Physics

Grade 7-9

Innovative High School

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Dedication

To all the passionate learners who dare to dream and strive for excellence. May this book inspire you to explore, question, and grow in knowledge.

Preface

In an ever-evolving world, education remains a cornerstone of personal and societal development. This book aims to bridge the gap between theoretical knowledge and practical application for students in grades 7 to 9. We have compiled a wealth of information, engaging exercises, and real-world examples to foster critical thinking and creativity.

Our goal is to empower students to take ownership of their learning journey, encouraging them to ask questions, seek answers, and develop a lifelong love for knowledge. We hope this book serves as a valuable resource for students, teachers, and parents alike.

Acknowledgement

We would like to express our heartfelt gratitude to everyone who contributed to the creation of this book. Special thanks to our educators and mentors who have inspired us with their wisdom and guidance. We also appreciate the feedback from students and teachers during the drafting process, which has helped us refine our content.

Additionally, we thank our families for their unwavering support and encouragement throughout this journey. Lastly, we acknowledge the countless authors and researchers whose work has shaped our understanding and provided the foundation for this book.

About the Authors

This book is the result of collaboration among a dynamic and innovative team of high school students. United by a passion for learning and a commitment to academic excellence, these young authors have pooled their diverse talents and perspectives to create a resource that speaks directly to their peers.

Each member of the team brings unique insights from their individual experiences in various subjects, extracurricular activities, and community involvement. Together, they have crafted this book with the aim of empowering fellow students to embrace their educational journeys, think critically, and prepare for future challenges.

Through teamwork, creativity, and dedication, this high school team has created a guide that reflects their collective voice and vision for a brighter educational experience.

Introduction

As students transition through grades 10 to 12, they encounter a pivotal stage in their academic journey. This period is marked by increased responsibility, deeper exploration of subjects, and preparation for future endeavors—whether that be higher education or entering the workforce.

In this book, we aim to provide comprehensive coverage of essential topics while encouraging analytical thinking and problem-solving skills. Each chapter is designed not only to inform but also to engage students through interactive activities and thought-provoking questions. Our hope is that readers will find this book both educational and enjoyable, equipping them with the tools they need for success in their academic pursuits and beyond.

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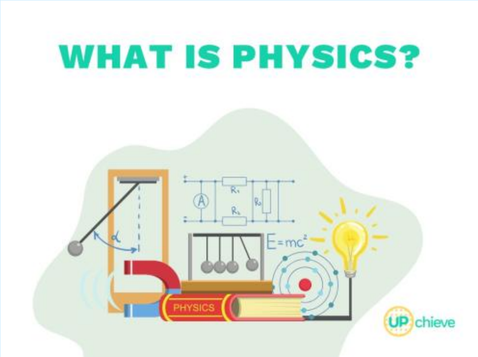
Chapter 1

Introduction to Physics

Lesson 1.1

What is Physics?



Physics is the branch of science that studies matter, energy, and how they interact. It helps us understand how things move, how forces work, why objects fall, how light travels, and how electricity flows. Physics explains the natural laws that govern our world and the universe.

Key Points

Physics deals with motion, forces, energy, heat, sound, light, electricity, and magnetism.
It helps us understand everyday events, from why the sky is blue to how machines work.
Physicists use experiments, observations, and mathematical models to explain the world.

Examples:

- A ball falling due to gravity
- A car speeding up and slowing down
- Light allowing us to see
- Sound traveling through air
- Electricity powering your phone

Why It Matters:

Physics forms the foundation of many fields such as engineering, medicine, astronomy, and technology.

Lesson 1.2

Importance of Physics in Everyday Life

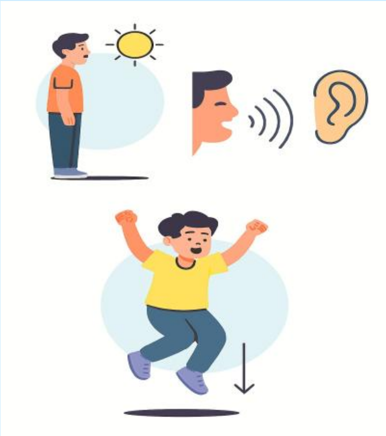
Physics is not just a subject in school it affects everything around us. Many devices, tools, and natural events can only be understood through physics.

Importance of Physics in Daily Life

1	**Technology**	Phones, computers, TVs, and the internet work because of physics principles.
2	**Transportation**	Cars, airplanes, and bicycles rely on motion, forces, and energy.
3	**Electricity**	Lights, chargers, fans, and refrigerators use electrical physics.
4	**Health and Medicine**	X-rays, MRI scanners, and laser treatments are based on physics.
5	**Nature**	Rainbows, sound echo, sunrise, and tides are explained through physics.

Examples:

- Your shadow changes size because of light physics.
- Your voice travels through air because of sound waves.
- When you jump, gravity pulls you back down.



Key Concept

Physics helps us make predictions, solve problems, and develop new technology. It is essential for understanding the world around us.

Summary of Chapter 1

Matter and Its Properties

Matter is anything that has mass and takes up space. It can be described by properties such as color, shape, texture, mass, volume, and density. These properties help us identify and compare different materials. Matter exists all around us in many forms and behaves differently depending on its characteristics.

Activity Box

Look around your classroom or home.

List **5 objects or situations** that involve physics (example: a light bulb, a moving fan).

For each one, write which area of physics it relates to (motion, light, sound, electricity, etc.).

For one day, observe where you use physics in your daily life.

Write down **3 moments** (example: boiling water, switching on lights, hearing sounds).

Explain briefly how physics is involved in each moment.

Question Review

What is physics?

Name three areas of physics.
Why is physics important in daily life?

Give two examples of physics in nature.

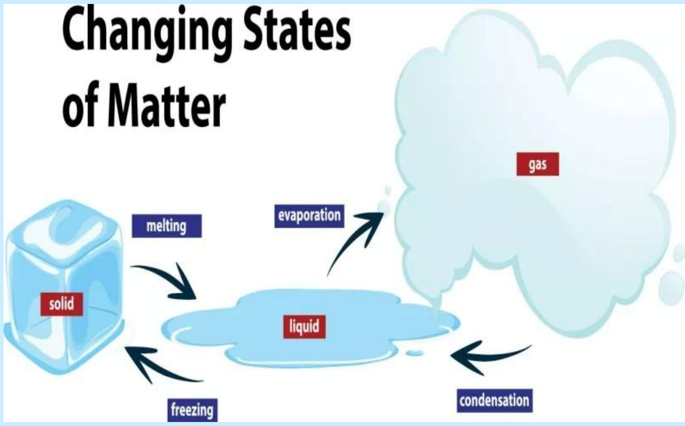
Explain how physics is used in technology.

Chapter 2

Matter and Its Properties

Lesson 2.1:

States of Matter



Matter is anything that has mass and takes up space. Everything around you is air, water, rocks, your notebook is made of matter. Matter exists in different forms based on how its particles are arranged and how much energy they have.

Three Main States

Solid	○ **Has a fixed shape and fixed volume** ○ **Particles are tightly packed and vibrate in place** ○ **Examples: ice, wood, stone**
Liquid	○ **Has a fixed volume but no fixed shape** ○ **Takes the shape of its container** ○ **Particles are close but can move around each other** ○ **Examples: water, milk, oil**
Gas	○ **Has no fixed shape and no fixed volume** ○ **Fills the entire space available** ○ **Particles are far apart and move freely** ○ **Examples: air, oxygen, carbon dioxide**

Lesson 2.2:

Physical and Chemical Properties

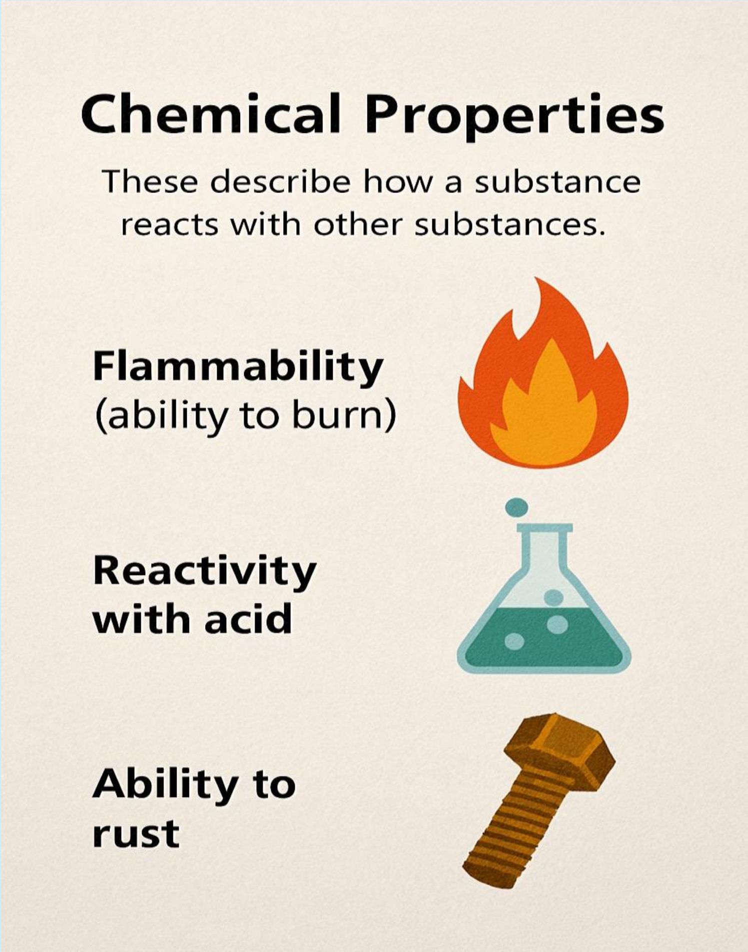
Matter has characteristics that help us identify and describe it. These characteristics are called properties.

