

2.3 Newton's Third Law

Name: _____ Class: _____ Date: _____

Total: 14 marks

Objective

Build the skills to answer exam questions on **Newton's third law**.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

■ 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.

■ 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.

■ 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.

2 Practice

Now apply the methods above.

2.1 A hammer hits a nail with 50 N. State the force the nail exerts on the hammer. [1]

2.2 State the two properties an action-reaction pair always shares. [2]

2.3 Why do action and reaction forces not cancel each other out? [1]

2.4 When you walk forward, what pushes you forward? [1]

3 Exam-style questions

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

3.2 A car tyre pushes back on the road with 2000 N. The road pushes the tyre forward with [1]

- **A** 0 N
- **B** 1000 N
- **C** 2000 N
- **D** 4000 N

3.3 A book of weight 8 N rests on a table.

(a) State the reaction to the Earth's gravitational pull on the book. [1]

(b) Explain why this is *not* the normal force from the table. [1]

3.4 A swimmer pushes water backward to move forward.

(a) Identify the action-reaction pair. [2]

(b) State which force of the pair moves the swimmer. [1]

4 Go further

You are ready for more on this subtopic:

- work through the interactive **2.3 Newton's Third Law** lesson on the **Learn** page;
- read the **Force and Translational Dynamics** section of the AP Physics C: Mechanics handout on the **Know** page for the full explanation and worked diagrams.

Solutions

2.1 50 N in the opposite direction (back on the hammer).

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

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

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

3.1 C —equal and opposite, on different objects.

3.2 C —the reaction is equal, 2000 N.

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

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