: area = $\frac{1}{2} \times$ base $\times$ height. Forgetting the $\frac{1}{2}$ is a very common mistake.

Marks: 1 mark for one correct area, e.g. 80 or 440. 1 mark for a full method for the total area. 1 mark for 620.

- (e) Work out the average speed for the 40 seconds.

Average speed = total distance $\div$ total time

$$= 620 \div 40$$

$$= 15.5$$

Answer: 15.5 m/s

Marks: 1 mark for your answer to part (d) $\div 40$. 1 mark for the answer (follow-through from part (d)).

2 (4 marks)

Lowri leaves home at 09:00 and cycles to a park.

She cycles at a constant speed of 18 km/h for 40 minutes to reach the park.

She stays at the park for 30 minutes.

She then cycles home at a constant speed and arrives home at 10:30

- (a) On the grid, draw a distance-time graph for her journey.

The speed is in km/h, so change the time into hours.

$$40 \text{ minutes} = \frac{40}{60} = \frac{2}{3} \text{ hour.}$$

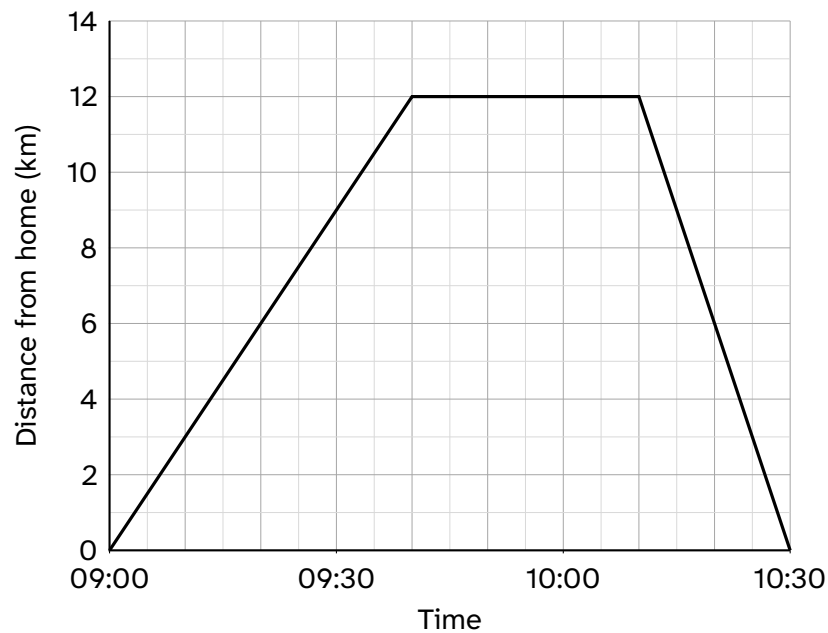
$$\text{Distance to the park} = 18 \times \frac{2}{3} = 12 \text{ km}$$

She reaches the park at 09:40, so draw a straight line from (09:00, 0) to (09:40, 12).

She stays for 30 minutes, so her distance from home stays at 12 km until 10:10.

Draw a horizontal line from (09:40, 12) to (10:10, 12).

She is back home at 10:30, so draw a straight line from (10:10, 12) to (10:30, 0).



Tip: There are 60 minutes in an hour, not 100. So 40 minutes is $\frac{2}{3}$ of an hour, not 0.4 hours.

Marks: 1 mark for a line from (09:00, 0) to (09:40, 12). 1 mark for a horizontal line lasting 30 minutes. 1 mark for a line back to 0 km at 10:30.

(b) Work out her speed on the way home.

She cycles 12 km home in 20 minutes.

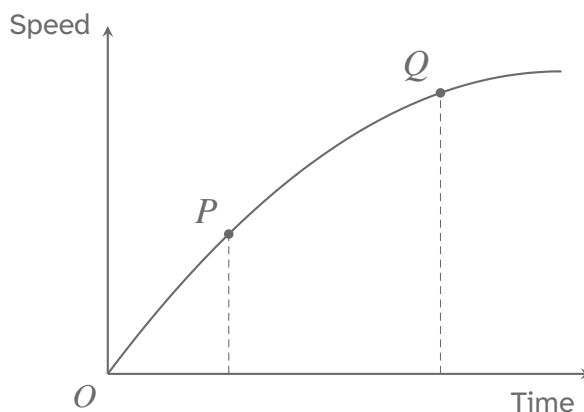
$$20 \text{ minutes} = \frac{1}{3} \text{ hour}$$

$$\text{Speed} = 12 \div \frac{1}{3} = 36$$

Answer: 36 km/h

3 (2 marks)

Here is a sketch of a speed-time graph for a cyclist.



- (a) Which of these represents the acceleration at P ?

Tick **one** box.

Acceleration is the rate of change of speed.