Physical Properties

These can be observed without changing the substance.


Color
Shape
Density
Melting and bolling point
State (solid, liquid, gas)
Texture

Chemical Properties



Example:

Iron reacting with oxygen to form rust is a chemical change.

Key Concept

Physical properties do not change the identity of a substance, but chemical properties do.

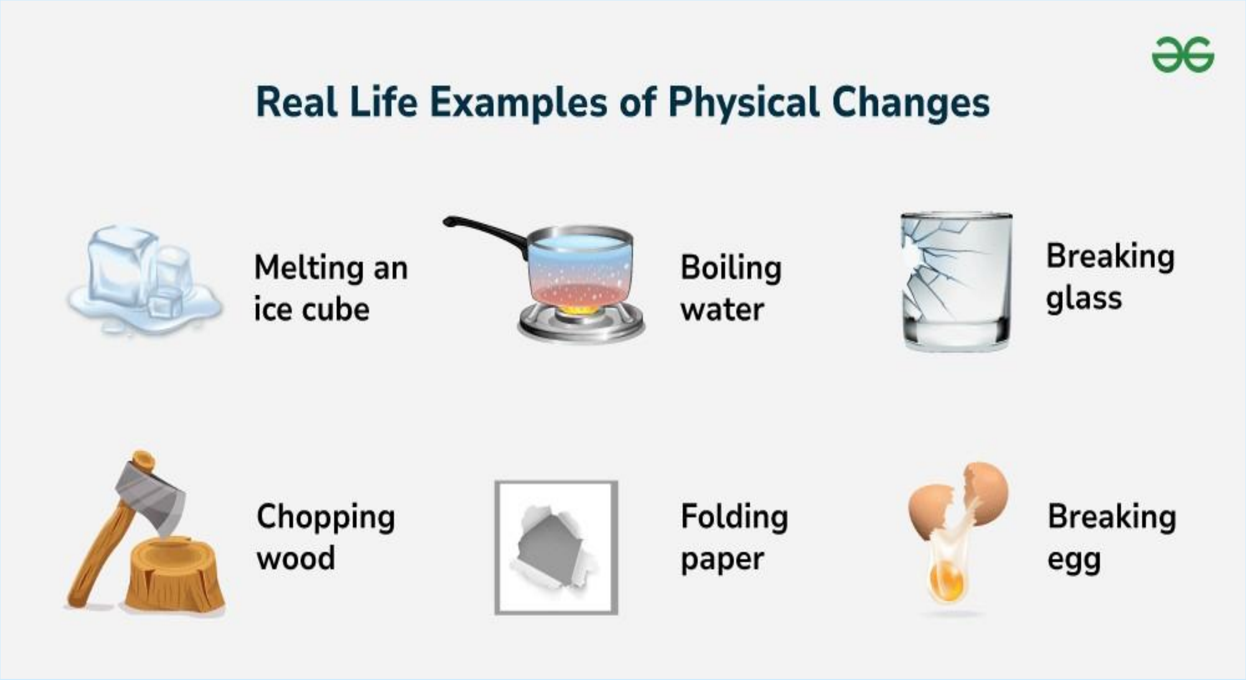
Lesson 2.3:

Changes in Matter

Matter can undergo changes. These changes are grouped into two types: physical changes and chemical changes.

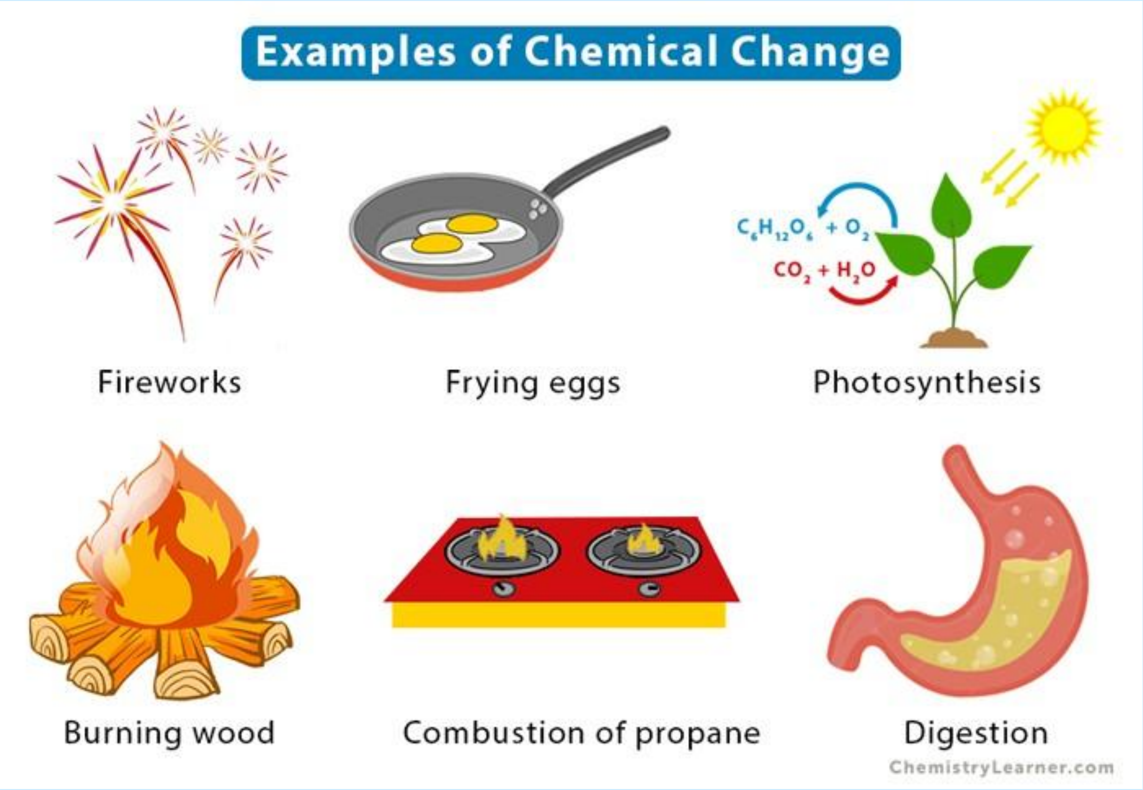
Physical Changes

- No new substance is formed
- Only the appearance or state changes
- Usually reversible



Chemical Changes

- A new substance is formed
- Often irreversible
- Signs include color change, gas production, or temperature change



Key Concept

A physical change affects form, while a chemical change affects identity.

Summary of Chapter 2

Elements, Compounds, and Mixtures

Elements are pure substances made of only one type of atom. Compounds are formed when two or more elements chemically combine to create a new substance. Mixtures are physical combinations of materials that keep their original properties. Mixtures can be separated by simple methods, while compounds cannot because they are chemically bonded.

Activity Box

Observe or imagine these simple scenarios at home:

- **Ice melting**
- **Paper burning**
- **Salt dissolving in water**

Classify each as a physical or chemical change.

Explain briefly *why* you chose that category.

Question Review
What is matter?
Describe the three states of matter.
What is the difference between a physical and chemical property?
Give two examples of physical changes.
Give two examples of chemical changes.
How are particles arranged in solids, liquids, and gases?
Why are chemical changes usually irreversible?

Chapter 3

Motion and Forces

Lesson 3.1:

Introduction to Motion

What Is Motion?

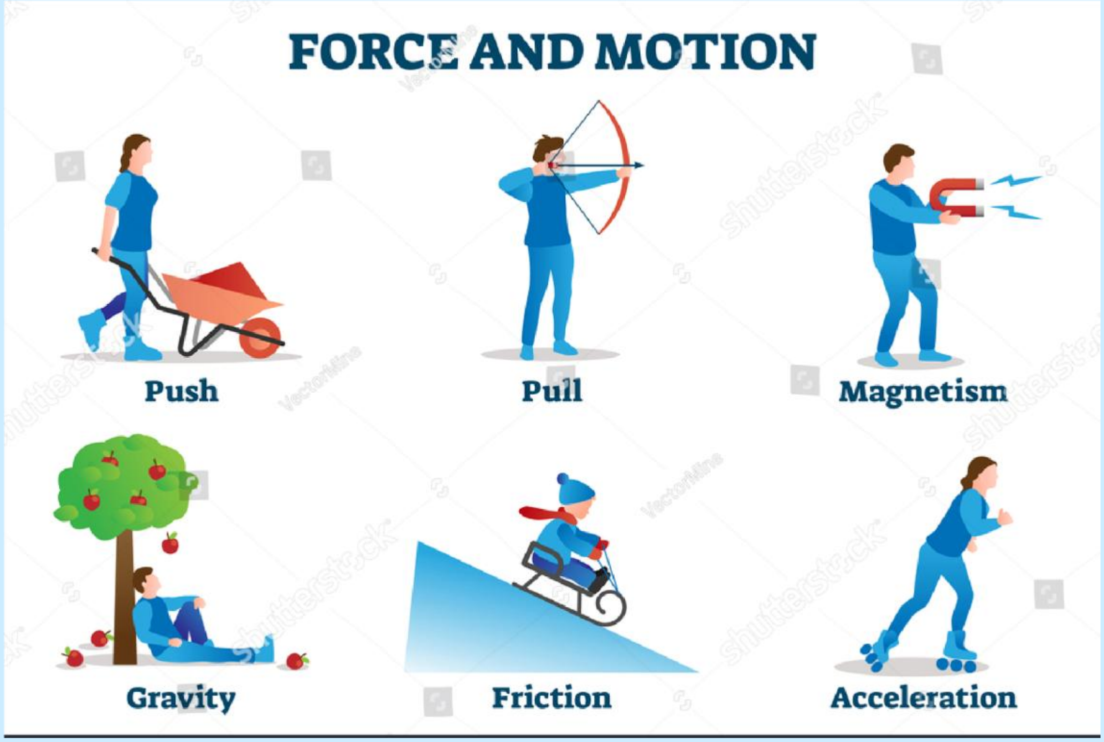
Motion is the change in position of an object over time.
If something moves from one place to another, it is in motion.

