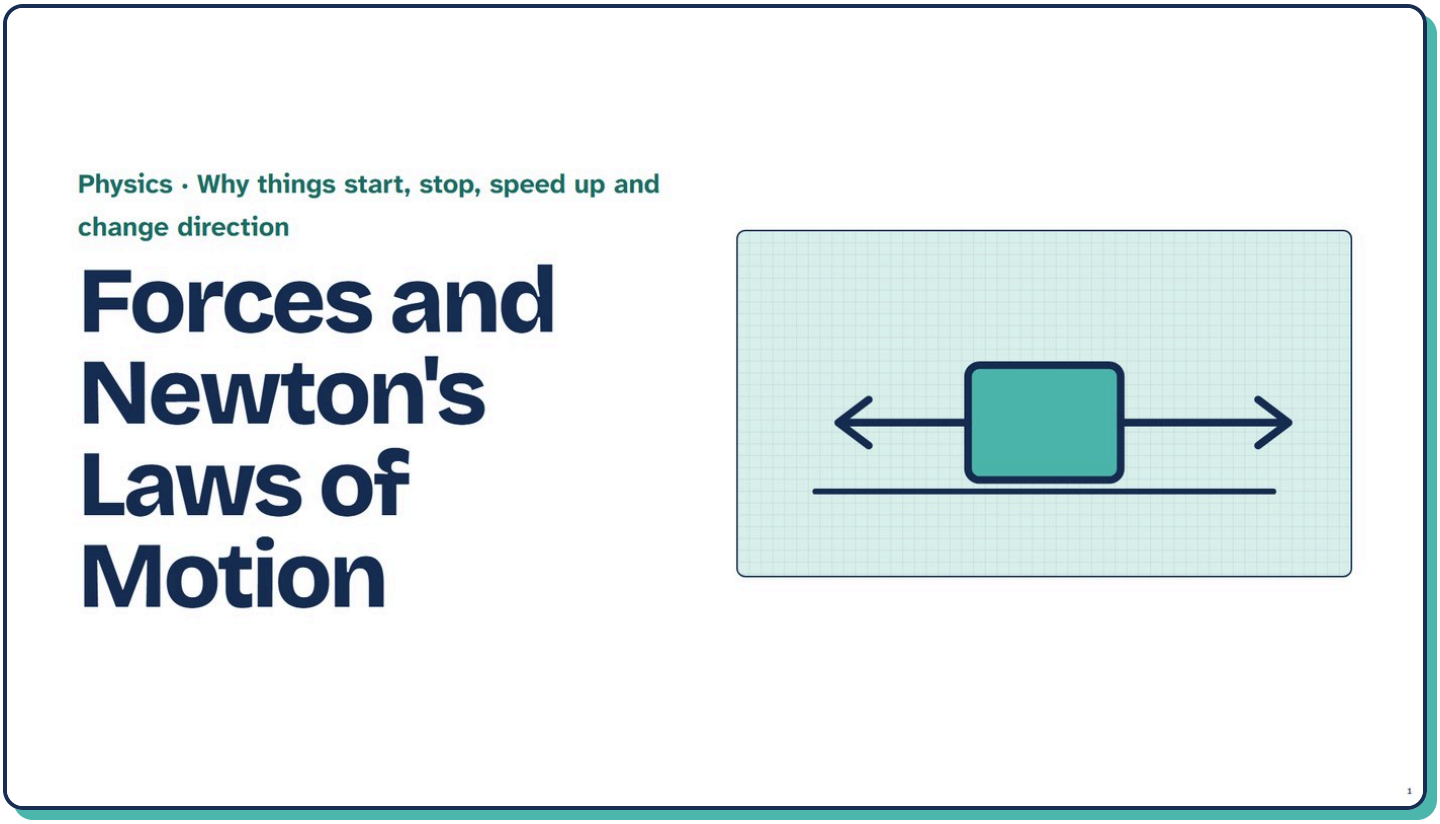
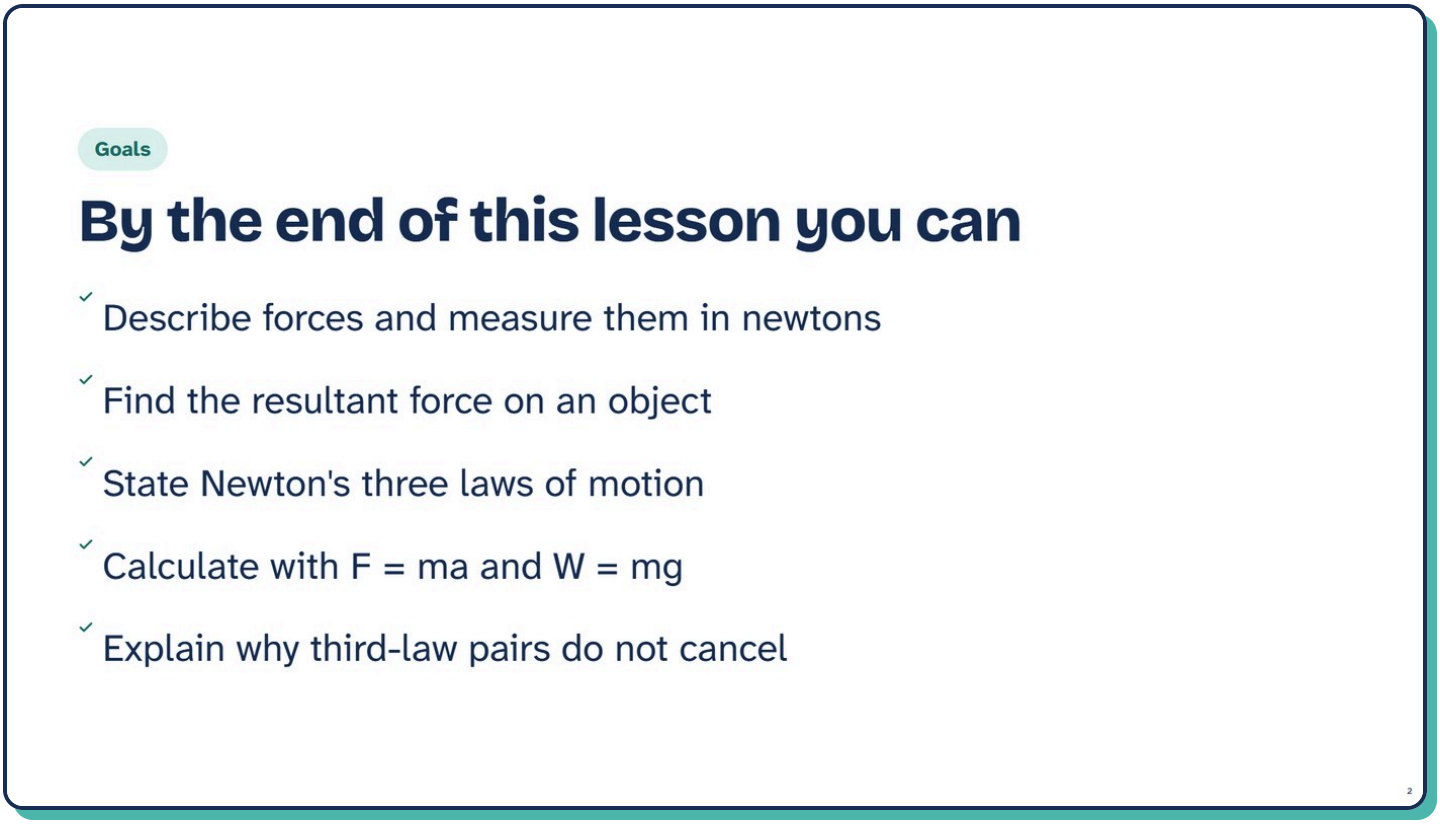