At one moment, this is how steep the speed-time graph is at that point.

So it is the gradient of the tangent at P .

Answer: The gradient of the tangent at P

Tip: The chord from O to P gives the **average** acceleration from the start to P , not the acceleration at P .

- (b) Which of these is represented by the area under the graph between P and Q ?

Tick **one** box.

On a speed-time graph, area = speed $\times$ time.

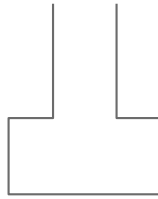
Speed $\times$ time = distance.

So the area between P and Q is the distance travelled between P and Q .

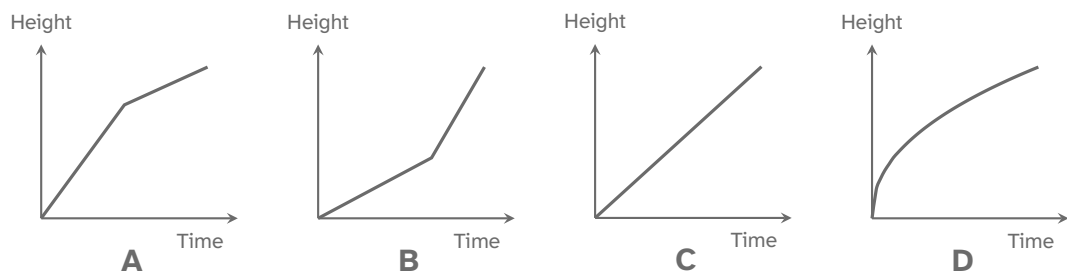
Answer: The distance travelled between P and Q

4 (3 marks)

Water flows at a constant rate into this empty container.



- (a) Which graph shows how the height of the water changes as the container fills?
Circle the letter of the correct graph.



Options: A, B, C, D

The container has two parts with straight sides, so the graph has two straight sections.

The bottom part is wide, so the height rises slowly at first (a shallow line).

The top part is narrow, so the height then rises quickly (a steeper line).

So the answer is graph B.

Answer: B

Tip: Wide part: the water level rises slowly. Narrow part: it rises quickly.

- (b) Water flows at a constant rate into a different empty container, shown below.



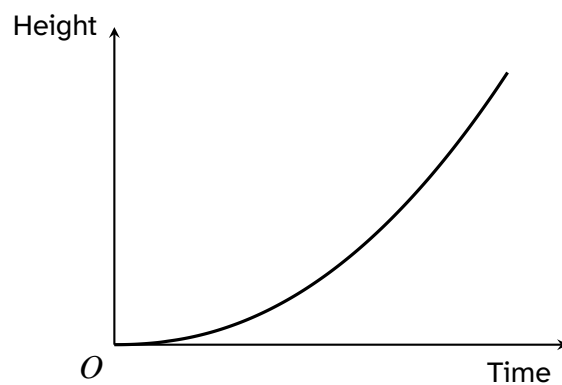
On the axes, sketch a graph to show how the height of the water changes as the container fills.

This container is wide at the bottom and gets narrower towards the top.

At first the water spreads over a wide area, so the height rises slowly.

As the container gets narrower, the height rises more and more quickly.

So the graph starts at O and is a curve that gets steeper.

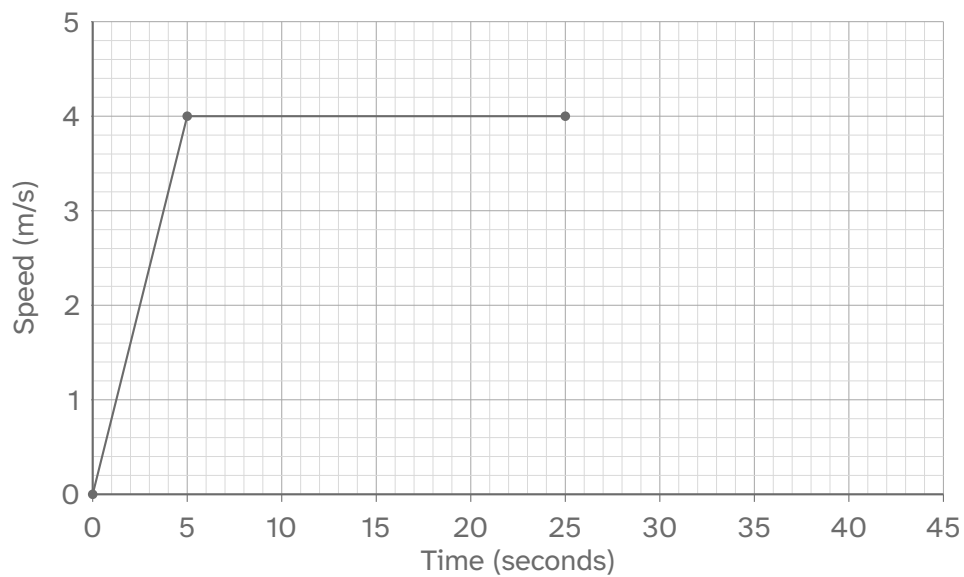


Tip: The sides slope, so the rate the height rises changes all the time. Draw a smooth curve, not straight lines.