Key Ideas

Motion needs **a reference point** (a fixed point used to compare).	If the position of an object changes compared to the reference point, it is moving.

Examples

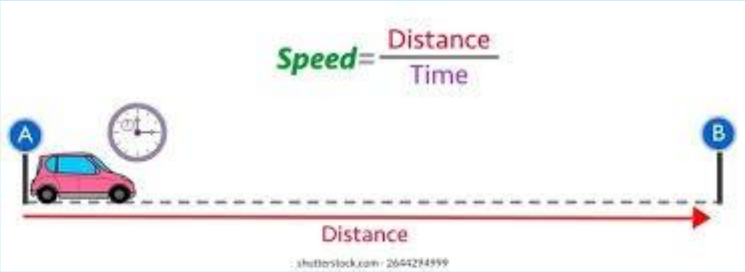
- A car moving on a road
- A boy walking across a room
- The Earth moving around the Sun



Lesson 3.2:
Speed and Velocity

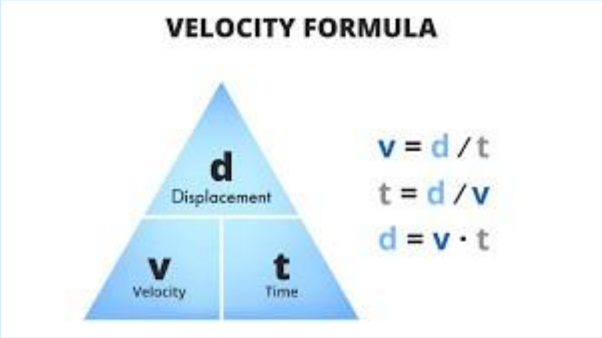
Speed

Speed tells us how fast something is moving.
It is calculated using:



Velocity

Velocity is speed **in a specific direction.**



Examples

- A car moving at 60 km/h ⟶ speed
- A car moving at 60 km/h east ⟶ velocity

Key Differences

Speed ⟶ no direction	Velocity ⟶ includes direction

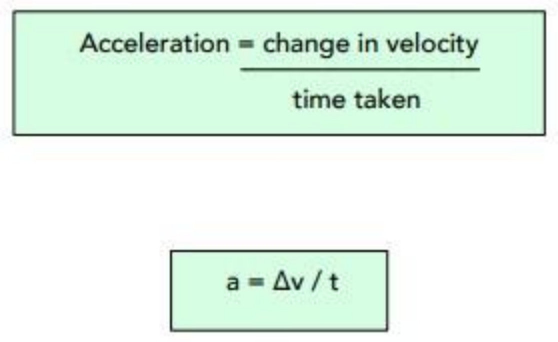
Lesson 3.3:
Acceleration

What Is Acceleration?

Acceleration is the **rate at which velocity changes**.

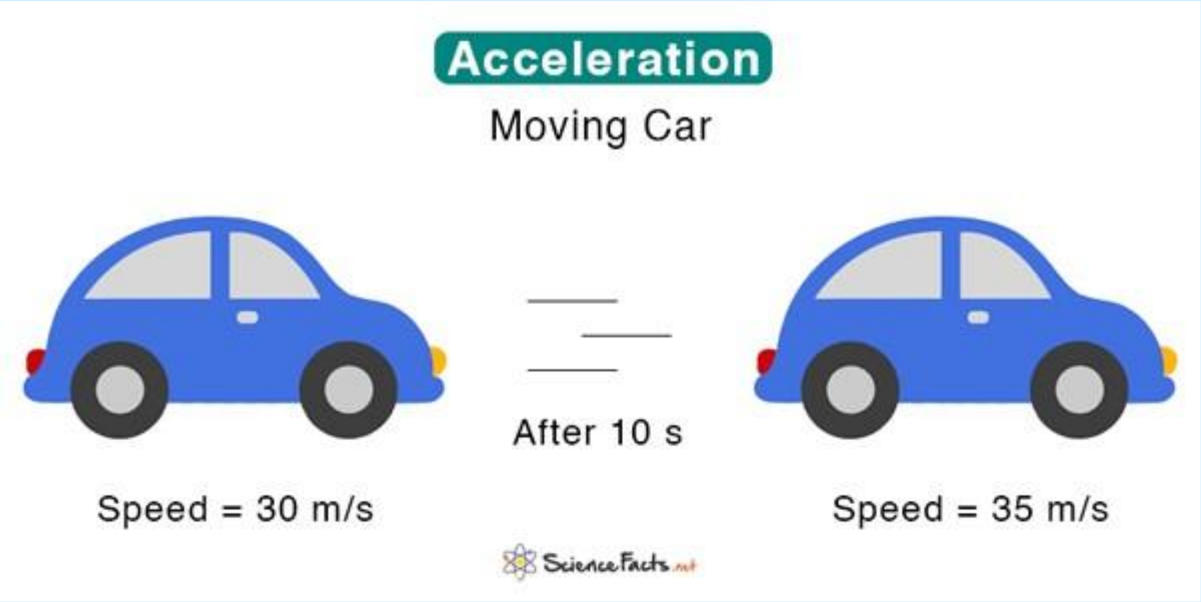
An object accelerates when:

- It speeds up
- It slows down
- It changes direction



Examples

- A bicycle increasing speed
- A car stopping at a red light
- A roller coaster turning a curve



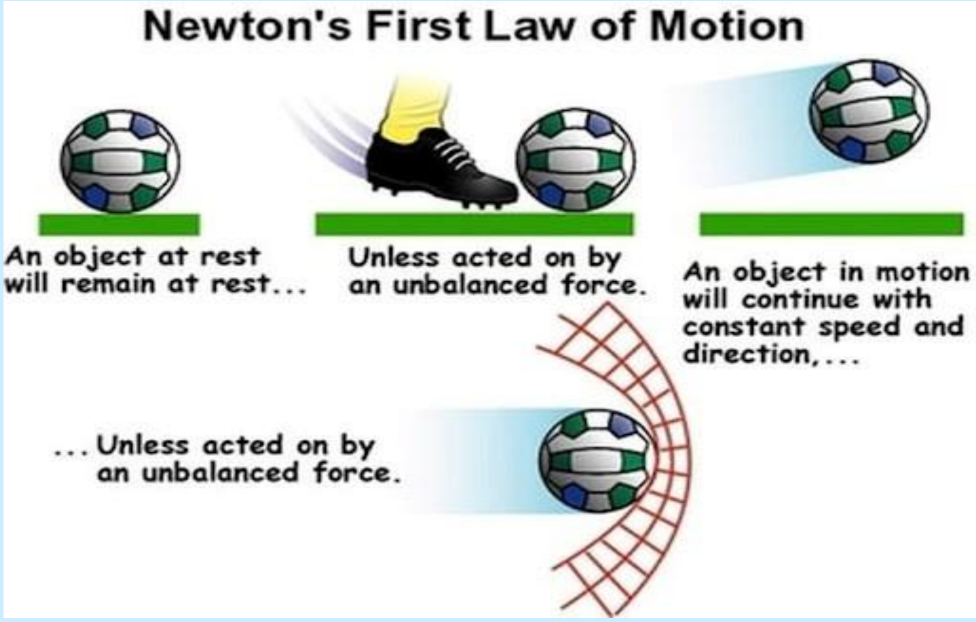
Lesson 3.4:

Newton's Laws of Motion

1. First Law (Law of Inertia)

An object at rest stays at rest, and an object in motion stays in motion, unless acted on by a force.

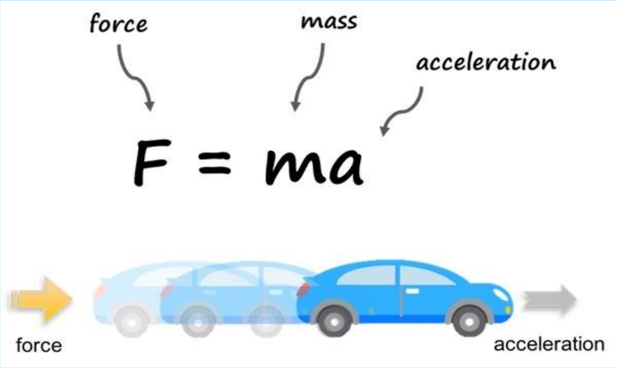
Example:
A ball will not move unless you kick it.



2. Second Law (Force = Mass × Acceleration)

A heavier object needs more force to accelerate.

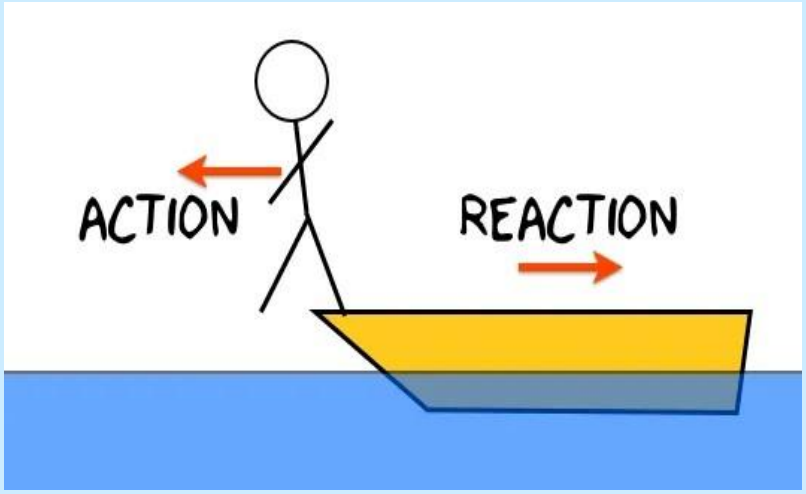
Example:
It is harder to push a full cart than an empty one.