Forces and Newton's Laws of Motion

Teacher notes

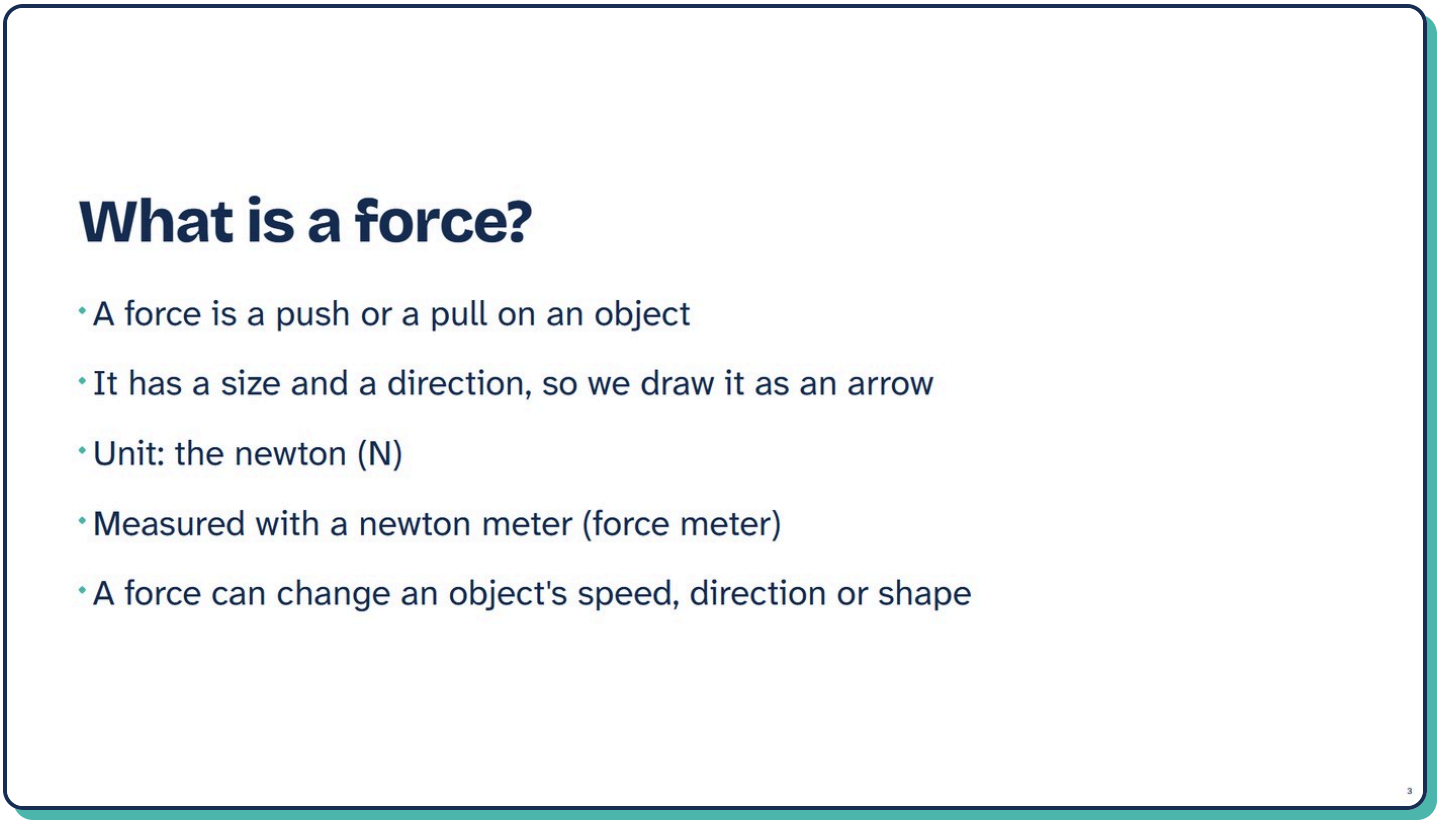
Slide a book across the desk and let it stop. Ask: why did it stop? Collect answers without judging them; many students will say it 'ran out of force'. Tell them that by the end of the lesson they will be able to explain it with Newton's first law.



By the end of this lesson you can

Teacher notes

Point out that two of the objectives involve calculations, so calculators are useful later. Ask students which law they have heard of before; most will know 'every action has an equal and opposite reaction', which is a loose version of the third law.



What is a force?

Teacher notes

A longer arrow means a bigger force. Pass round a newton meter and let students feel 1 N: it is roughly the weight of a 100 g apple, because 0.1 kg × 9.8 N/kg is about 1 N. Ask for one example of a force changing shape (squashing a sponge) and one changing direction (kicking a moving ball).

