SCIENCE FOUNDATIONS

Newton's laws of motion

Difficulty level: Intermediate

Science Foundations

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Overview of the concept

This is how you explain why you lurch forward when a bus brakes, why a rocket pushes exhaust down to go up, and why a heavier box is harder to shove. A seatbelt works because your body keeps moving forward when the car stops, exactly as the first law says. A rocket climbs because every push down on the exhaust comes with an equal push up on the rocket. Knowing Newton's laws tells you how motion and forces fit together, from a shopping cart to a spacecraft.



Rule

Newton's laws of motion: first, an object keeps its motion unless a net force acts on it. Second, net force equals mass times acceleration, $F = m \times a$. Third, every action has an equal and opposite reaction, and the two forces act on different objects.

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Worked examples

EXAMPLE 1

Q A 2 kg object is pushed with a net force of 10 N. Acceleration?

SOLUTION

Recall the second law:

force = mass × acceleration

Rearrange:

acceleration = force ÷ mass

Substitute:

acceleration = 10 ÷ 2 = 5 $\frac{m}{s^2}$

The result is acceleration 5 $\frac{m}{s^2}$.

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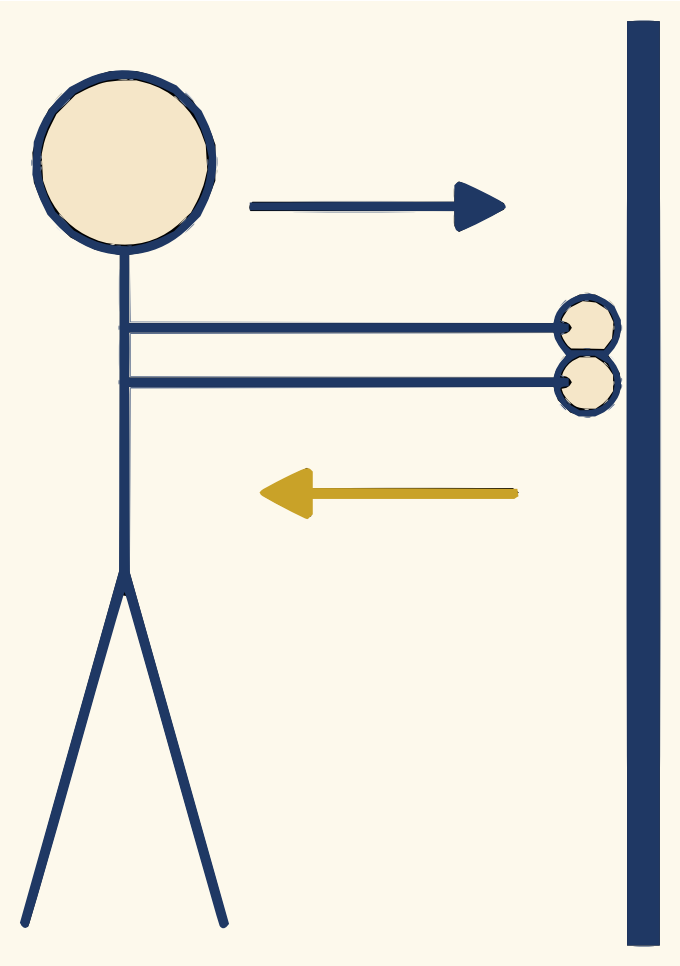
EXAMPLE 2

Q You push a wall; the wall pushes back. Which law?



SOLUTION

Ask what is happening: two forces, equal and opposite.

Check the laws: the third law describes action-reaction pairs.

Label it the third law.

The result is Newton's third law.

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Practice questions

1 A 6 kg object is pushed with a net force of 18 N. What is its acceleration?

- **A** $2\ \frac{m}{s^2}$
- **B** $3\ \frac{m}{s^2}$
- **C** $6\ \frac{m}{s^2}$
- **D** $12\ \frac{m}{s^2}$

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2 A net force of 20 N accelerates an object at 4 $\frac{m}{s^2}$. What is the mass of the object?

- **A** 4 kg
- **B** 5 kg
- **C** 16 kg
- **D** 80 kg

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3 A 10 kg object accelerates at 3 $\frac{m}{s^2}$. What net force acts on it?

- **A** 10 N
- **B** 20 N
- **C** 30 N
- **D** 40 N

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4 A swimmer pushes water backwards, and the water pushes the swimmer forwards. Which law is this?

- **A** Newton's first law
- **B** Newton's second law
- **C** Newton's third law
- **D** Newton's law of gravitation

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5 A 10 kg box and a 2 kg box are pushed with the same net force. Which one accelerates more?

- **A** The 10 kg box
- **B** The 2 kg box
- **C** They accelerate the same
- **D** Neither accelerates

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6 Which statement is the first law?

- A. An object keeps its motion unless a net force acts on it.
- B. Force equals mass times acceleration.
- C. Every action has an equal and opposite reaction.
- D. Acceleration depends only on the mass.

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7 A book sits still on a table. Which law explains it staying still?

- A. The first law
- B. The second law
- C. The third law
- D. The law of gravitation

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8

Which is the second law equation?

A F = m × a

B F = m ÷ a

C a = F × m

D F = m + a

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9

If the net force on an object is zero, what is its acceleration?

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10

Do action-reaction forces act on the same object?

A Yes

B No

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ANSWER KEY

1. 3 $\frac{m}{s^2}$

2. 5 kg

3. 30 N

4. Newton's third law

5. The 2 kg box

6. An object keeps its motion unless a net force acts on it.

7. The first law

8. $F = m \times a$

9. 0

10. No

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