Newton's Third Law

4.5.6.2.3 · Forces · revision notes

Newton's Third Law says that whenever two objects interact, the forces they exert on each other are equal and opposite. You need to identify these pairs of forces and not confuse them with balanced forces on a single object, especially in equilibrium situations.

Key facts

- Third Law: interacting objects exert equal and opposite forces on each other
- Third Law pairs never cancel, because they act on different objects
- Book on a table: weight of book ↔ book pulls Earth up; table pushes book up ↔ book pushes table down
- Third Law pair: same size, opposite directions, same type of force, different objects
- Balanced forces act on the SAME object

Notes

The law

- Whenever two objects interact, the forces they exert on each other are **equal and opposite**.
- If object A exerts a force on object B, then object B exerts a force of the same size on object A, in the opposite direction.

Features of a Third Law pair

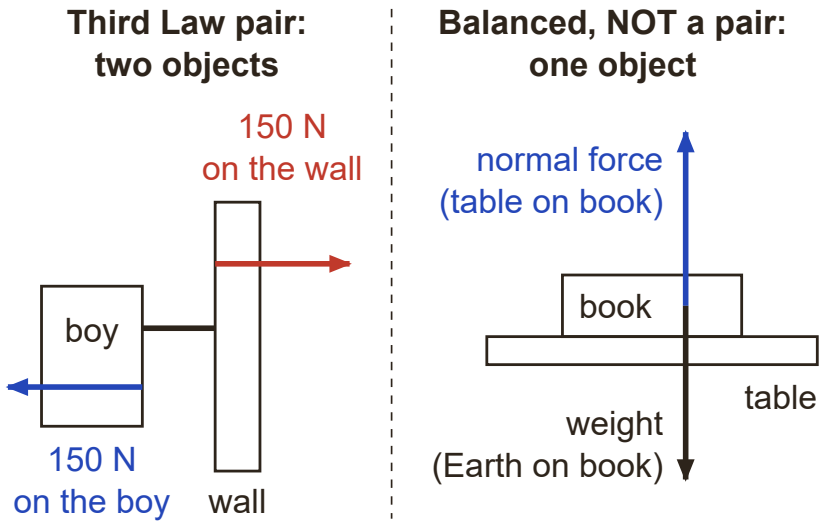
- The two forces are the same size.
- They act in opposite directions.
- They are the same type of force (both gravitational, both normal contact forces, both frictional, and so on).
- They act on **different** objects, so they never cancel each other out.

Examples

- Walking: your foot pushes backwards on the ground; the ground pushes forwards on your foot (both are friction forces).
- Rocket: the engine pushes exhaust gas backwards; the gas pushes the rocket forwards.
- Swimming: your hands push the water backwards; the water pushes you forwards.
- Gravity: the Earth pulls an apple down with a force equal to the apple's weight; the apple pulls the Earth up with a force of the same size.

Equilibrium: do not mix up the pairs

- A book resting on a table is in equilibrium. Its **weight** (down) and the **normal contact force** from the table (up) are balanced. Both act on the book, so they are **not** a Third Law pair.



A Third Law pair acts on two different objects. Balanced forces act on the same object.

- The Third Law partner of the book's weight is the gravitational pull of the book on the Earth, upwards.
- The Third Law partner of the table's push up on the book is the book's push down on the table.

How to answer each type of question

Give the partner force

2 marks **Grade 5**

1. Swap the two objects: 'A on B' becomes 'B on A'.
2. Give the same size and the opposite direction.

Example. A boy pushes on a wall with a force of 150 N.
State the size and direction of the force that the wall exerts on the boy.

Model answer.

150 N (1)

away from the wall, in the opposite direction to the boy's push (1)

Explain motion using the Third Law

3 marks | Grade 6

1. Say what the object pushes on, and in which direction.
2. Say that the other object pushes back with an equal force.
3. Say that this force is in the opposite direction and moves the object.

Example. Explain how a swimmer uses Newton's Third Law to move forwards.

Model answer.

The swimmer's hands and feet push the water backwards (1).
The water exerts an equal force on the swimmer (1)
in the opposite direction, pushing the swimmer forwards (1).

Explain why two forces are not a Third Law pair

2 to 3 marks | Grade 7

1. Check which object each force acts on.
2. Check whether the two forces are the same type.
3. Say what the forces actually are (e.g. balanced forces on one object).

Example. A lamp hangs at rest from a ceiling on a cable. A student says that the weight of the lamp and the tension in the cable are a Newton's Third Law pair, because they are equal and opposite. Explain why the student is wrong.

Model answer.

Both forces act on the same object, the lamp (1).
A Third Law pair acts on two different objects (1)
and is the same type of force, but weight is gravitational and tension is a contact force (1).

Identify the forces in an equilibrium situation

3 to 4 marks | Grade 7

1. Balancing force: a force on the same object, opposite to the one given.
2. Third Law partner: the same type of force, acting on the other object.
3. Give the size and direction.

Example. A book rests on a table.
(a) Name the force that balances the weight of the book.
(b) Describe the force that forms a Newton's Third Law pair with the weight of the book.

Model answer.

(a) The normal contact force of the table on the book (1).
(b) The gravitational force of the book on the Earth (1)
equal in size to the book's weight (1)
acting upwards (1).

Don’t lose marks

- Saying that the weight of a resting object and the normal contact force on it are a Third Law pair.
- Thinking that Third Law pairs cancel, so nothing can move. They act on different objects, so they do not cancel.
- Saying that in a collision the heavier or faster object exerts a bigger force. The forces on the two objects are always equal in size.
- Giving the partner force in the same direction as the original force. It is always opposite.

More tips

Memory tricks

- Third Law pairs: 'A on B' and 'B on A'. Just swap the names of the objects.
- If both forces are drawn on the same object, they are not a Third Law pair.
- Pair checklist: same size, same type, opposite directions, different objects.

Exam technique

- When describing a Third Law pair, name both objects in each force: 'the force of the Earth on the ball' and 'the force of the ball on the Earth'.
- Give both the size and the direction of the partner force.
- Use the phrases 'equal and opposite' and 'act on different objects' in explanations.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 4 — **State Newton's Third Law**
Whenever two objects interact, the forces they exert on each other are equal and opposite.

Grade 5 — **Identify Third Law partner forces**
If a boy pushes a wall with 150 N, the wall pushes the boy with 150 N in the opposite direction.

Grade 5 — **Apply the Third Law to equilibrium situations**
A book on a table pushes down on the table, and the table pushes up on the book with an equal force.

Grade 6 — **Describe the features of a Third Law pair**
Same size, opposite directions, same type of force, acting on two different objects.

Grade 6 — **Explain motion using the Third Law**
A swimmer pushes water backwards; the water pushes the swimmer forwards.

Grade 7 — **Distinguish Third Law pairs from balanced forces**
Balanced forces act on the same object; a Third Law pair acts on two different objects.

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