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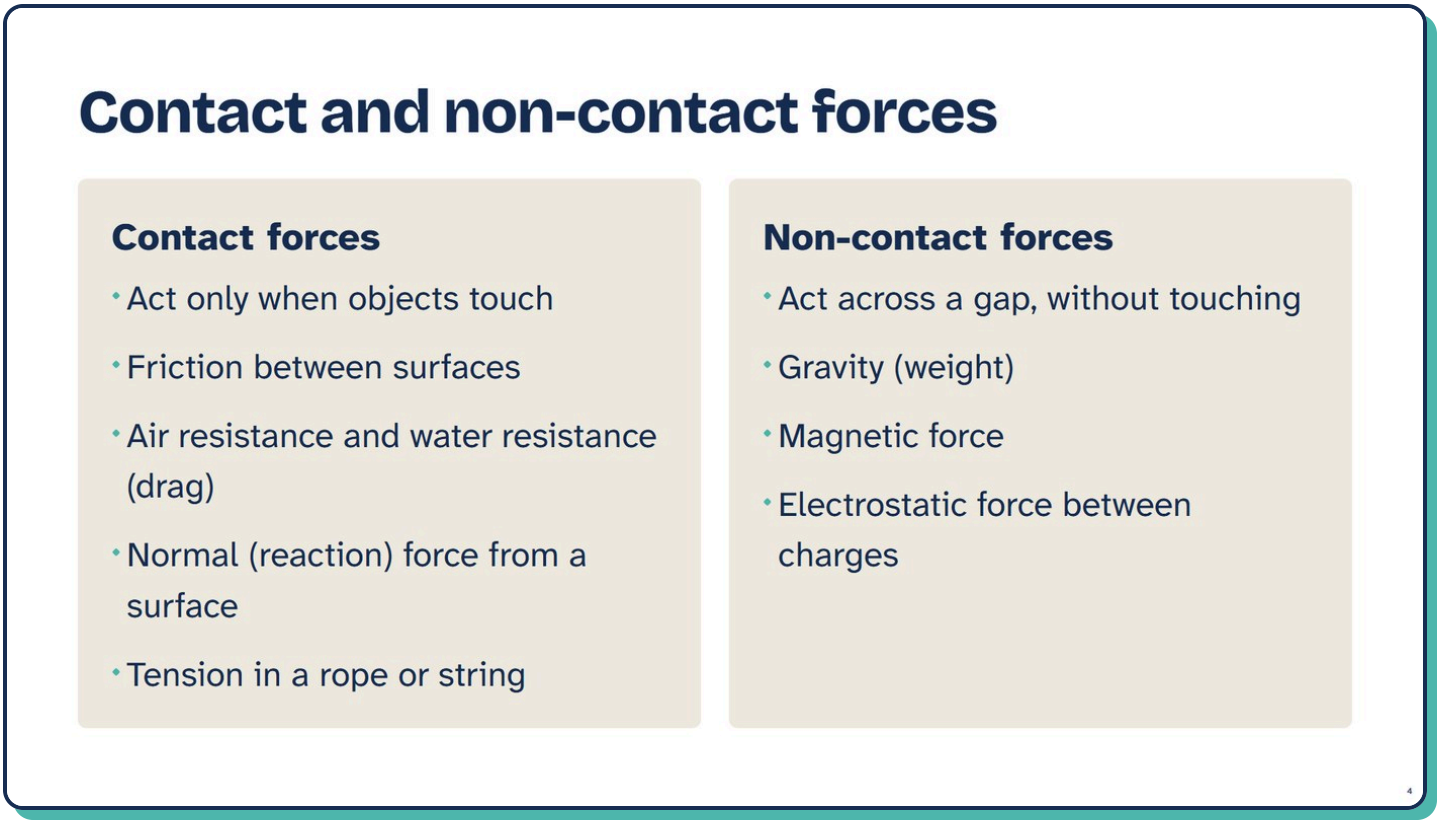
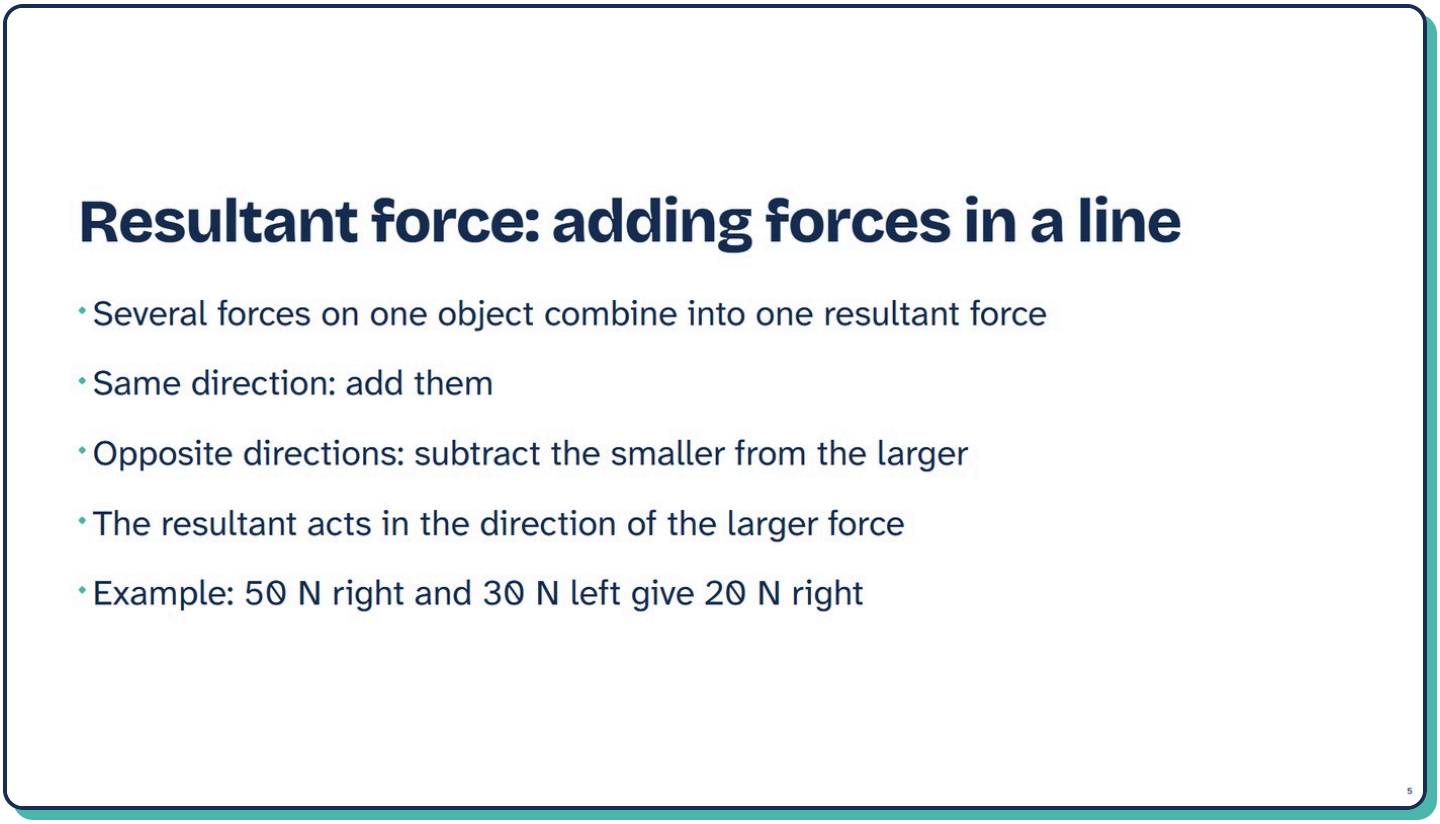


