Exercise walk-through

Newton's Third Law ▪ 2.3

eXercise

You must be able to

- state **Newton's third law 牛顿第三定律**: every force has an equal and opposite reaction
- identify an **action-reaction pair 作用-反作用对** acting on two different objects
- explain why the two forces do not cancel (they act on different bodies)
- apply it to walking, rockets, and collisions

Method — Equal and opposite, on different objects

If A pushes B, then B pushes A with an equal and opposite force. The two forces are the same size, opposite in direction, and act on **different** objects.

Method — Why they don't cancel

Action and reaction act on *different* bodies, so they never appear in the same free-body diagram and never cancel. Only forces on the *same* object can cancel.

Method — Everyday examples

- Walking: your foot pushes back on the ground; the ground pushes you forward.
- Rocket: the engine pushes gas down; the gas pushes the rocket up.

Practice 2.1 ▪ 1 mark

A hammer hits a nail with 50 N. State the force the nail exerts on the hammer.

Solution 2.1

Worked steps

50 N in the opposite direction (back on the hammer) B1.

Practice 2.2 ▪ 2 marks

State the two properties an action-reaction pair always shares.

Solution 2.2

Method: Why they don't cancel

Worked steps

Equal in size and opposite in direction (and they act on different objects) B1 B1.

Practice 2.3 ▪ 1 mark

Why do action and reaction forces not cancel each other out?

Solution 2.3

Method: Why they don't cancel

Worked steps

They act on different objects, so they never appear together on one free-body diagram B1.

Practice 2.4 ▪ 1 mark

When you walk forward, what pushes you forward?

Solution 2.4

Method: Everyday examples

Worked steps

The ground pushes you forward (the reaction to your foot pushing back on it) B1.

Exam-style 3.1 ▪ 1 mark

Newton's third law says forces come in pairs that are

A equal and in the same direction

B equal and opposite, on the same object

C equal and opposite, on different objects

D unequal and opposite

Solution 3.1

A equal and in the same direction

B equal and opposite, on the same object

C equal and opposite, on different objects ✓

D unequal and opposite

Worked steps

C — equal and opposite, on different objects.

Exam-style 3.2 ▪ 1 mark

A car tyre pushes back on the road with 2000 N. The road pushes the tyre forward with

A 0 N

B 1000 N

C 2000 N

D 4000 N

Solution 3.2

Method: Everyday examples

A 0 N

B 1000 N

C 2000 N ✓

D 4000 N

Worked steps

C — the reaction is equal, 2000 N.

Exam-style 3.3 ▪ 1 mark

A book of weight 8 N rests on a table.
(a) State the reaction to the Earth's gravitational pull on the book.
(b) Explain why this is *not* the normal force from the table.

Solution 3.3

Worked steps

(a) The book's gravitational pull on the Earth, equal and upward B1. (b) The normal force acts on the book from the table, a different pair; the reaction to gravity acts on the Earth B1.

Exam-style 3.4 ▪ 2 marks

A swimmer pushes water backward to move forward.
(a) Identify the action-reaction pair.
(b) State which force of the pair moves the swimmer.

Solution 3.4

Worked steps

(a) The swimmer pushes water back; the water pushes the swimmer forward B1 B1.
(b) The forward push of the water on the swimmer B1.