

Deducing acceleration

AS Level

9702 AS Ch.2

Chapter 2: Accelerated motion

Lesson 2.4

Sections 2.4

Goal: Find acceleration from the gradient of a velocity-time graph.

01 The big picture

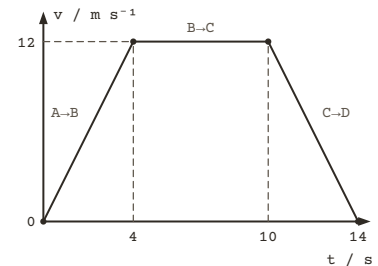
On a velocity-time graph the gradient is $\Delta v / \Delta t$, which is the acceleration. A steeper line means a larger acceleration; a horizontal line means constant velocity (zero acceleration); a line sloping down means the object is slowing.

A straight line means uniform acceleration. For a curved line, draw a tangent at the moment you want and find its gradient with a large triangle.

Gradient [paraphrase]

Change in velocity ÷ change in time, read from a large triangle on the line.

Fig. 1 · A velocity-time graph



Steeper line = larger acceleration. Flat = constant velocity. Downward slope = slowing down.

02 Key equations

Acceleration = gradient of v-t

$$a = \frac{\Delta v}{\Delta t}$$

Symbols and units

v	velocity	m s^{-1}	t	time	s	a	acceleration	m s^{-2}
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03 Sample problems with solutions

Sample 1 · Reading the graph

Use the graph in Fig. 1 to find the acceleration during each of the three stages.

Step 1. A to B:

$$a = \frac{12 - 0}{4 - 0} = 3.0 \text{ m s}^{-2}$$

Step 2. B to C: the line is horizontal, so the velocity is constant: $a = 0$.

Step 3. C to D: the gradient is negative, so it is slowing:

$$a = \frac{0 - 12}{14 - 10} = -3.0 \text{ m s}^{-2}$$

Answer: $+3.0 \text{ m s}^{-2}$, then 0, then -3.0 m s^{-2}

Unit check: $\frac{\text{m s}^{-1}}{\text{s}} = \text{m s}^{-2} \checkmark$

04 Practice problems

P1 What does a horizontal line on a velocity-time graph show?

Answer: Constant velocity (zero acceleration)

P2 A straight line goes from $(0 \text{ s}, 4.0 \text{ m s}^{-1})$ to $(5.0 \text{ s}, 14 \text{ m s}^{-1})$. Find the acceleration.

Answer: 2.0 m s^{-2}

P3 A tangent to a curved v-t graph passes through $(0 \text{ s}, 2.0 \text{ m s}^{-1})$ and $(4.0 \text{ s}, 10 \text{ m s}^{-1})$. Find the acceleration there.

Answer: 2.0 m s^{-2}

P4 A v-t line falls from 20 m s^{-1} to 0 in 8.0 s. Find the acceleration.

Answer: -2.5 m s^{-2}

05 Other useful information

Common mistakes

- ✗ **Wrong:** Read a horizontal v-t line as "at rest".
- ✓ **Right:** That is an s-t graph. On a v-t graph it means constant velocity.

Exam tips

- Check the axes first: s-t gradient = velocity; v-t gradient = acceleration.

What the syllabus asks

- 9702 topic 2: acceleration from the gradient of a v-t graph. Coursebook 2.4.

Explore: Practice questions for this lesson