Contact and non-contact forces

Teacher notes

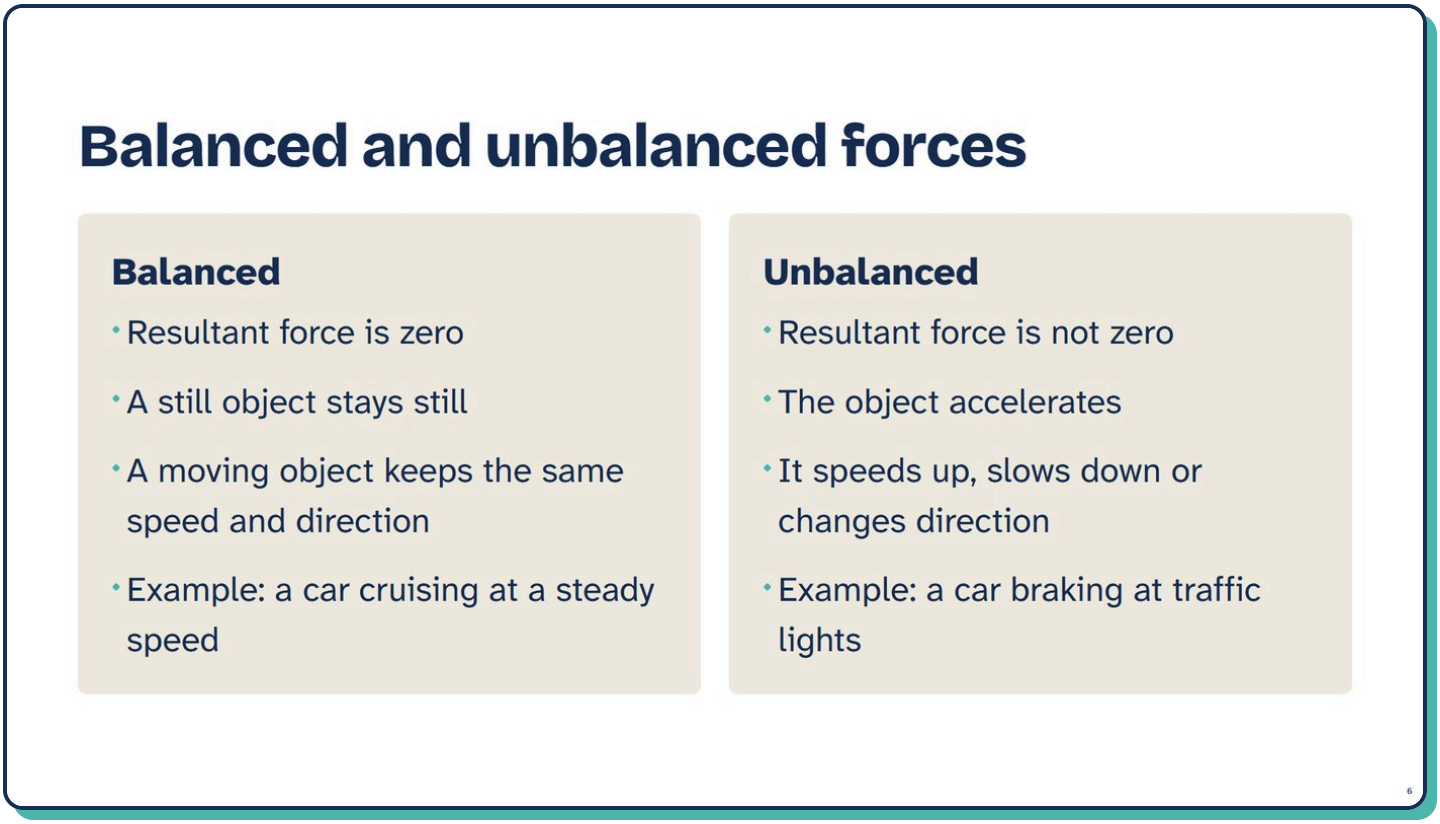
Hold a magnet above a paper clip to show a non-contact force in action. Ask students to name the forces on a book resting on a table: weight (non-contact) down and the normal force from the table (contact) up. Keep this example; it returns when we meet the third law.



Resultant force: adding forces in a line

Teacher notes

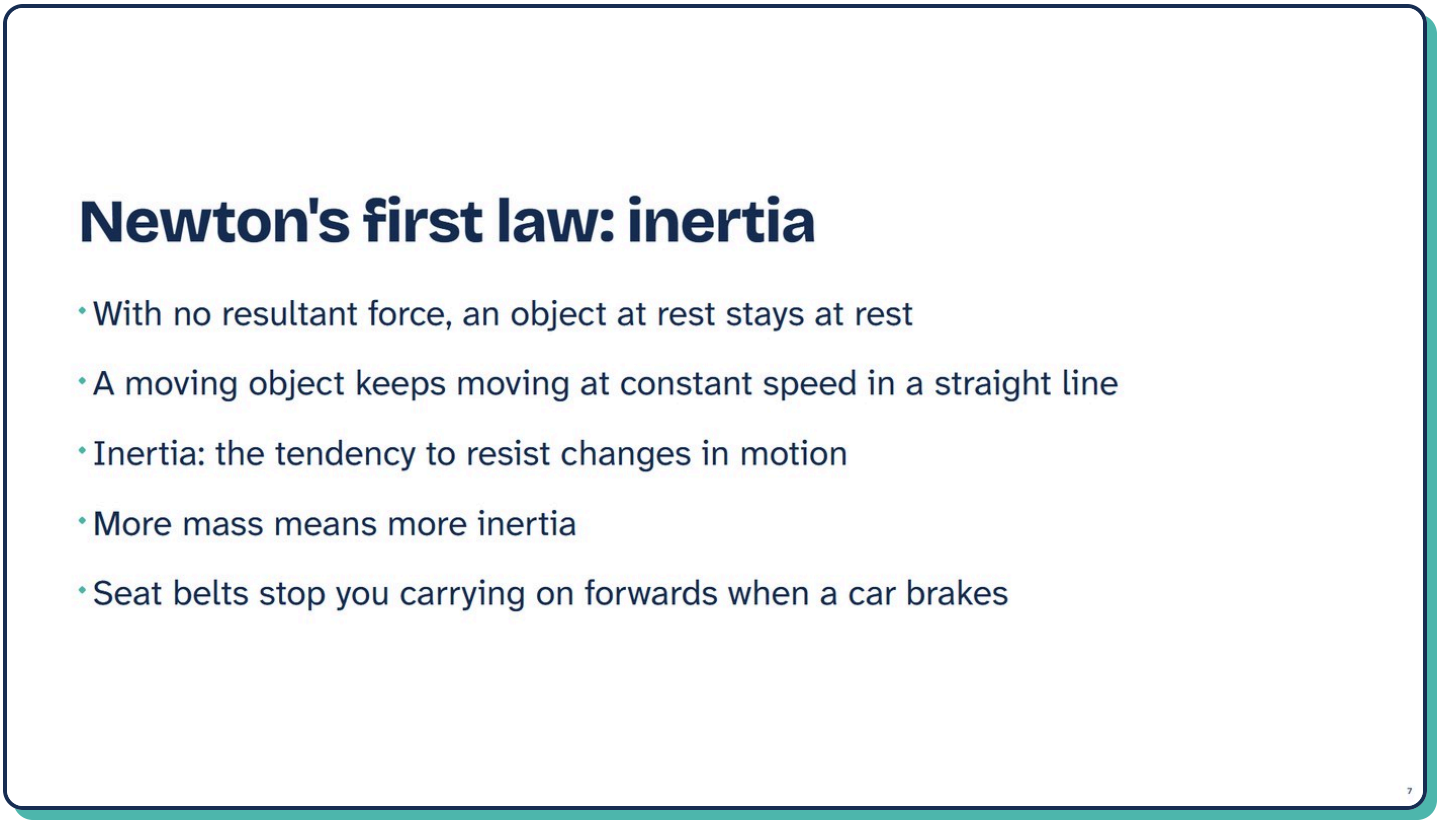
Draw a tug of war on the board with arrows of different lengths. Ask: what is the resultant if both teams pull with 400 N? Zero, so nothing changes. At this level we only add forces along one line; adding forces at angles comes later.



Balanced and unbalanced forces

Teacher notes

Stress the surprising half of this slide: balanced forces do not mean 'not moving'. A car at a steady 50 km/h (about 30 mph) on a straight road has balanced forces, because the driving force equals friction plus air resistance. This is the most common misconception in the topic.



Newton's first law: inertia

Teacher notes

Return to the sliding book: it stopped because friction acted as an unbalanced force, not because its force ran out. In space, far from other objects, a probe keeps moving without its engines. Ask: why is it harder to start pushing a full shopping trolley than an empty one?

