

Speed and velocity

AS Level

9702 AS Ch.1

Chapter 1: Kinematics

Lesson 1.3

Sections 1.3

Goal: Calculate average velocity from displacement and contrast it with average speed.

01 The big picture

Velocity is the rate of change of displacement: speed in a stated direction. It is a vector, so it uses displacement, not distance.

In a straight line, choose one direction as positive; a negative velocity then means moving the other way. Average speed and average velocity differ whenever the motion turns back: a round trip has an average velocity of zero.

Velocity [paraphrase]

The rate of change of displacement (displacement per unit time), with a direction.

Average velocity [paraphrase]

Total displacement divided by total time.

02 Key equations

Average velocity (Δs : displacement)

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

Average speed (d : distance)

$$\text{speed} = \frac{d}{t}$$

Symbols and units

v	velocity	m s^{-1}	Δs	change in displacement	m	d	distance travelled	m
$\Delta t, t$	time	s						

03 Sample problems with solutions

Sample 1 · There and partly back

A car drives 300 m east in 20 s, then 100 m west in 10 s. Calculate its average speed and its average velocity for the whole trip.

Step 1. Speed uses the total distance:

$$\text{speed} = \frac{300 + 100}{20 + 10} = \frac{400}{30} = 13.3 \text{ m s}^{-1}$$

Step 2. Velocity uses the displacement (east positive):

$$v = \frac{300 - 100}{30} = \frac{200}{30} = 6.67 \text{ m s}^{-1}$$

Answer: average speed 13 m s^{-1} ; average velocity 6.7 m s^{-1} east

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

04 Practice problems

P1 A ball is thrown 5.0 m straight up and caught at the same height 2.0 s after it was thrown. Calculate its average speed and average velocity.

Answer: 5.0 m s^{-1} ; zero

P2 A train travels 12 km north in 10 minutes. Calculate its average velocity.

Answer: 20 m s^{-1} north

P3 Can an object have a constant speed but a changing velocity? Explain.

Answer: Yes, if its direction changes (e.g. moving in a circle).

P4 Taking east as positive, a cyclist has a velocity of -15 m s^{-1} . Describe the motion.

Answer: 15 m s^{-1} towards the west

05 Other useful information

Common mistakes

✗ **Wrong:** Use the total distance to find the average velocity.

✓ **Right:** Use the displacement (start to finish), with a direction.

✗ **Wrong:** A negative velocity means slowing down.

✓ **Right:** It means moving in the negative direction.

Exam tips

- State your positive direction before writing any velocity.

What the syllabus asks

- 9702 topic 2: define and use speed and velocity. Coursebook 1.3.

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