

Deducing displacement

AS Level

9702 AS Ch.2

Chapter 2: Accelerated motion

Lesson 2.5

Sections 2.5

Goal: Find displacement from the area under a velocity–time graph.

01 The big picture

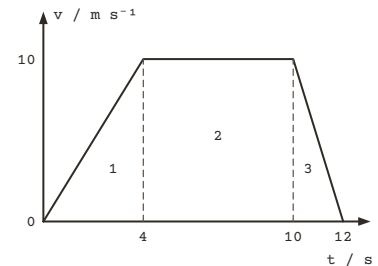
The area between a velocity–time graph and the time axis is the displacement: velocity $\times$ time, added up over the whole journey. Split the area into rectangles and triangles and add them.

Area below the time axis is negative displacement (moving back). For uniform acceleration the area is a trapezium, which gives $s = \frac{1}{2}(u + v)t$.

Area under a v–t graph [paraphrase]

The displacement during that time interval.

Fig. 1 · Area under a v–t graph



The shaded area is the displacement: two triangles and a rectangle.

02 Key equations

Displacement = area under v–t

$$s = \text{area under the } v\text{--}t \text{ graph}$$

Uniform acceleration (trapezium)

$$s = \frac{1}{2}(u + v)t$$

Symbols and units

s	displacement	m	u, v	initial, final velocity	m s^{-1}	t	time	s
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03 Sample problems with solutions

Sample 1 · Adding up the areas

Use the graph in Fig. 1 to find the total displacement and the average velocity for the 12 s journey.

Step 1. Area 1 (triangle) + area 2 (rectangle) + area 3 (triangle):

$$s = \frac{1}{2}(4)(10) + (6)(10) + \frac{1}{2}(2)(10) = 20 + 60 + 10 = 90 \text{ m}$$

Step 2. Average velocity = total displacement $\div$ total time:

$$\bar{v} = \frac{90}{12} = 7.5 \text{ m s}^{-1}$$

Answer: 90 m; average velocity 7.5 m s^{-1}

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

04 Practice problems

P1 A car travels at a constant 8.0 m s^{-1} for 15 s. Find the displacement.

Answer: 120 m

P2 A car accelerates uniformly from rest to 20 m s^{-1} in 10 s. Find the distance travelled.

Answer: 100 m

P3 A cyclist accelerates uniformly from 6.0 m s^{-1} to 14 m s^{-1} in 5.0 s. Find the displacement.

Answer: 50 m

P4 Part of a v–t graph lies below the time axis. What does that part show?

Answer: Moving in the negative direction (negative displacement)

05 Other useful information

Common mistakes

✗ **Wrong:** Use $s = vt$ when the velocity is changing.

✓ **Right:** Use the area: for uniform acceleration

$$s = \frac{1}{2}(u + v)t.$$

Exam tips

- Label the shapes 1, 2, 3 on the graph and write each area with its unit.

What the syllabus asks

- 9702 topic 2: displacement from the area under a v–t graph. Coursebook 2.5.

Explore: [Practice questions for this lesson](#)