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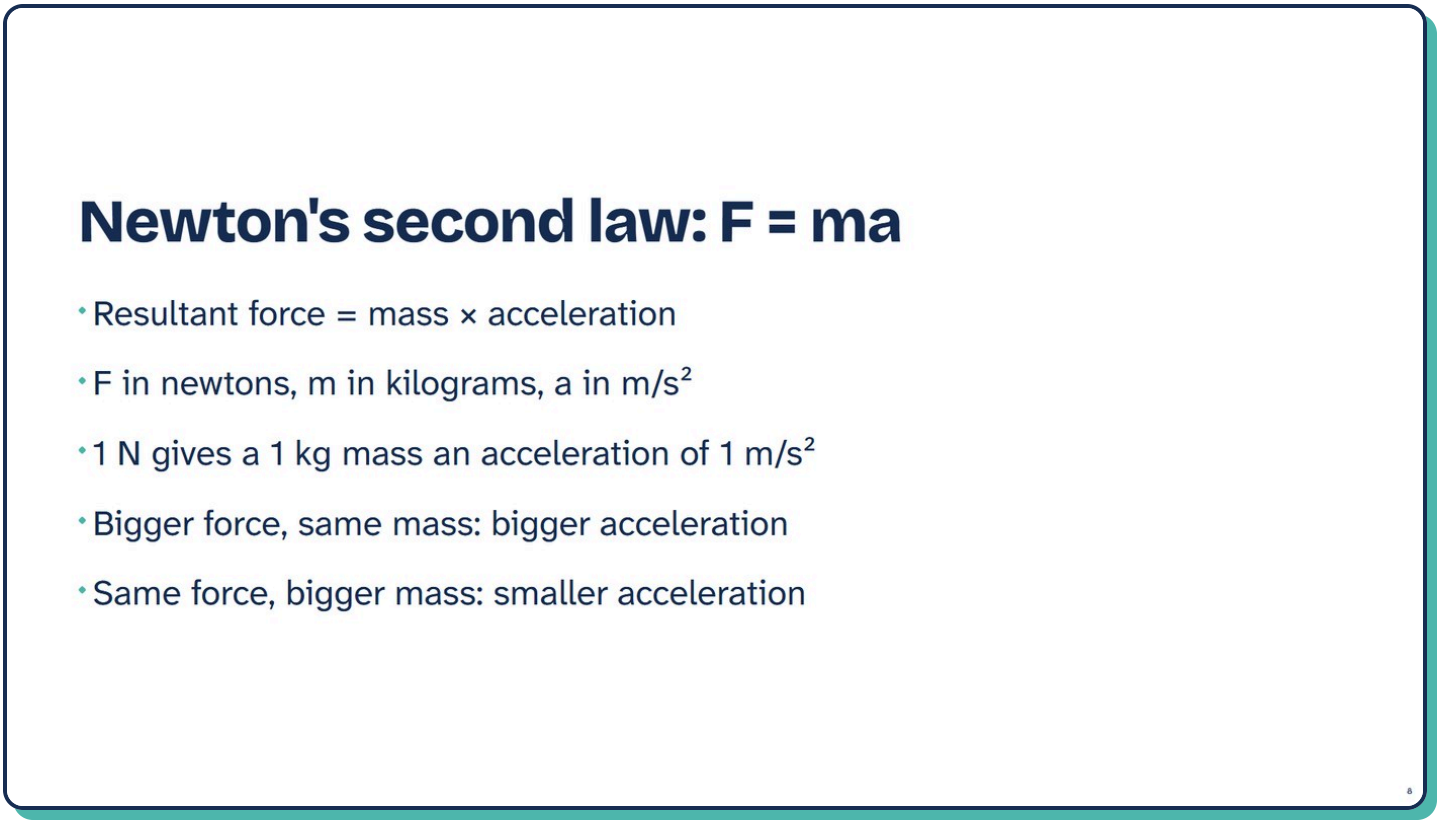

Newton's second law: F = ma

Teacher notes

Write the formula triangle if your students use one, and show the rearrangements a = F ÷ m and m = F ÷ a. Make sure students use the resultant force, not just one of the forces. Acceleration is in the same direction as the resultant force.

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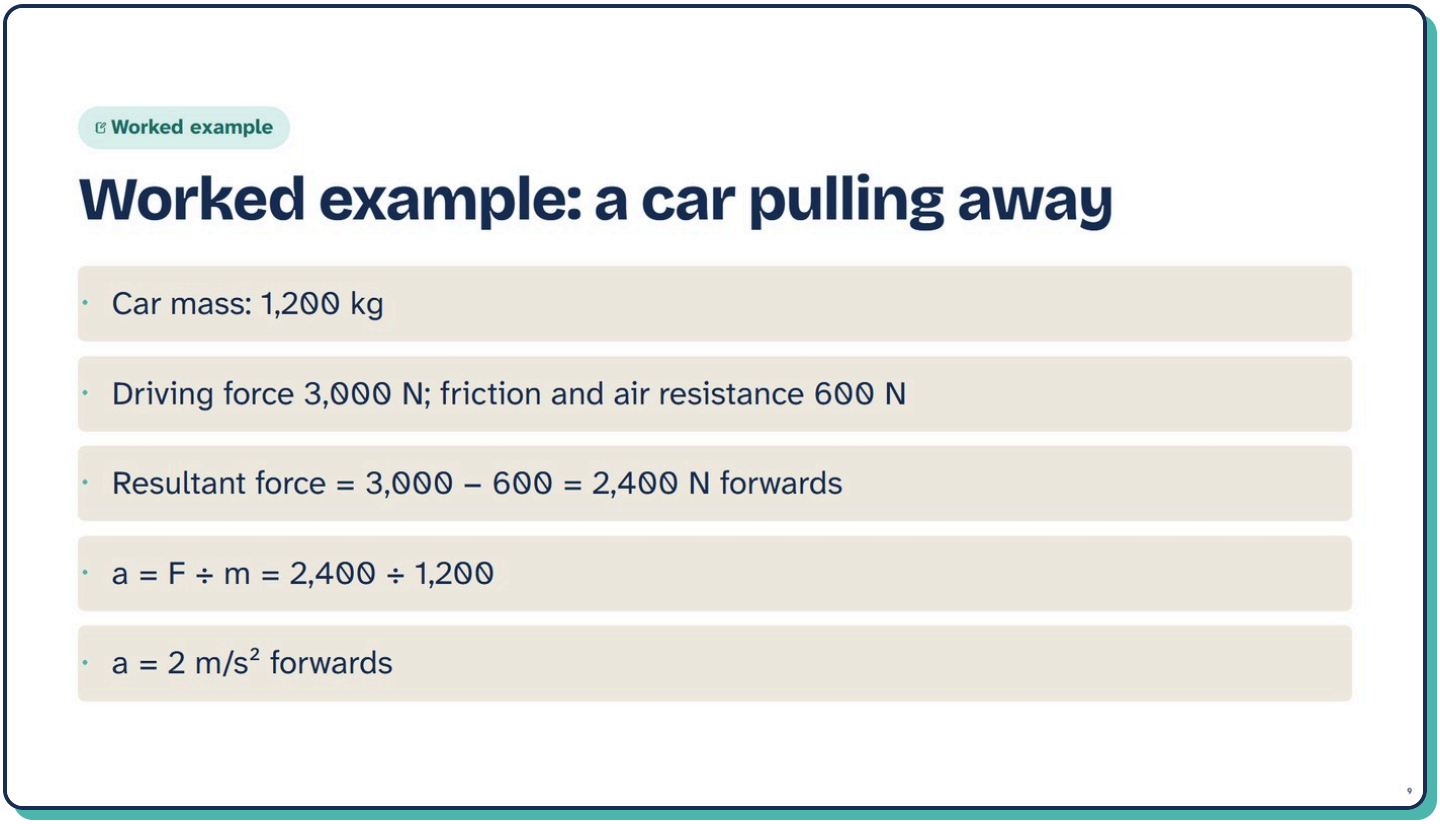

Worked example: a car pulling away

Teacher notes

Work through each line on the board. Ask what happens to the acceleration as the car speeds up and air resistance grows: the resultant force falls, so the acceleration falls. When air resistance plus friction equals 3,000 N, the forces balance and the car travels at a steady top speed.

