

The distance–time relationship

6.5.4.1.4 · Physics · revision notes

A distance–time graph shows how far an object is from a point as time goes on. You need to draw them from measurements, describe motion from their shape and find speed from the gradient.

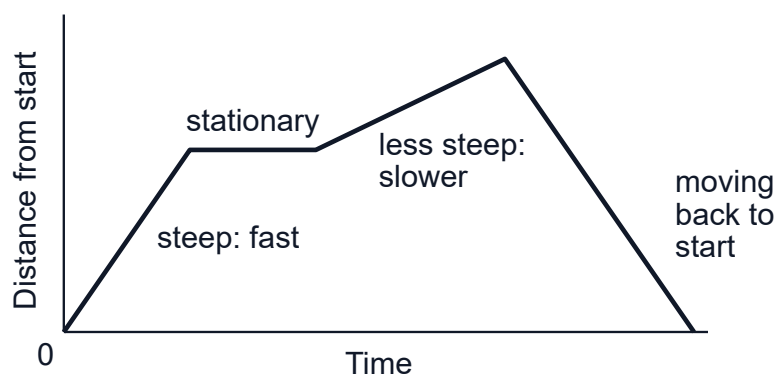
Key facts

- Distance–time graph: gradient = speed
- Horizontal line = stationary
- Straight sloping line = constant speed
- Steeper line = greater speed
- Curve getting steeper = accelerating; getting less steep = decelerating
- Average speed = total distance ÷ total time

Notes

Reading a distance–time graph

- Distance is on the y-axis and time is on the x-axis.
- A **horizontal** line means the object is stationary: its distance is not changing.
- A **straight sloping** line means the object is moving at a constant speed. The steeper the line, the greater the speed.
- If distance is measured from a starting point, a line sloping back down towards the time axis means the object is moving back towards the start.



Reading a distance–time graph: the gradient is the speed.

Speed from the gradient

- Speed = gradient = change in distance ÷ change in time.
- Use two points far apart on a straight section and draw a large triangle.
- Example: from (2 s, 10 m) to (6 s, 34 m), speed = $(34 - 10) \div (6 - 2) = 24 \div 4 = 6$ m/s.
- Average speed for a whole journey = total distance ÷ total time, read from the start and end of the graph.

Curved lines: changing speed

- A curve that gets **steeper** shows that the object is **accelerating**.
- A curve that gets **less steep** shows that the object is **decelerating**.

Drawing the graph

- Put time on the x-axis and distance on the y-axis. Label both axes with units.
- Choose scales that use more than half the grid, plot the points accurately, then draw a line of best fit (a straight line or a smooth curve).

How to answer each type of question

Describe the motion shown by a graph

2 to 3 marks

Grade 3

1. Describe each section in turn.
2. Use the words stationary, constant speed, accelerating or decelerating.
3. Compare sections: 'faster than', 'slower than'.

Example. A distance–time graph for a jogger has three sections. A: a steep straight line. B: a horizontal line. C: a straight line that is less steep than A.
Describe the motion of the jogger in each section.

Model answer. A: constant speed (1)
B: stationary (1)
C: constant speed, slower than in A (1)

Calculate speed from the gradient

2 marks

Grade 5

1. Read two points on the straight line, far apart.
2. $\text{Speed} = \text{change in distance} \div \text{change in time}$.
3. Give the unit (usually m/s).

Example. The distance–time graph for a cyclist is a straight line from 0 m at 0 s to 450 m at 90 s.
Calculate the speed of the cyclist.

Model answer. $\text{speed} = 450 \div 90$ (1)
 $\text{speed} = 5.0 \text{ m/s}$ (1)

Don't lose marks

- ✗ Mixing up distance–time and velocity–time graphs: on a distance–time graph a horizontal line means stationary.
- ✗ Using a time axis in minutes but giving the gradient in m/s without converting.

More tips

Memory tricks

- Flat = stopped. Steep = fast.
- Gradient = rise $\div$ run = distance $\div$ time = speed.
- Use a big triangle for gradients: it reduces reading errors.

Exam technique

- Draw your gradient triangle on the graph and write down the values you read.
- When describing motion, use the key words stationary, constant speed, accelerating and decelerating, and compare sections.
- Check the axis units: time may be in minutes or hours, and distance in km.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Describe motion from a distance–time graph

A horizontal line means stationary; a straight sloping line means constant speed.

Grade 4

Plot a distance–time graph from data

Time on the x-axis, distance on the y-axis, labelled axes with units and sensible scales.

Grade 5

Calculate speed from the gradient

Speed = change in distance $\div$ change in time for a straight section.

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