

# 1 Describing motion and reading graphs

## – Part 1

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

### Vocabulary 词汇

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*Write each word three times. 把每个单词抄写三遍。*

| English      | 中文  | Write it 3 times (English) |       |       |
|--------------|-----|----------------------------|-------|-------|
| Kinematics   | 运动学 | _____                      | _____ | _____ |
| scalar       | 标量  | _____                      | _____ | _____ |
| magnitude    | 大小  | _____                      | _____ | _____ |
| vector       | 矢量  | _____                      | _____ | _____ |
| Distance     | 距离  | _____                      | _____ | _____ |
| Displacement | 位移  | _____                      | _____ | _____ |
| Speed        | 速率  | _____                      | _____ | _____ |
| Velocity     | 速度  | _____                      | _____ | _____ |
| Acceleration | 加速度 | _____                      | _____ | _____ |
| deceleration | 减速  | _____                      | _____ | _____ |
| gradient     | 斜率  | _____                      | _____ | _____ |

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### Recall

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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

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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** 运动学 is the study of how things move. It uses two kinds of quantity.

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

**Distance** 距离 is the whole path length you travel –it only grows. **Displacement** 位移 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** 速率 tells you how fast, as a scalar. **Velocity** 速度 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** 加速度 is how quickly velocity changes:  $a = \frac{\Delta v}{\Delta t}$  (change in velocity  $\div$  time taken). Its unit is  $\text{m/s}^2$ .

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

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

### ■ 4 Position–time graphs

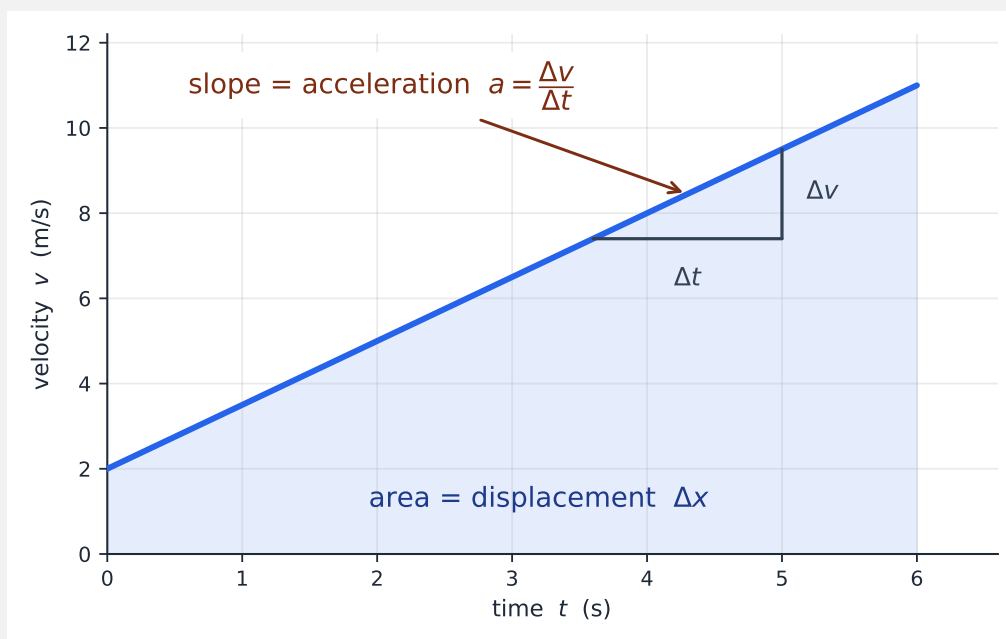
A graph shows motion at a glance. On a **position–time** graph, the **gradient** 斜率 (steepness) is the velocity.

- 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]

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

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**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]

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