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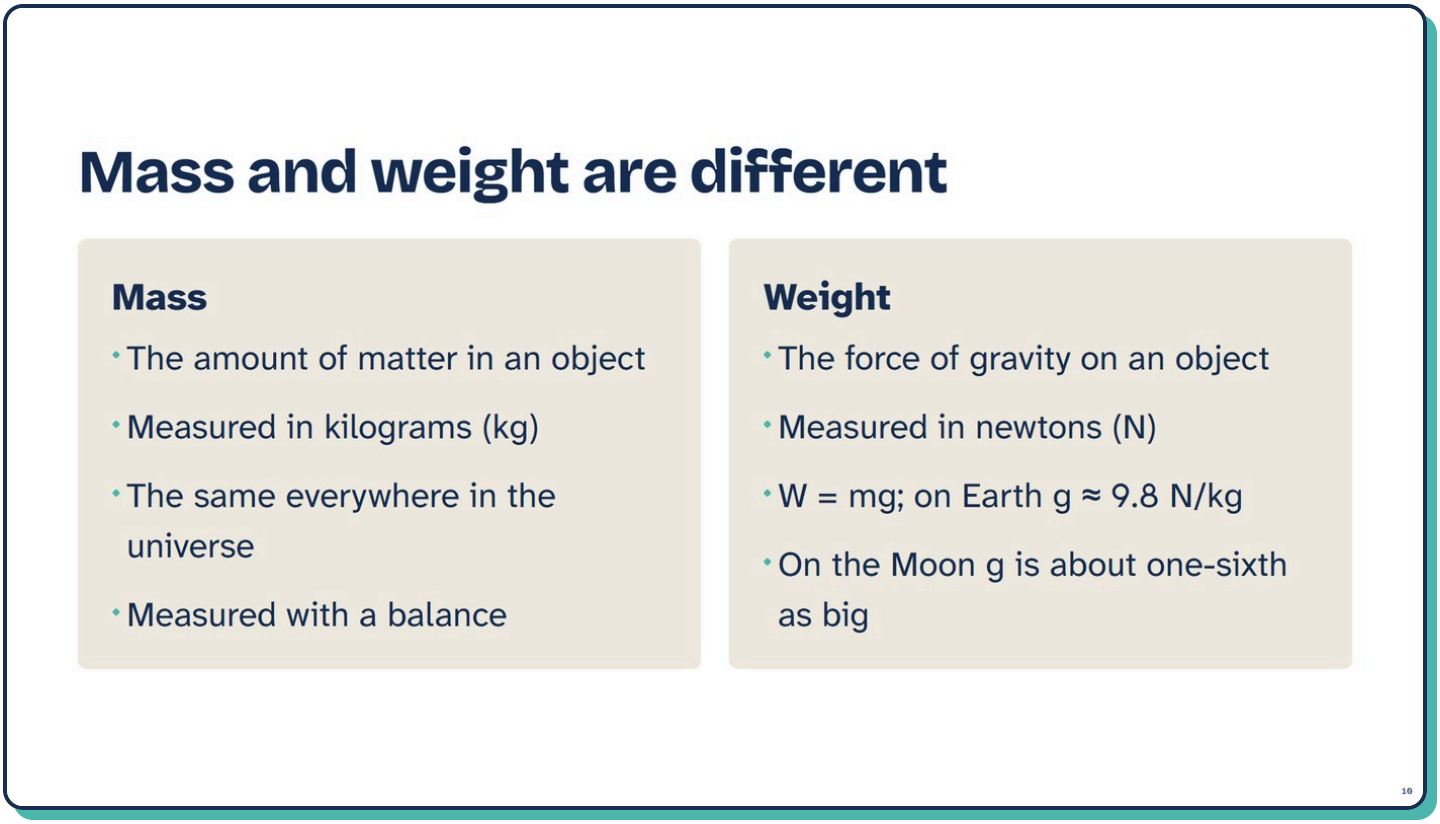
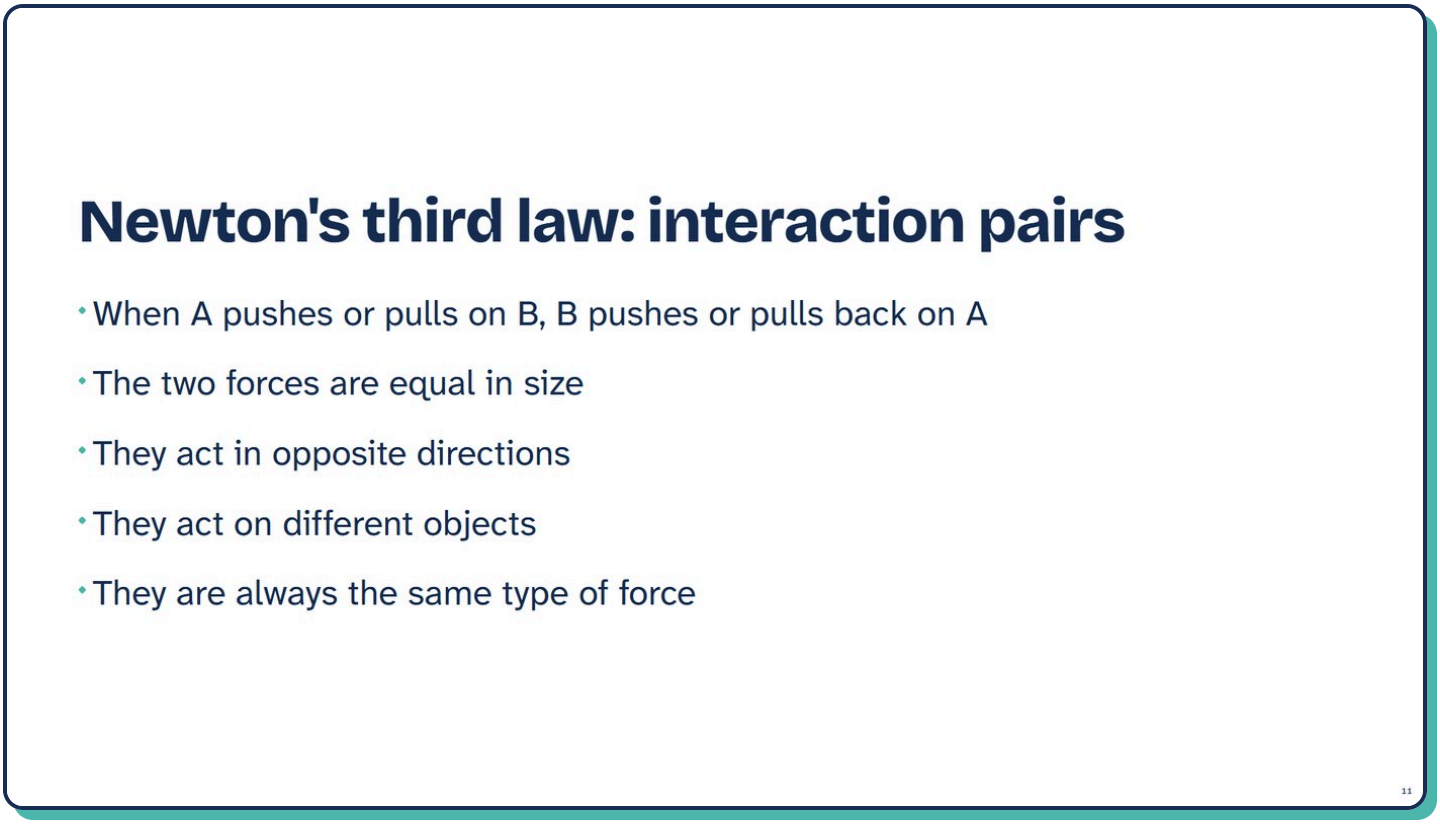