Marks: 1 mark for a graph that starts at O and goes up. 1 mark for a curve that gets steeper.

5 (4 marks)

A lift travels 150 metres from the ground floor to the top floor of a tower.
The speed-time graph shows the first 25 seconds of the journey.



After 25 seconds, the lift continues at the same speed.
It then slows down at a constant rate and stops at the top floor.
It takes 4 seconds to slow down.

Work out the total time for the journey.

The distance travelled is the area under the speed-time graph.

First 5 seconds (triangle): $\frac{1}{2} \times 5 \times 4 = 10$ m

From 5 to 25 seconds (rectangle): $20 \times 4 = 80$ m

Distance in the first 25 seconds = $10 + 80 = 90$ m

Distance left = $150 - 90 = 60$ m

Last 4 seconds (triangle): $\frac{1}{2} \times 4 \times 4 = 8$ m

So the lift travels $60 - 8 = 52$ m at 4 m/s after 25 seconds.

Time for this part = $52 \div 4 = 13$ seconds

Total time = $25 + 13 + 4 = 42$ seconds

Answer: 42 seconds

Tip: The lift is still moving at 4 m/s at 25 seconds. Do not start slowing it down straight away.

Marks: 1 mark for 90. 1 mark for 8 (the area of the last triangle). 1 mark for $52 \div 4$ or 13. 1 mark for 42.

6 (6 marks)

A van is travelling along a straight road.

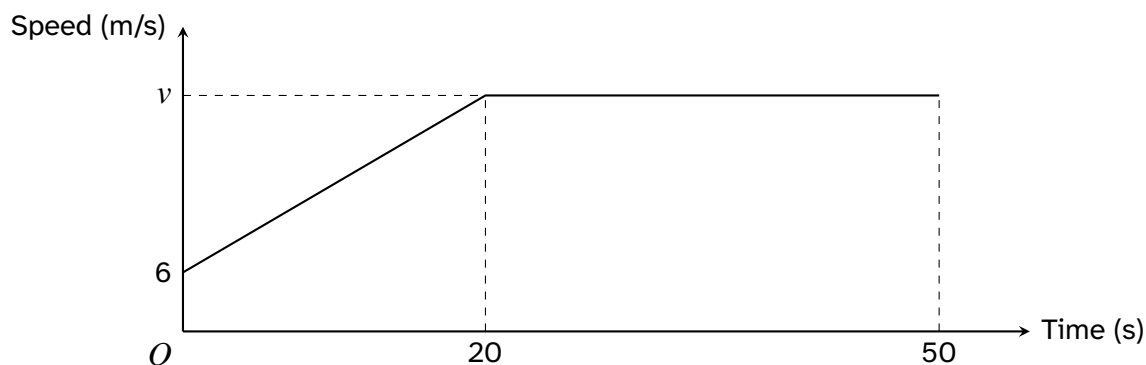
At the start, the speed of the van is 6 m/s

For the first 20 seconds, its speed increases at a constant rate to v m/s

For the next 30 seconds, it travels at a constant speed of v m/s

In the 50 seconds, the van travels 1020 metres.

Here is a sketch of its speed-time graph.



Not drawn accurately

(a) Work out the value of v .

The distance, 1020 m, is the area under the graph.

First 20 seconds (trapezium): $\frac{1}{2}(6 + v) \times 20 = 60 + 10v$

Last 30 seconds (rectangle): $30v$

Total area: $60 + 10v + 30v = 1020$

$60 + 40v = 1020$

$40v = 960$

$$v = 24$$

Answer: $v = 24$

Tip: The graph does not start at 0. The first shape is a trapezium with parallel sides 6 and v , not a triangle.

Marks: 1 mark for the trapezium area in terms of v . 1 mark for $30v$. 1 mark for an equation with total area = 1020. 1 mark for $v = 24$.

- (b) Work out the acceleration of the van in the first 20 seconds.
State the units of your answer.

Acceleration is the gradient of a speed-time graph.

The speed goes up from 6 m/s to 24 m/s in 20 seconds.

$$\text{Acceleration} = (24 - 6) \div 20$$

$$= 0.9$$

The units are metres per second squared, m/s^2 .

Answer: 0.9 m/s^2

Tip: The unit of acceleration is m/s^2 (metres per second squared), not m/s .

Marks: 1 mark for 0.9 (follow-through from your v). 1 mark for the units m/s^2 .