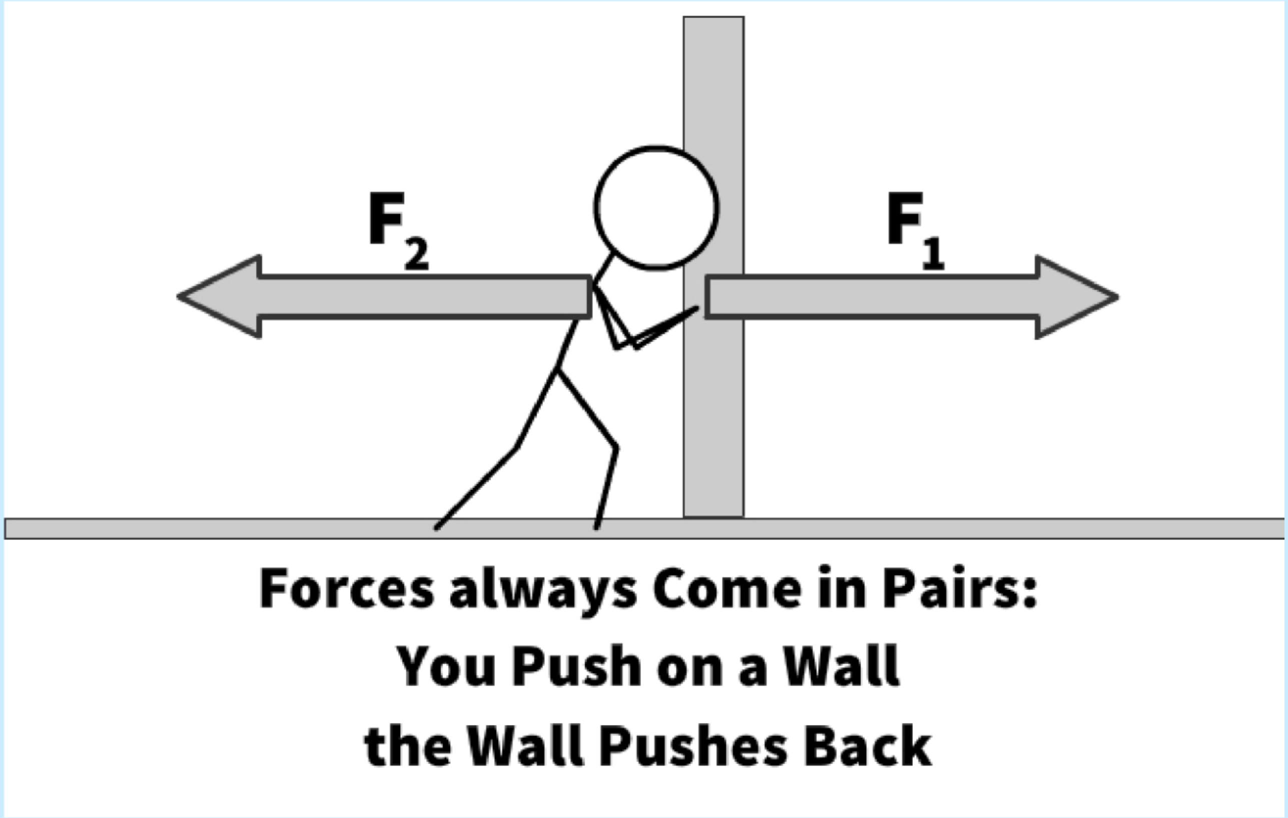


3. Third Law (Action and Reaction)

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

Example:
When you jump, your legs push down on the ground/river, and the ground pushes you up.





Summary of Chapter 3

States of Matter

Matter can exist as a solid, liquid, or gas. Solids have a fixed shape and volume. Liquids have a definite volume but take the shape of their container. Gases have no fixed shape or volume. Changes of state such as melting, freezing, evaporation, and condensation happen when heat energy is added or removed.

Activity Box

Materials: A small ball

Steps:

1. **First Law:** Place the ball on the floor. What happens? Then gently push it what changes?

2. **Second Law:** Push the ball softly, then push it strongly. Which push makes it accelerate more?

3. **Third Law:** Throw the ball against a wall. Notice how it pushes back (bounces).

Write one sentence for each law explaining what you observed.

Question Review

1. What is motion?
2. What is a reference point? Why is it important?
3. Write the formula for speed.
4. What is the difference between speed and velocity?
5. Define acceleration in your own words.
6. Give an example of an object that is accelerating even if its speed does not change.
7. State Newton’s First Law.
8. State Newton’s Second Law and write its formula.
9. State Newton’s Third Law.
10. Give two real-life examples of Newton’s Laws.

Chapter 4

Energy

Lesson 4.1:

Types of Energy (Kinetic & Potential)

Energy Notes

What is Energy?

Energy makes change. Energy moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs on the radio and lights our homes.

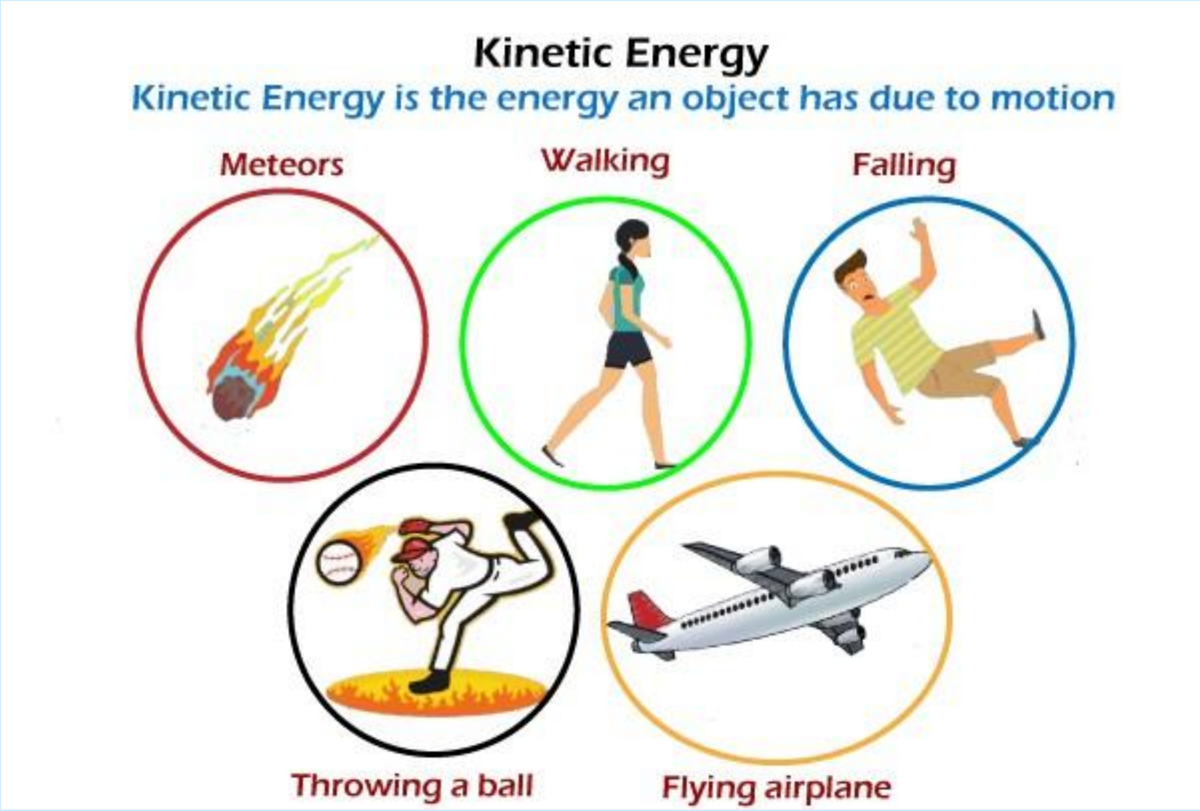
Energy makes our bodies grow and allows our minds to think. Scientists define energy as the ability to do work. People have learned how to change energy from one form to another so that we can do work more easily and live more comfortably.

Kinetic Energy (Energy of Motion)

Kinetic energy is the energy an object has because it is **moving**.

