1 Describing motion and reading graphs – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

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			

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 speed = distance ÷ 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 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 $\dfrac{100}{5} = +20$ m/s. A car going the other way at the same rate has velocity -20 m/s.

■ 3 Acceleration

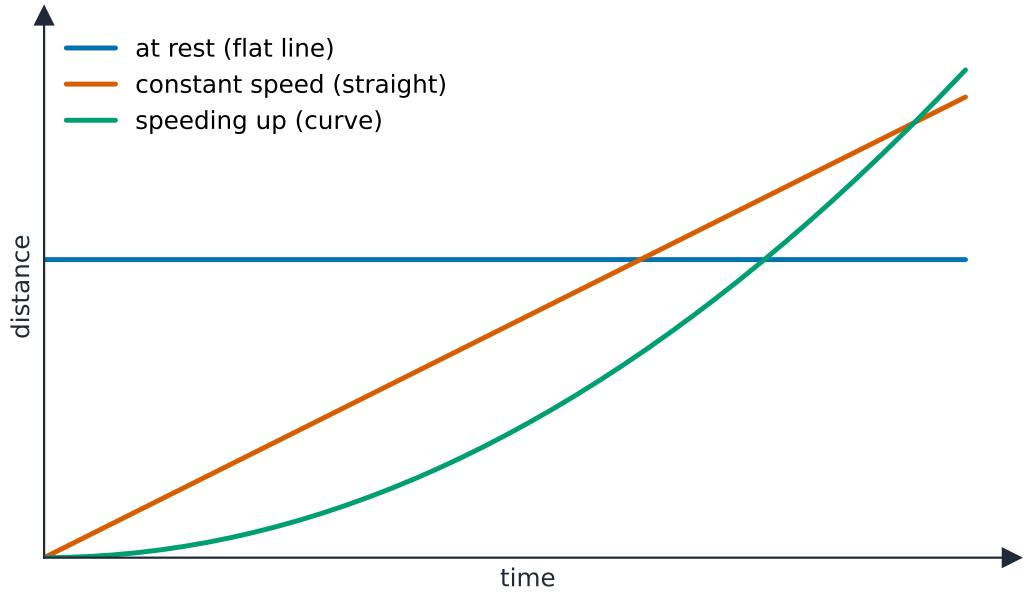
Acceleration 加速度 is how quickly velocity changes: $a = \dfrac{\Delta v}{\Delta t}$ (change in velocity ÷ time taken). Its unit is $\mathrm{m/s^2}$.

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: $a = \dfrac{8-2}{3} = 2\ \mathrm{m/s^2}$.

■ 4 Position–time graphs

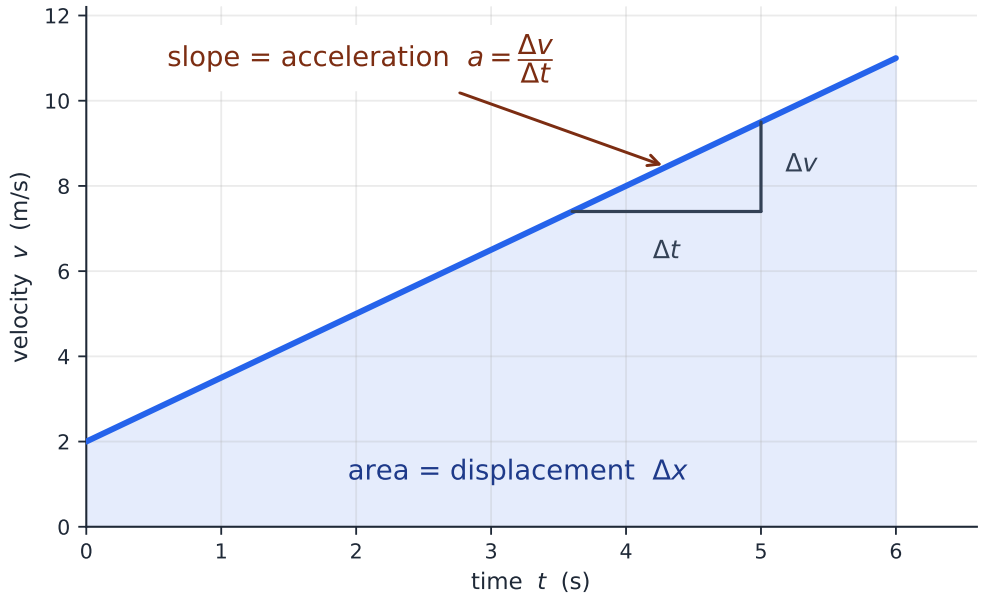
A graph shows motion at a glance. On a **position–time** graph, the **gradient** 斜率 (steepness) is the velocity.



- 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]

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]