Mass and weight are different

Teacher notes

Example: a 50 kg student weighs 50 × 9.8 = 490 N on Earth, but only about one-sixth of that, roughly 80 N, on the Moon. Their mass is 50 kg in both places. Some courses round g to 10 N/kg; tell students which value your exam uses. Ask: why is 'I weigh 50 kg' not quite right in physics?



Newton's third law: interaction pairs

Teacher notes

Examples: a swimmer pushes backwards on the pool wall and the wall pushes the swimmer forwards; your foot pushes backwards on the ground and the ground pushes you forwards; a rocket pushes gas backwards and the gas pushes the rocket forwards. Ask a pair of students on wheeled chairs (if safe) to push palms: both move apart.

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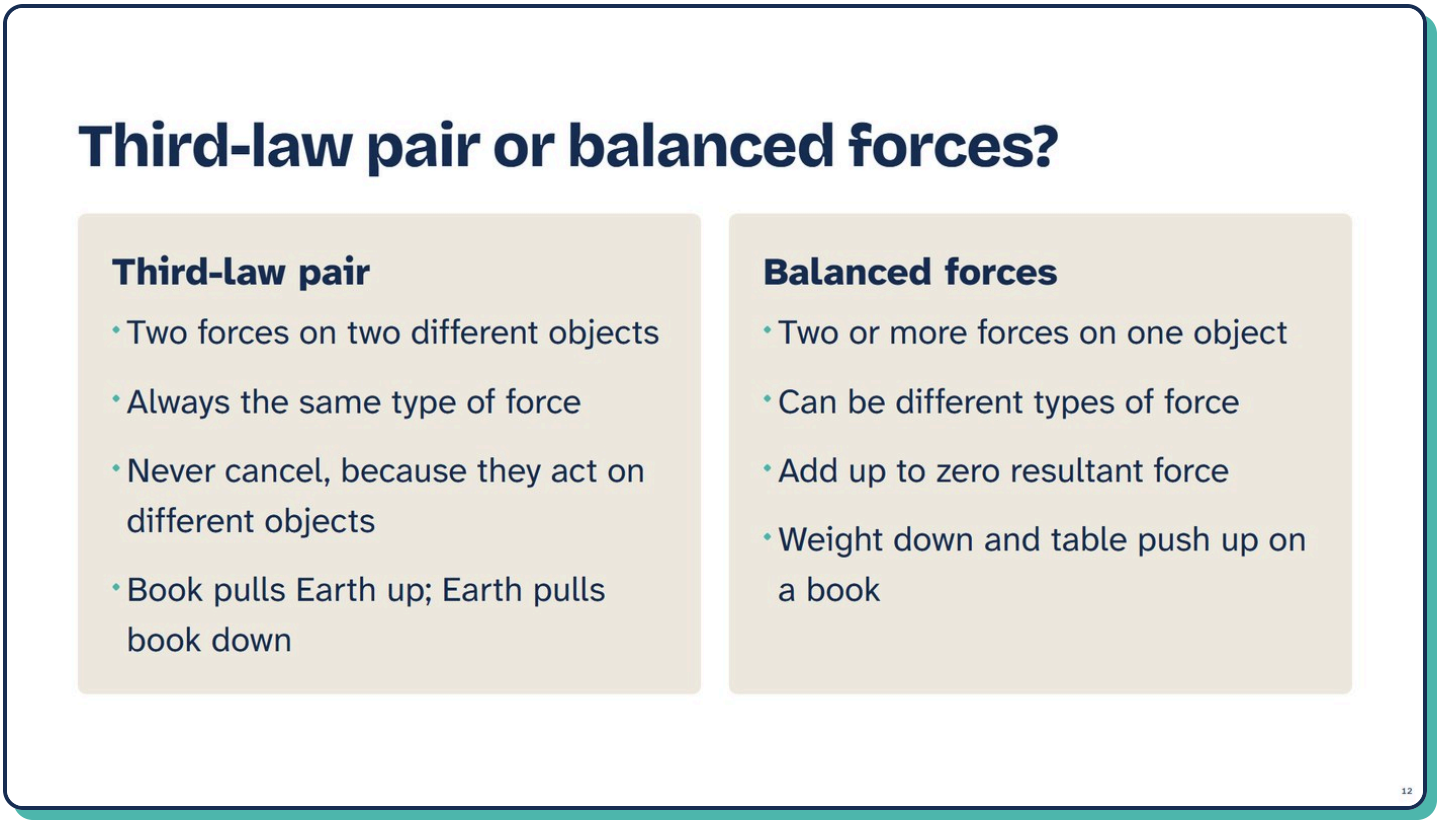

Third-law pair or balanced forces?

Teacher notes

This is the hardest idea in the lesson. The book's weight and the table's push are equal and opposite, but they are not a third-law pair: both act on the book and they are different types of force. The partner of the book's weight is the book's gravitational pull on the Earth.

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All three laws on one page

First law: no resultant force, no change in motion. Second law: F = ma. Third law: forces come in equal and opposite pairs on different objects.