Examples:

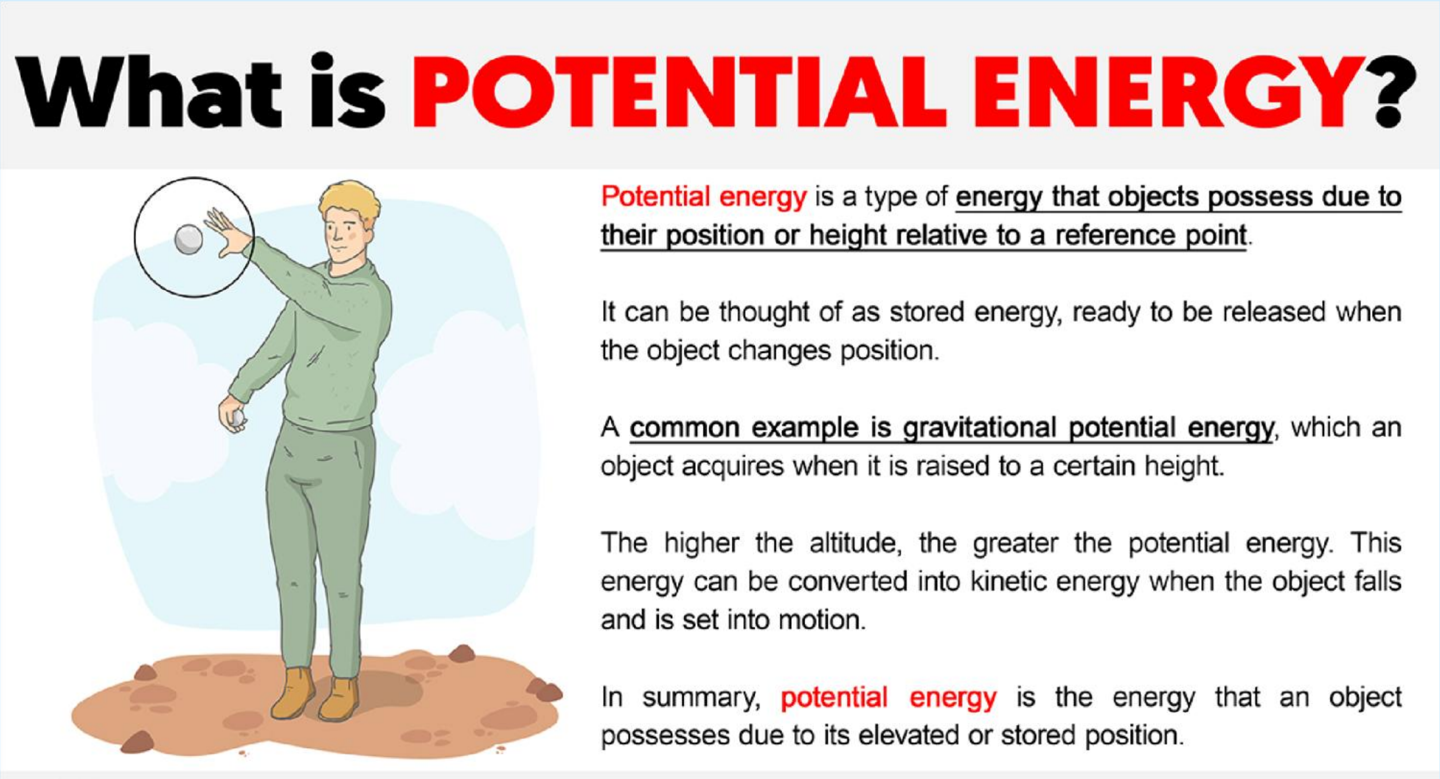
- A moving car
- A running person
- Flowing water
- A rolling ball



Key Point:
Faster or heavier objects have **more** kinetic energy.

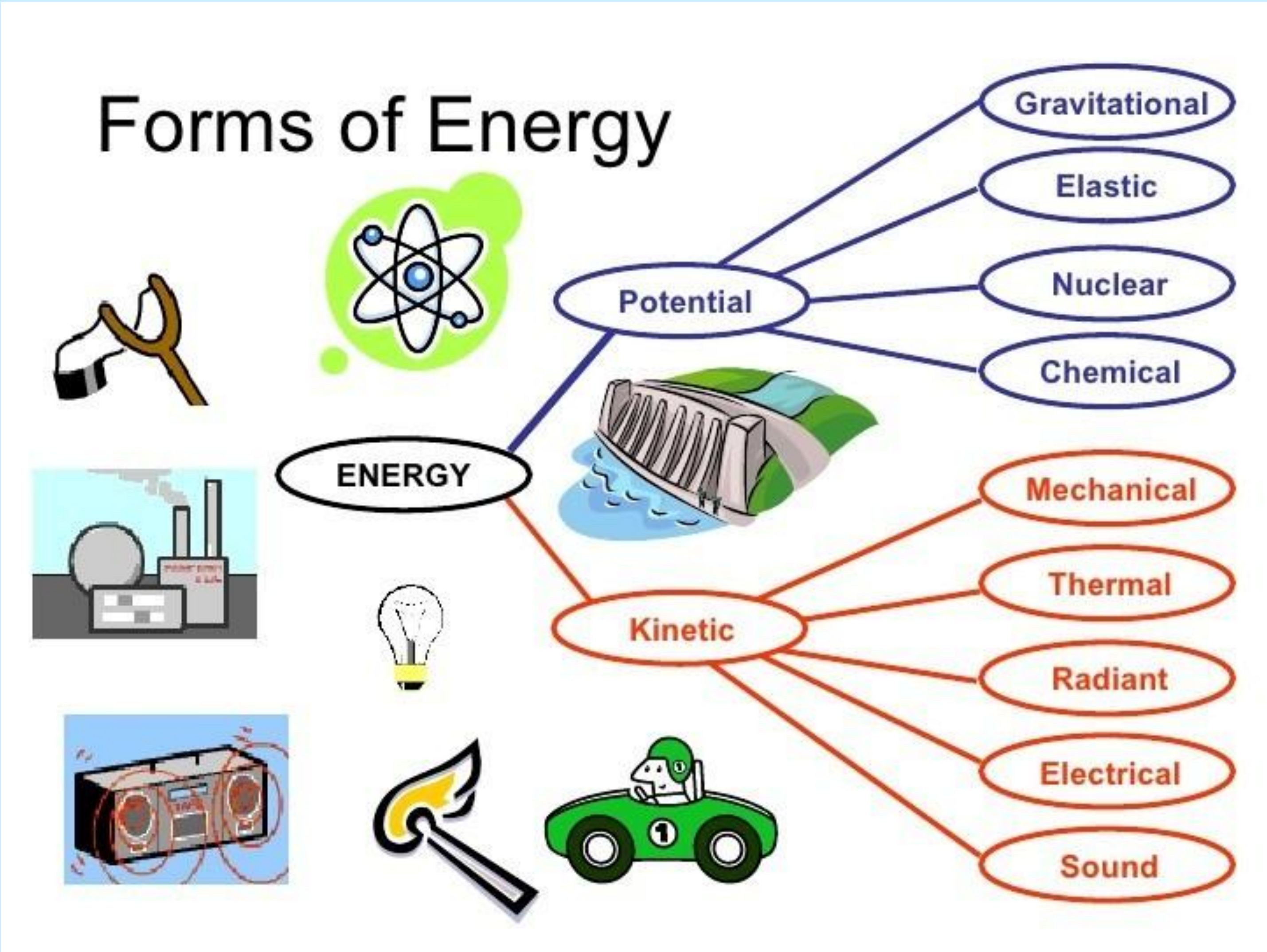
Potential Energy (Stored Energy)

Potential energy is the energy **stored** in an object because of its position or condition.



Two common types:

1. Gravitational Potential Energy Energy stored in an object because of its height. Examples: ● A book on a shelf ● Water behind a dam ● A ball held in your hand	**2. Elastic Potential Energy** Energy stored when objects are stretched or compressed. Examples: ● A stretched rubber band ● A compressed spring



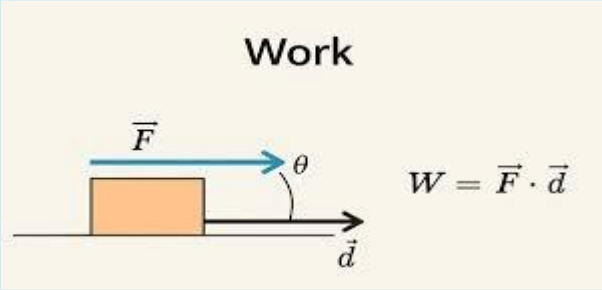
Forms of Energy
ENERGY
Potential
Gravitational
Elastic
Nuclear
Chemical
Kinetic
Mechanical
Thermal
Radiant
Electrical
Sound

Lesson 4.3:

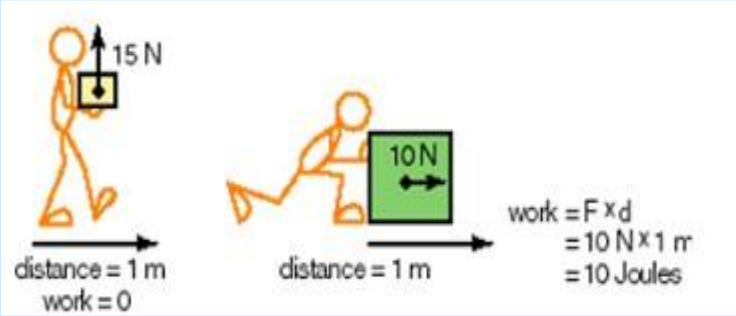
Work and Energy

What Is Work in Physics?

Work is done when a **force** moves an object in the direction of the force.



Examples of Work



- Lifting a box
- Pushing a cart
- Pulling a rope

When Is No Work Done?

