Exercise walk-through

Scalars and Vectors in One Dimension ▪ 1.1

eXercise

You must be able to

- distinguish a **scalar** 标量 (magnitude only) from a **vector** 矢量 (magnitude **and** direction 方向)
- use a **positive or negative sign** to show a 1-D vector's direction along a chosen axis
- set up a **coordinate system** 坐标系 — an **origin** 原点 and a positive direction
- add and subtract **collinear** 共线 vectors to get a single **resultant** 合矢量

Method — Scalar or vector?

A **scalar** has size only; a **vector** has size **and** direction. Decide by asking: "does a direction belong to this quantity?"

scalar	**vector**
distance 距离, speed	displacement 位移, velocity
mass, time, energy	force, acceleration, momentum
temperature	any push or pull with a direction

Method — Signs for direction in 1-D

Once you pick a positive direction, a vector along that line is just a **signed number**. Take **east as positive**:

- $+6$ m s^{-1} means 6 m s^{-1} east
- -6 m s^{-1} means 6 m s^{-1} **west** — same speed, opposite direction

The sign is the direction; the magnitude is the number without its sign, $|-6| = 6$ m s^{-1}.

Method — Choosing a coordinate system

State the **origin** and the **positive direction** *before* putting numbers on anything. A ball starts at the origin, moves $+3$ m (right), then -8 m (left). Its position is

$$x = (+3) + (-8) = -5 \text{ m},$$

i.e. 5 m to the left of the start.

Method — Adding and subtracting collinear vectors

Collinear vectors lie on one line, so **add the signed values**. Two forces on a box, right positive: $F_1 = +12$ N, $F_2 = -5$ N.

$$F_{\text{net}} = (+12) + (-5) = +7 \text{ N} \quad (7 \text{ N to the right}).$$

To **subtract** a vector, add its negative: $\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$ — reverse $\vec{B}$, then add.

Practice 2.1 ▪ 2 marks

State whether each quantity is a scalar or a vector: (a) temperature, (b) velocity, (c) distance, (d) force.

Solution 2.1

Method: Scalar or vector?

Worked steps

(a) scalar; (b) vector; (c) scalar; (d) vector B1 B1 *any two correct; all four.*

Practice 2.2 ▪ 1 mark

Taking **up as positive**, write the signed value of a displacement of 4 m **downward**.

Solution 2.2

Worked steps

-4 m B1.

Practice 2.3 ▪ 2 marks

A drone flies $+50$ m then -30 m along an east-positive axis. Find its **resultant** displacement, with direction.

Solution 2.3

Method: Signs for direction in 1-D

Worked steps

$(+50) + (-30) = +20$ m **M1**; 20 m east **A1**.

Practice 2.4 ▪ 2 marks

Two collinear forces act on a trolley (right positive): $+8$ N and -15 N. Find the net force, with direction.

Solution 2.4

Method: Adding and subtracting collinear vectors

Worked steps

$(+8) + (-15) = -7$ N **M1**; 7 N to the left **A1**.

Exam-style 3.1 ▪ 1 mark

Which quantity is a vector?

A distance

B speed

C acceleration

D mass

Solution 3.1

Method: Scalar or vector?

A distance

B speed

C acceleration ✓

D mass

Worked steps

C — acceleration is a vector; the others are scalars.

Exam-style 3.2 ▪ 1 mark

A car moves along a straight road. Taking north as positive, its velocity is -25 m s^{-1}. This means the car moves

A at 25 m s^{-1} north

B at 25 m s^{-1} south

C at -25 m s^{-1} north

D with a decreasing speed

Solution 3.2

Method: Signs for direction in 1-D

A at 25 m s^{-1} north

B at 25 m s^{-1} south ✓

C at -25 m s^{-1} north

D with a decreasing speed

Worked steps

B — the sign gives the direction (south), and the speed is $|-25| = 25$ m s^{-1}.

Exam-style 3.3 ▪ 1 mark

An object on a number line starts at $x = +2$ m and undergoes a displacement of -9 m.
(a) Find its final position.
(b) State how far it is from the origin, and on which side.

Solution 3.3

Method: Choosing a coordinate system

Worked steps

(a) $x = (+2) + (-9) = -7$ m A1. (b) 7 m from the origin, on the negative side B1.

Exam-style 3.4 ▪ 2 marks

Three collinear forces act at a point, with rightward positive: $+10$ N, -4 N and -2 N.
(a) Calculate the resultant force.
(b) State whether the point is in equilibrium 平衡, and give a reason.

Solution 3.4

Method: Adding and subtracting collinear vectors

Worked steps

(a) $(+10) + (-4) + (-2) = +4$ N **M1** **A1**. (b) No — the resultant is not zero ($+4$ N), so the point is not in equilibrium **B1**.