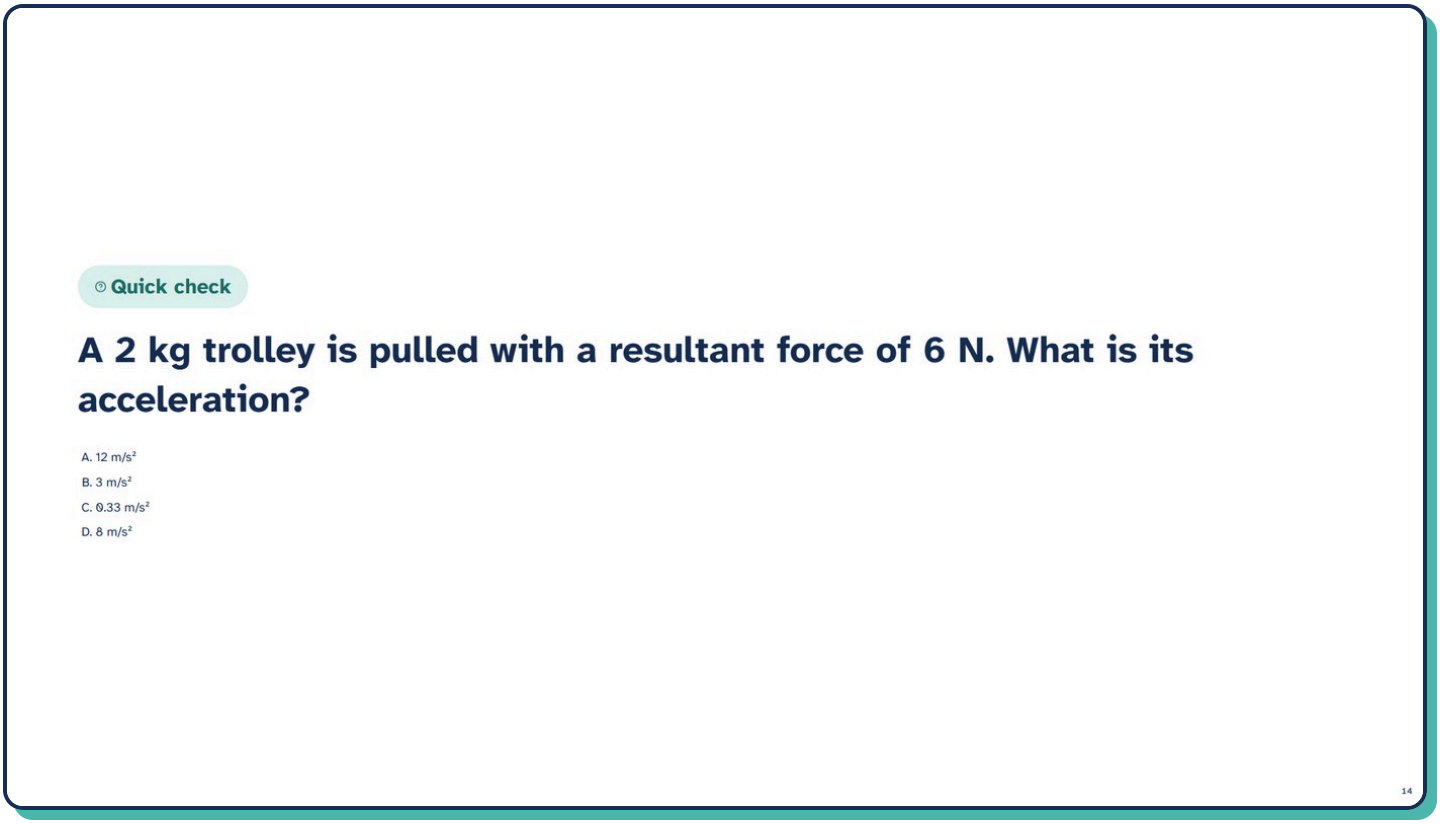
Poster: Newton's Three Laws of Motion Explained

13

All three laws on one page

Teacher notes

Use the poster as a recap or print it for the classroom wall. Ask students to add their own everyday example under each law in their books, then share one with a partner. Good examples: a bus passenger lurching forwards (first), a full trolley being harder to accelerate (second), a rowing boat moving forwards as the oars push water back (third).



Quick check

Teacher notes

Answer: B, 3 m/s², from a = F ÷ m = 6 ÷ 2. Students who chose A multiplied instead of dividing; students who chose D added the numbers. Ask one student to explain how they rearranged F = ma.

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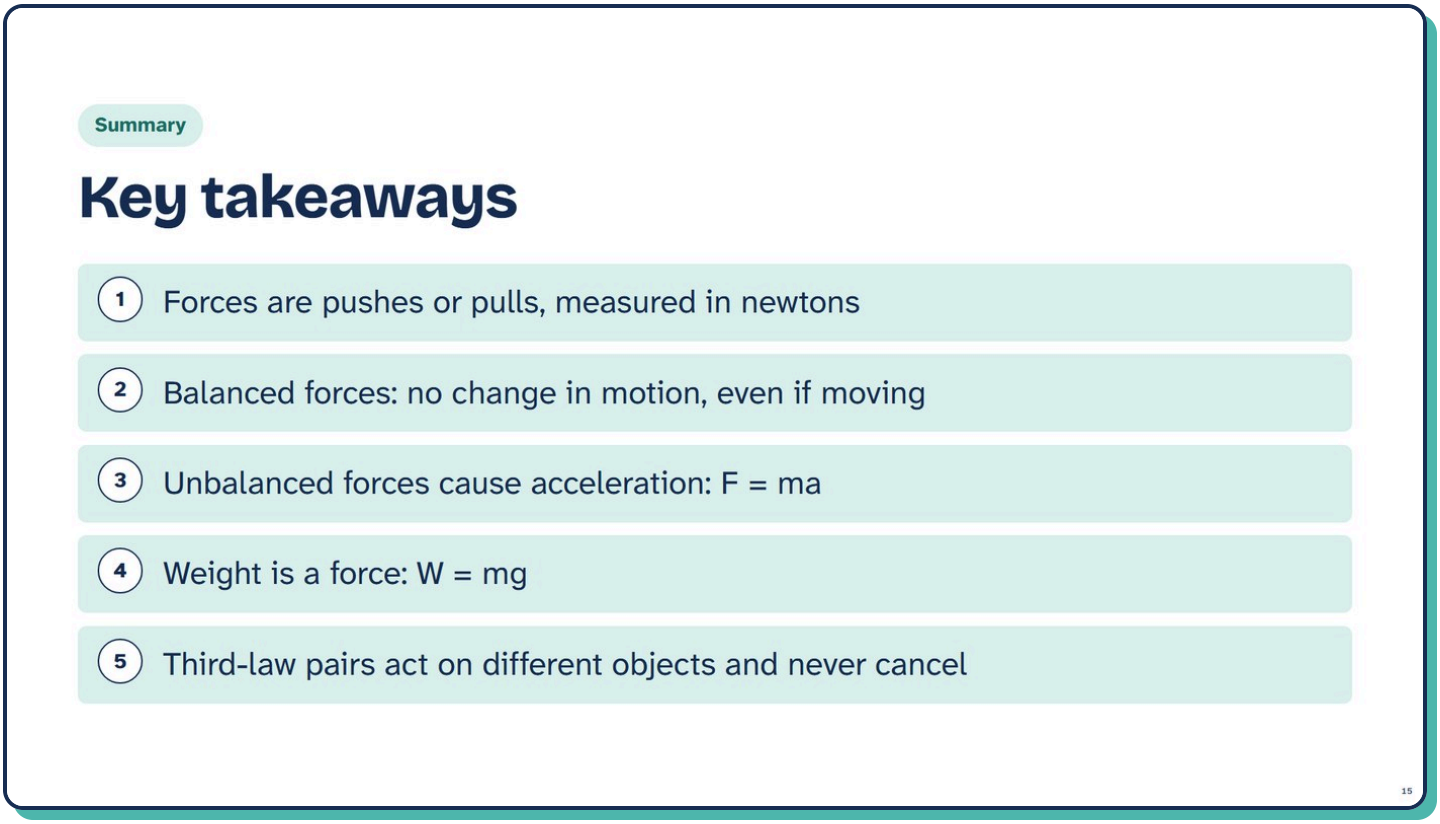

Key takeaways

Teacher notes

Ask students to explain the sliding book from the start of the lesson using the first law. Then move to the five-question quiz. Homework idea: find three examples of Newton's laws at home or on the way to school and label the forces with arrows.