- If you push a wall and it does not move
- If you hold a heavy bag without moving it
  (There is force, but no movement → no work)

Relationship Between Work and Energy

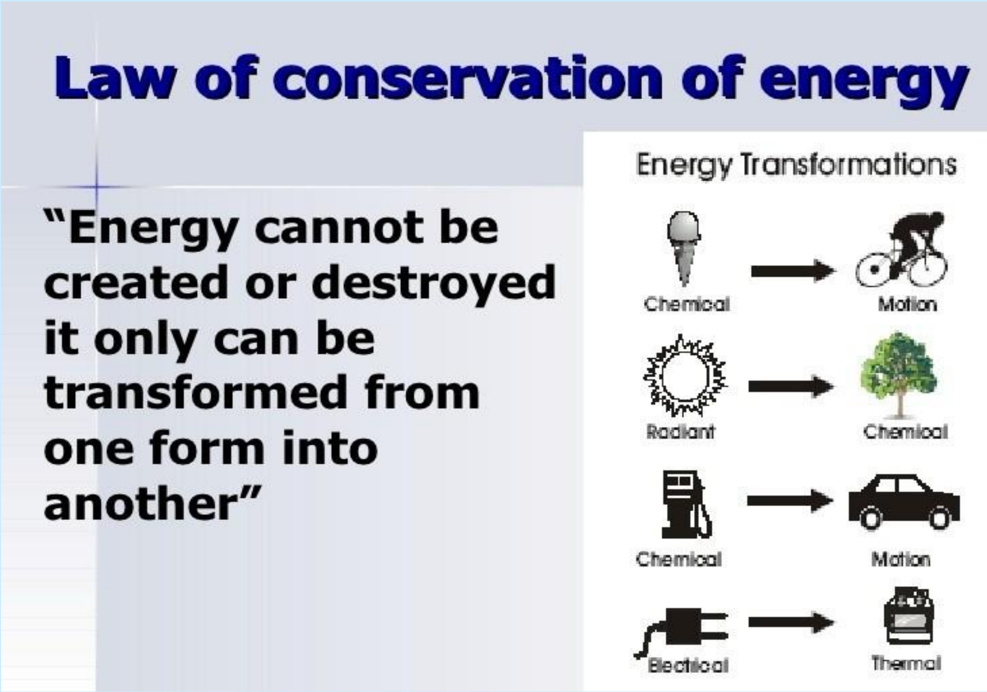
- Doing work **uses energy**
- Energy is the **ability to do work**

Example: You use chemical energy from your muscles to lift an object.

Lesson 4.2:
Law of Conservation of Energy

What Does the Law Say?

Energy **cannot be created or destroyed**, but it can **change from one form to another**.



Examples of Energy Transformations

- When you drop a ball:
  - Potential energy → Kinetic energy
- When you turn on a lamp:
  - Electrical energy → Light + Heat
- A car engine:
  - Chemical energy (fuel) → Motion + Heat

Key Point:

The **total amount of energy** stays the same.

Summary of Chapter 4

Plasma and Changes of State

When a gas receives enough energy, it becomes plasma an extremely energized state where particles are electrically charged. Plasma is found in lightning, the sun, and neon signs. Heat energy affects states of matter: adding heat causes particles to move faster, while removing heat slows them down. This process explains why substances melt, freeze, boil, or condense.

Activity Box

Look around your classroom, home, or school yard and identify:

- **3 examples of kinetic energy** (things that are moving)
- **3 examples of potential energy** (things that are stored or positioned)

Observe any of the following items or actions:

- A flashlight
- A bouncing ball
- A moving bicycle
- A burning candle

Write down:

1. The **initial form** of energy
2. The **final form(s)** of energy
3. How energy was *transformed*

Question Review

1. What is energy?
2. What is the difference between kinetic and potential energy?
3. Give two examples of kinetic energy and two examples of potential energy.
4. State the Law of Conservation of Energy.
5. Give an example of energy changing from one form to another.
6. What is work in physics?
7. Write the formula for work.
8. Why is no work done when you push a wall that does not move?
9. How are work and energy related?
10. Which has more kinetic energy:

● A slow-moving truck OR a fast-moving bicycle?
Explain your answer

Chapter 5

Waves and Sound

Lesson 5.1:

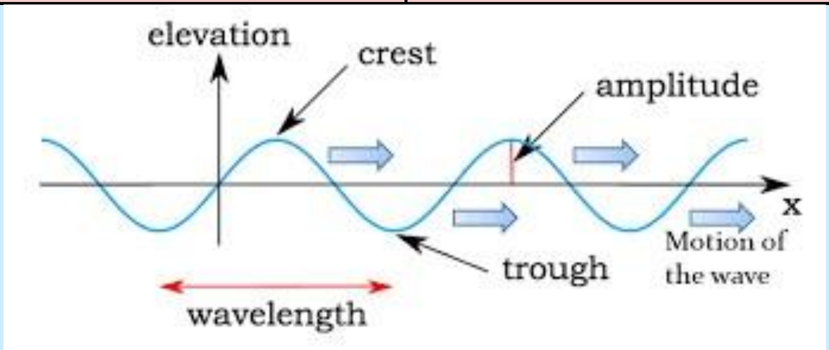
Nature of Waves

What Is a Wave?

A wave is a **disturbance** that carries **energy** from one place to another **without moving matter permanently**.

Two Main Types of Waves

1. Mechanical Waves	2. Electromagnetic Waves
• Need a **medium** (solid, liquid, or gas) to travel. • Examples: sound waves, water waves, waves on a rope.	• Do **not** need a medium; can travel through empty space. • Examples: light, radio waves, X-rays.



Key Wave Terms

- **Crest:** highest point of a wave
- **Trough:** lowest point
- **Wavelength:** distance between two crests or troughs
- **Frequency:** number of waves passing a point per second

Lesson 5.2:
Sound Waves

What Is Sound?

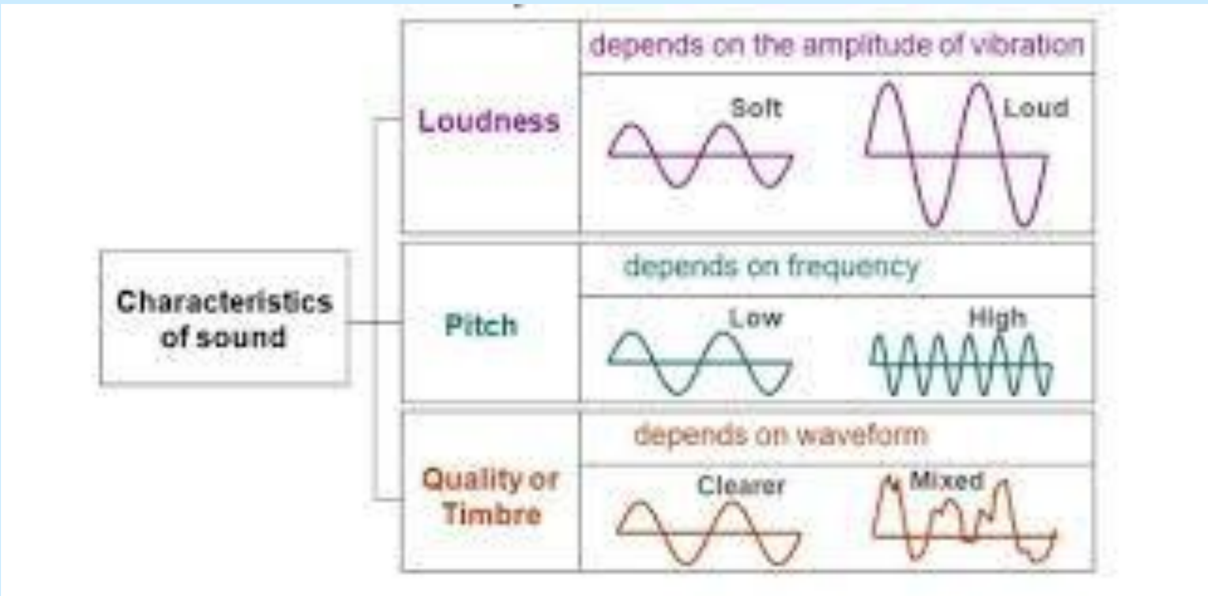
Sound is a type of **mechanical wave** that travels by **vibrations** moving through a medium.

How Sound Is Produced

- When something vibrates, it causes nearby air particles to move.
- These vibrations travel as **longitudinal waves**.

Characteristics of Sound

- **Pitch:** how high or low a sound is (depends on frequency)
- **Loudness:** depends on the wave's amplitude
- **Speed of sound:** fastest in solids, slower in liquids, slowest in gases


Characteristics of sound
Loudness
depends on the amplitude of vibration
Soft
Loud
Pitch
depends on frequency
Low
High
Quality or Timbre
depends on waveform
Clearer
Mixed

Lesson 5.3:
Properties of Sound

Frequency ● High frequency → high-pitched sound ● Low frequency → low-pitched sound Example: A whistle has a high pitch; a drum has a low pitch.
Amplitude ● Taller waves → louder sound ● Shorter waves → softer sound
Speed of Sound Depends on the medium: ● Solids: fastest (particles are closest) ● Liquids: medium speed ● Gases: slowest
Reflection of Sound (Echo) Sound can bounce off surfaces. When sound reflects back, it produces an echo. Example: Shouting in a large empty hall or mountains.

Summary of Chapter 5

Physical and Chemical Changes

A physical change alters the appearance or state of matter without forming a new substance (like cutting paper or melting ice). A chemical change creates a new substance with new properties (like rusting or burning). Signs of chemical change include temperature change, color change, gas formation, or formation of a solid.

Activity Box

1. Hold one end of the rope while a partner holds the other end.
2. Move your arm up and down to create waves.
3. Observe the **crests** and **troughs**.
4. Try shaking the rope faster—what happens to the frequency?
5. Try shaking slower—what changes?

Write your observations about wavelength and frequency.

