

1 Describing motion and reading graphs

– Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	Write it 3 times (English)		
Kinematics	_____	_____	_____
scalar	_____	_____	_____
magnitude	_____	_____	_____
vector	_____	_____	_____
Distance	_____	_____	_____
Displacement	_____	_____	_____
Speed	_____	_____	_____
Velocity	_____	_____	_____
Acceleration	_____	_____	_____
deceleration	_____	_____	_____
gradient	_____	_____	_____

Recall

You met motion long before AP. Bring it with you:

- You measured **distance** with a ruler and **time** with a clock, and found **speed** from $\text{speed} = \text{distance} \div \text{time}$.

- You described a moving car, a falling ball, a running friend – how fast each one goes.
- At AP we look more carefully at **direction** (not just how fast, but which way) and at how motion **changes**.

Nothing on this sheet is harder than what you already know. It just lines up the ideas the AP course starts with.

New ideas

Read these first. Each idea has a short worked example. Once you have read them you can do the Practice below.

■ 1 Distance and displacement

Kinematics is the study of how things move. It uses two kinds of quantity.

A **scalar** has only size (its **magnitude**): distance, speed, time, mass. A **vector** has size **and** direction: displacement, velocity, acceleration.

Distance is the whole path length you travel – it only grows. **Displacement** is the straight line from start to finish, together with a direction.

Worked example. Walk 3 m east, then 1 m back west. The distance is $3 + 1 = 4$ m, but the displacement is only 2 m east – how far you ended from where you began.

■ 2 Speed and velocity

Speed tells you how fast, as a scalar. **Velocity** tells you how fast **and** which way, so it is a vector.

In one dimension, direction is just a **sign**. First choose which way is positive. Then a velocity of -5 m/s means 5 m/s in the negative direction – it does **not** mean "slow."

Worked example. A car covers 100 m in 5 s in the $+x$ direction, so its velocity is $\frac{100}{5} = +20$ m/s. A car going the other way at the same rate has velocity -20 m/s.

■ 3 Acceleration

Acceleration is how quickly velocity changes: $a = \frac{\Delta v}{\Delta t}$ (change in velocity $\div$ time taken). Its unit is m/s^2 .

An object speeds up when velocity and acceleration point the **same** way, and slows down (**deceleration**) when they point **opposite** ways.

Worked example. A bike speeds up from 2 m/s to 8 m/s in 3 s: $a = \frac{8 - 2}{3} = 2$ m/s^2 .

■ 4 Position–time graphs

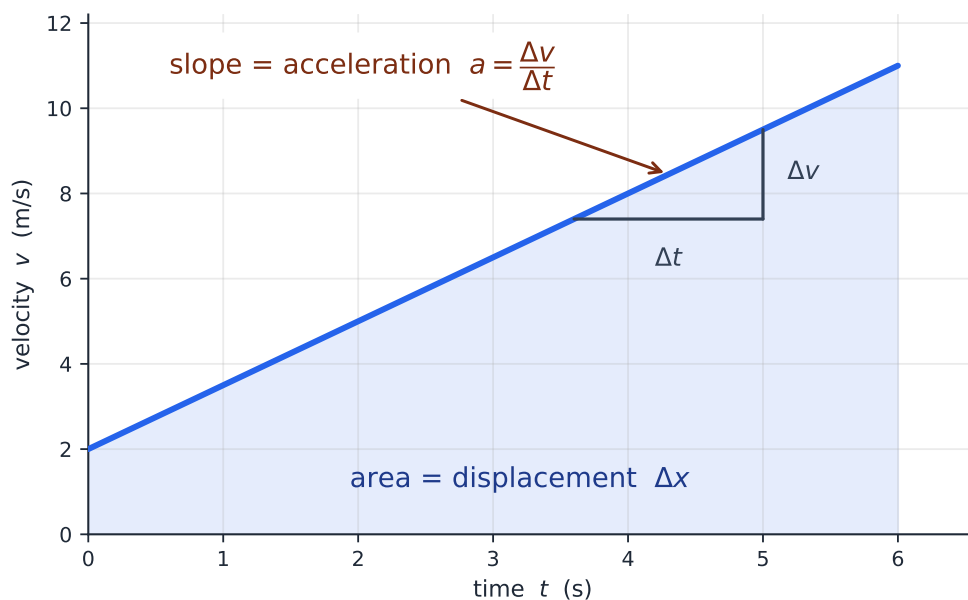
A graph shows motion at a glance. On a **position–time** graph, the **gradient** (steepness) is the velocity.

- A flat line means the object is not moving.

- A straight slope means constant velocity (steeper = faster).
- A curve means the velocity is changing.

■ 5 Velocity–time graphs

On a **velocity–time** graph, two useful things are hidden in the shape:



- The gradient (slope) is the acceleration.
- The **area** under the line is the displacement.

Worked example. A car holds 6 m/s for 4 s. On the velocity–time graph this is a rectangle, so the displacement is $6 \times 4 = 24$ m.

Watch out: a negative velocity does not mean slow – it means moving in the negative direction. Speed is the size of the velocity, so it is always positive.

Practice

Try these in order. They get a little harder. The methods are all above.

2.1 A car travels 6 km north, then 2 km south. Find (a) the distance travelled, (b) the displacement. [2]

2.2 State whether each quantity is a scalar or a vector: (a) speed, (b) velocity, (c) distance, (d) acceleration. [2]

2.3 A runner covers 200 m in 25 s. Calculate the average speed. [1]

2.4 A velocity is written as -8 m/s. Explain what the minus sign tells you. [1]

2.5 A train speeds up from 5 m/s to 20 m/s in 6 s. Calculate its acceleration. [2]

2.6 A velocity–time graph shows a constant 12 m/s for 8 s. Find the displacement. [2]

2.7 On a position–time graph, describe the motion shown by (a) a flat horizontal line, (b) a straight upward slope. [2]
