

YEAR 10 SCIENCE

PHYSICAL WORLD: PART 2

LESSON 4: NEWTON'S LAWS

SAMPLE RESOURCES

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MATRIX
EDUCATION

THE HSC EXPERTS

3. Newton's First Law – The Principle of Inertia

□ Definition of Newton's First Law

- Newton's first law:

An object remains at rest or continues to travel with constant velocity unless acted upon by an unbalanced external force.

NOTE TO STUDENTS

Please do not rephrase or paraphrase the law. Students often omit the important parts of the law in exams.

- [Watch VIDEO](#) (Length 1:32): Newton's First Law explained using a car's safety devices.

□ Examples of Newton's First Law

- If you leave a book on your coffee table overnight, when you return in the morning, unless an external force moved it, it will be in the same place you left it.
- If you kick a soccer ball, it will continue moving until it hits something. However, a soccer ball may stop before hitting something. Explain.⁹⁰

- Consider a crash test dummy moving along with a car. It is not wearing a seat belt.

- The car hits a cement road divider. What happens to the car?⁹¹

- [Watch VIDEO](#) (Length: 0:41): Crash tests with and without seat belt and air bags.

4. Newton's Second Law

□ **Definition of Newton's Second Law**

- Newton's second law:

The magnitude of acceleration is proportional to the magnitude of the net force and inversely proportional to its mass.

- Newton's second law is expressed by the equation:

$$\mathbf{a} = \frac{\Sigma \mathbf{F}}{m} \quad \text{which is often expressed as} \quad \Sigma \mathbf{F} = m\mathbf{a}$$

- What are the units of:

- Mass?⁹²

- Acceleration?⁹³

- Mass × acceleration?⁹⁴

- Force is expressed in units of **Newtons** (N), which are equivalent to kg m s^{-2} . Define 1 N.⁹⁵

- **WHEN A NET FORCE ACTS ON A MASS, ACCELERATION IS PRODUCED.**
 - **The greater the net force, the greater the resulting acceleration.** Draw a graph of acceleration vs net force.⁹⁶

- **The greater the mass of the object being accelerated, the greater the amount of net force needed to accelerate the object.** Draw a graph of acceleration vs mass.⁹⁷

- Suppose a net force is moving a trolley.
 - Explain the effect on the acceleration of the trolley if the net force is doubled.⁹⁸

- Explain the effect on the acceleration if the trolley's mass is doubled.⁹⁹

☐ **Examples of Newton's Second Law**

- The diagram shows the horizontal forces that act on a moving motorbike.



- Describe the movement of the motorbike when force A equals force B.¹⁰⁰

- What happens to the speed of the motorbike if force B becomes smaller than force A?¹⁰¹

5. Newton's Third Law

□ Definition of Newton's Third Law

- Newton's third law is:

For every action force, there is an equal and opposite reaction force.

- [Watch VIDEO](#) (Length 5:58): Newton's Third Law explained by the astronauts on European Space Agency.

□ Example: Space Travel

- The picture below shows a space shuttle taking off from the ground.



By NASA; edited by jjron (tilt corrected) [Public domain or Public domain], via Wikimedia Commons

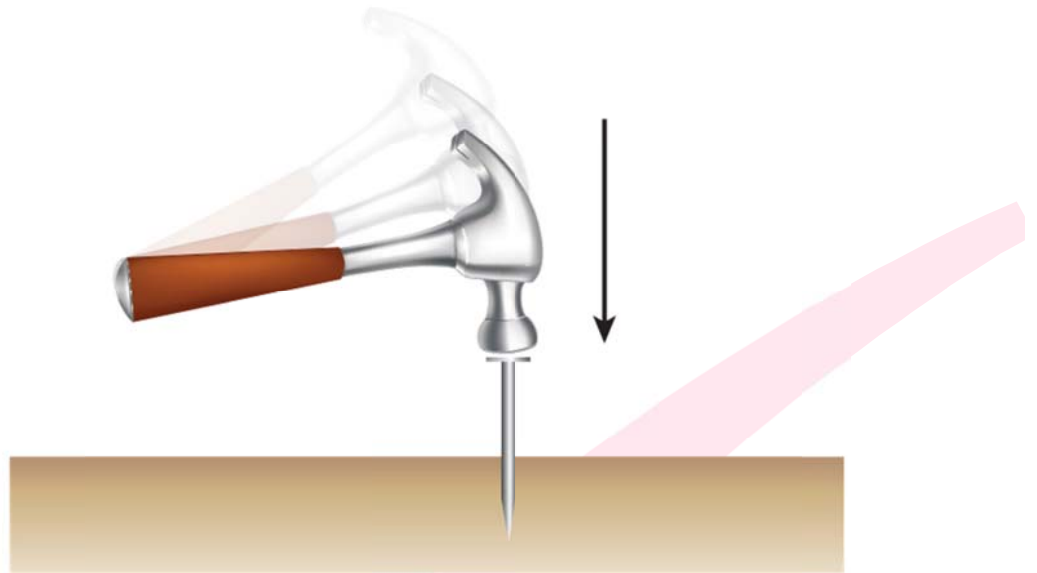
- The engines propel gas particles out the back of the space ship. Since every action force has an equal and opposite reaction force, the **space ship will be propelled forwards**, because it is pushing **gas particles out backwards**.