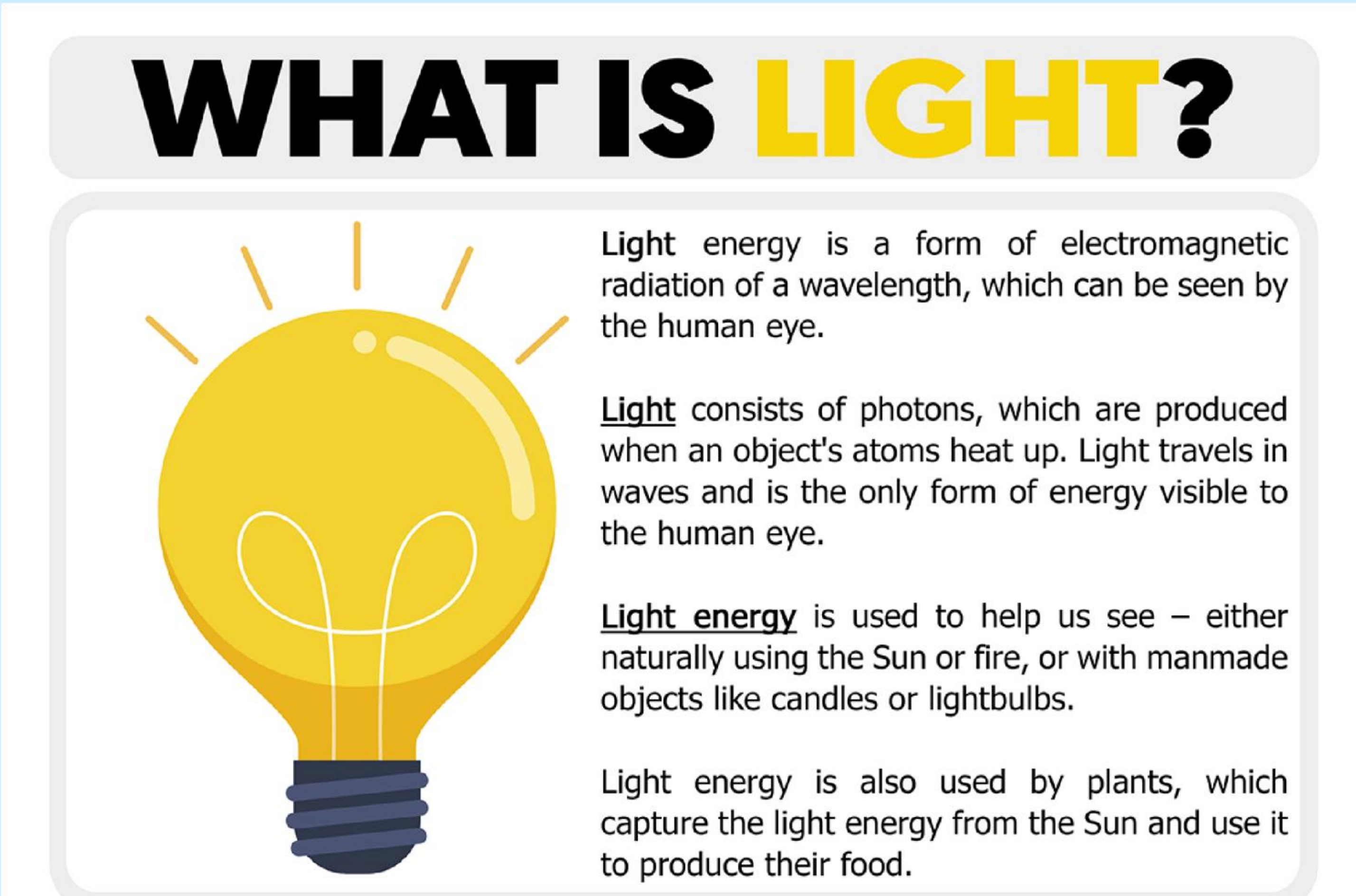
Question review
What is a wave? Name the two main types of waves. What is the difference between mechanical and electromagnetic waves? What causes sound? Why can't sound travel through space? What is pitch? What property of a sound wave determines loudness? In which medium does sound travel the fastest? Why? What is an echo? Give two real-life examples of sound reflection.

Chapter 6

Light and Optics

Lesson 6.1:

Nature of Light



Speed of Light	**How Light Travels**	**Sources of Light**
● Light travels extremely fast: about **300,000 km per second** in air/vacuum. ● It travels slower in liquids and solids.	● Light travels in **straight lines**. ● These straight lines are called **rays**.	● **Natural:** Sun, stars, fire ● **Artificial:** Bulbs, flashlights, LEDs

Lesson 6.2: Reflection and Refraction

Reflection

Reflection is when light **bounces off** a surface.

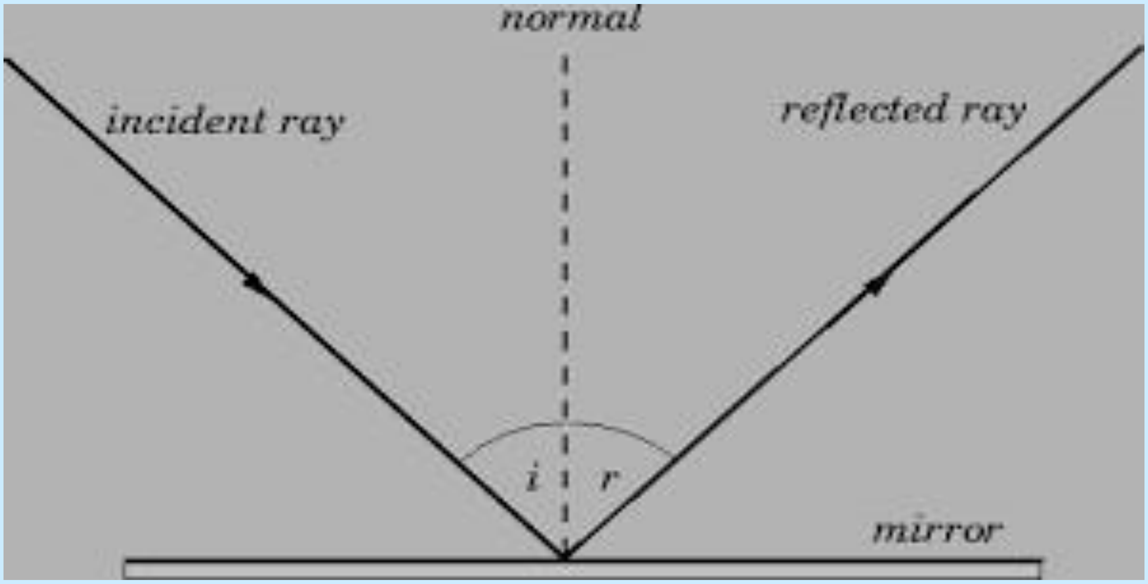
Examples:

- Seeing yourself in a mirror
- Light bouncing off water
- A shiny metal object reflecting light

Laws of Reflection

1. The **angle of incidence** = the **angle of reflection**

2. The incident ray, reflected ray, and normal all lie on the same plane



Refraction

Refraction is the **bending of light** when it passes from one medium to another.

Examples:

- A straw looks bent in water
- Lenses in glasses bending light
- A prism creating a rainbow

Why Does Refraction Happen?

Light changes **speed** when it enters a different material (air → water → glass).

Lesson 6.3: Lenses and Mirrors

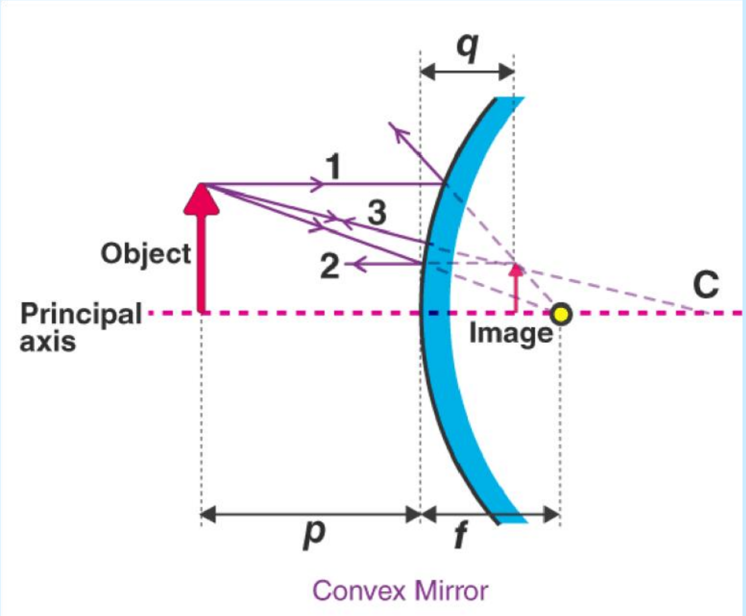
Mirrors

- **Plane mirror:** flat surface •
Produces an image that is:

    - same size
    - Upright
    - reversed (left becomes right)

Curved Mirrors:

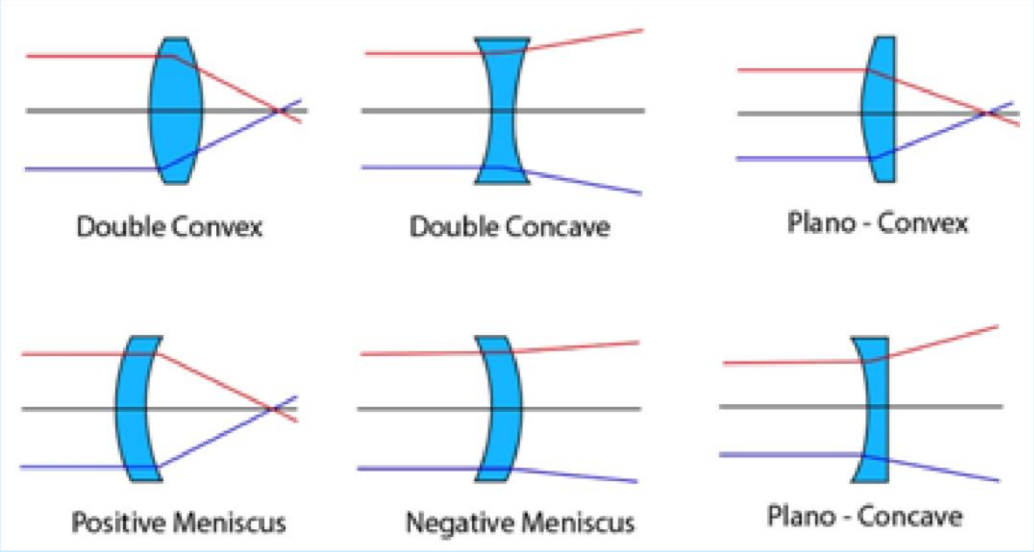
Concave mirror – curves inward ○ Can magnify images ○ Used in makeup mirrors, headlights
Convex mirror – curves outward ○ Shows a wider view ○ Used in security mirrors, car side mirrors



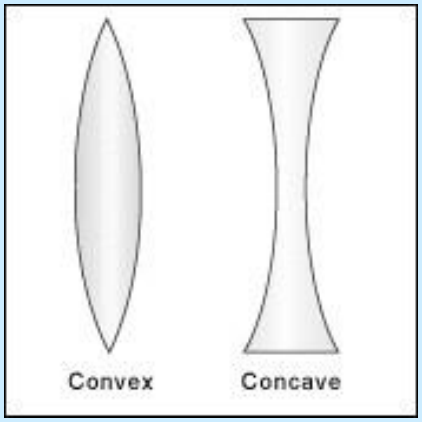
Lenses

A lens is a transparent material that **refracts** light.