- Identify the action and reaction forces for a space ship moving forward.¹⁰²

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- [Watch VIDEO](#) (Length 4:50): Newton's Third Law in space.

□ **Example: Hammering a nail**

- The diagram shows a person hammering a nail.



- What does the person feel as she hammers the nail into the board?¹⁰³

- Identify the action and reaction forces.¹⁰⁴

- **ACTION:** The force of the hammer on the nail

- **REACTION:** _____

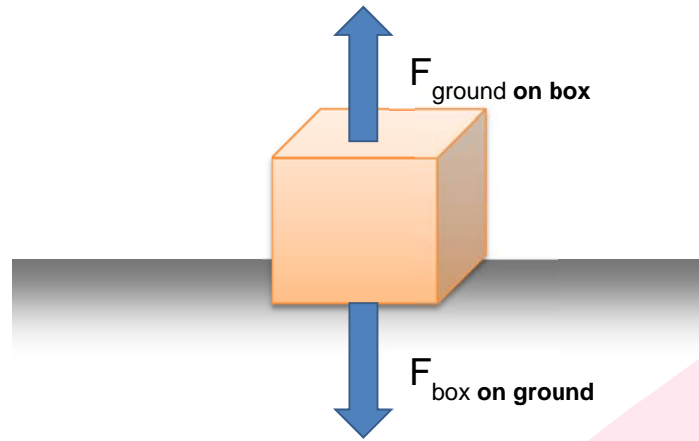
- Explain why the force of the hammer on the nail is equal to the force of the nail on the hammer.¹⁰⁵

NOTE TO STUDENTS

The action/reaction pair of forces acts separately on the two interacting objects. They do not act on the same object and hence they do not cancel out.

□ **Example: A box resting on a horizontal surface**

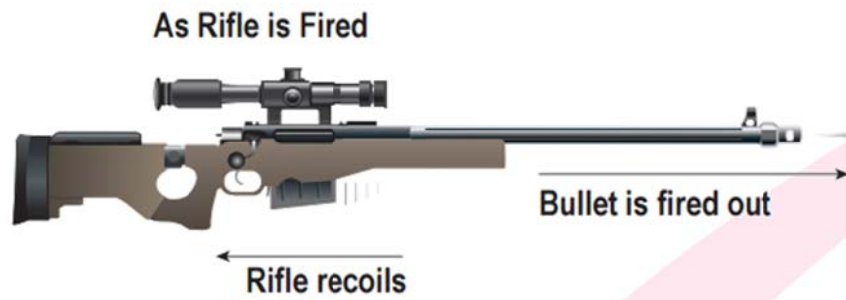
- Consider a box on the ground.



- There is a downward **action force** of attraction between the box and the earth (the weight force of the box).
 - There is an **equal but opposite reaction force** acting on the box from the ground.
- Identify the action and reaction forces:¹⁰⁶
 - **ACTION:** _____
 - **REACTION:** _____

□ **Example: Gun**

- A gun recoils when it is fired.
 - The recoil is the result of action-reaction force pairs.
 - As the gases from the gunpowder explosion expand, the gun pushes the bullet forwards and the bullet pushes the gun backwards.



- Identify the action and reaction forces:¹⁰⁷
 - **ACTION:** _____
 - **REACTION:** _____
- The action-reaction forces are equal and opposite in direction.