Types of Lenses



1. **Convex Lens (Converging Lens)**



  ○ Bulges outward

  ○ Brings light rays together

  ○ Used in:

    ■ magnifying glasses
    ■ Cameras
    ■ human eye
    ■ Microscopes

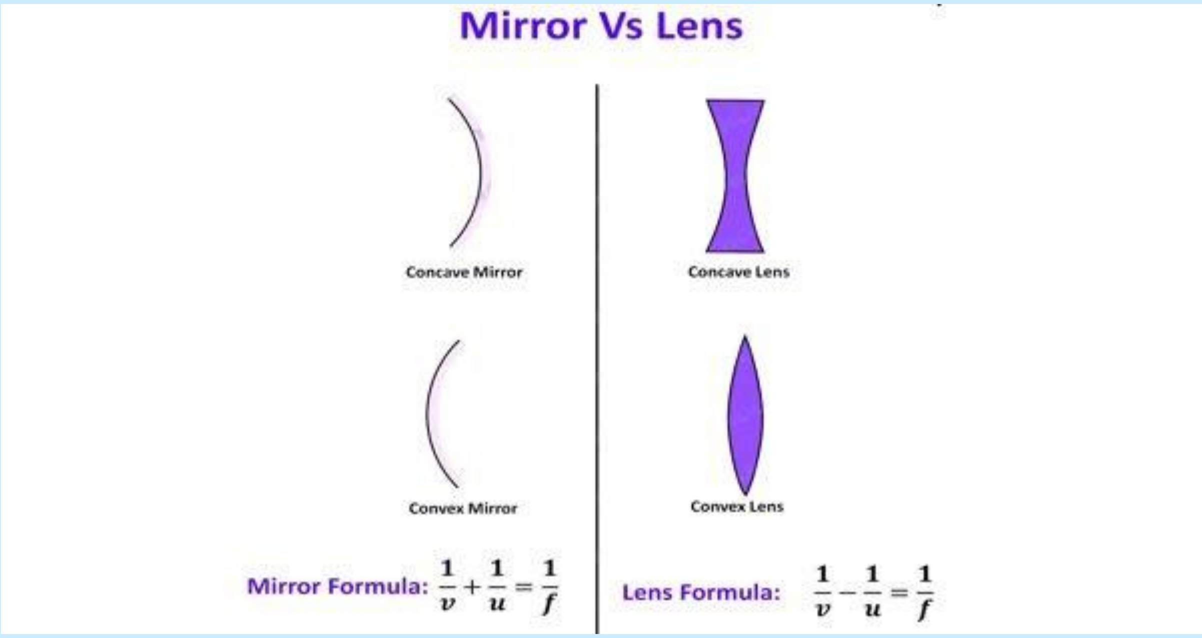
2. **Concave Lens (Diverging Lens)**

  ○ Curves inward

  ○ Spreads light rays apart

  ○ Used in:

    ■ eyeglasses for nearsightedness
    ■ peepholes in doors



Summary of Chapter 6

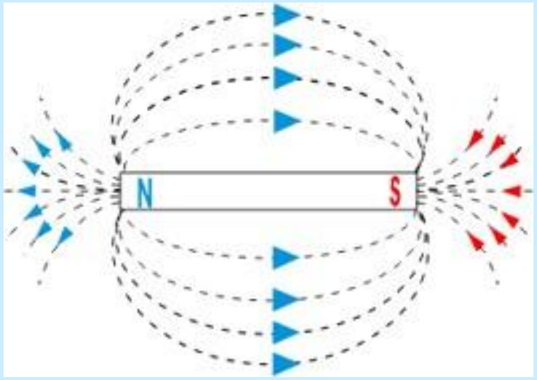
Forces and Energy

A force is a push or pull that can start, stop, or change the direction of motion. Gravity pulls objects toward Earth, and friction slows objects down. Energy appears in forms like light, heat, sound, and electricity. Energy can move from one place to another or change forms, helping us understand how things work in everyday life.

Chapter 7

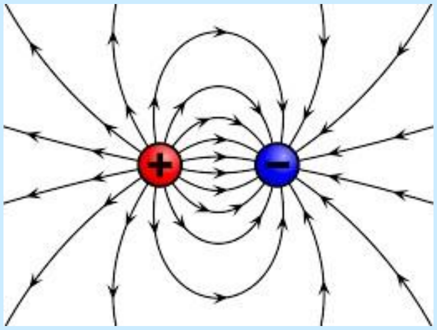
Electricity and Magnetism

Lesson 7.1: Basics of Electricity



Electricity is the movement of electric charges, usually electrons. Many things around us lights, phones, computers work because of electricity. Understanding how charges behave helps us understand how electrical devices function.

Electric Charge



- Matter contains tiny particles with electric charge.
- There are **two types of charges**: *positive* and *negative*.
- **Like charges repel**, and **opposite charges attract**.

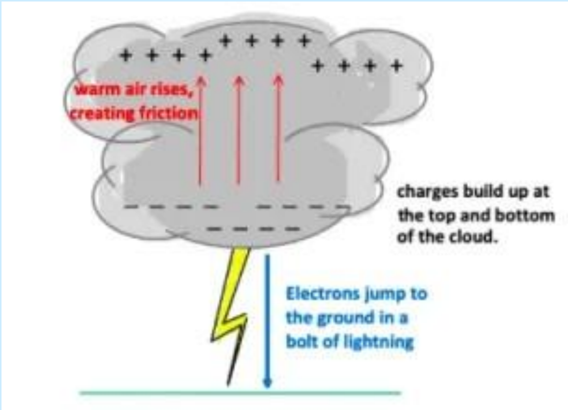
Conductors and Insulators

- **Conductors** allow electricity to pass through easily.
Examples: copper, aluminum, metals.
- **Insulators** do NOT allow electricity to pass easily.
Examples: plastic, rubber, wood.

Static Electricity

Static electricity happens when charges build up on a surface.
Examples:

- Rubbing a balloon on your hair
- Clothes sticking together after drying
- Small sparks when touching a metal door in a dry room



Key Concept

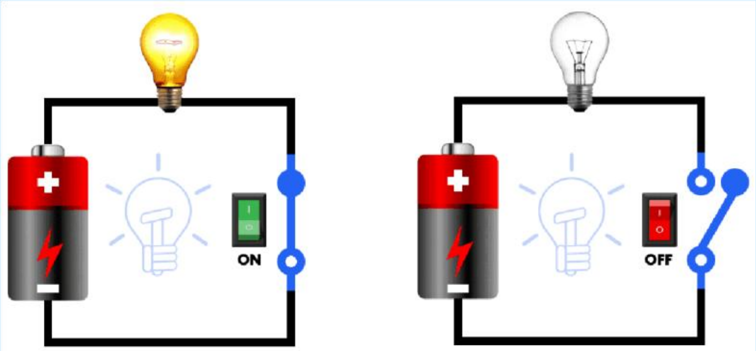
Electricity is caused by the movement or build-up of electric charges. Conductors allow charges to move, while insulators stop them.

Lesson 7.2: Circuits and Current

For electricity to flow and do work, it needs a complete path. This path is called an **electric circuit**. Circuits allow electric current to move and power devices like bulbs, fans, and chargers.

What is an Electric Circuit?

A circuit is a closed loop that allows electric current to flow.



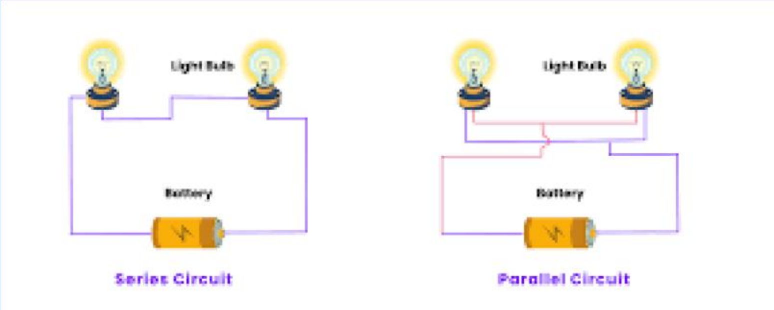
Basic Parts of a Circuit

- **Battery** – provides energy
- **Wires** – carry electric current
- **Switch** – opens or closes the circuit
- **Bulb or device** – uses electrical energy

Electric Current

- Electric current is the flow of electrons through a conductor.
- Measured in **Amperes (A)**.

Types of Circuits



Series Circuit

- One path for current
- If one bulb burns out, all bulbs go off

Parallel Circuit

- Multiple paths for current
- If one bulb burns out, others stay on

Key Concept

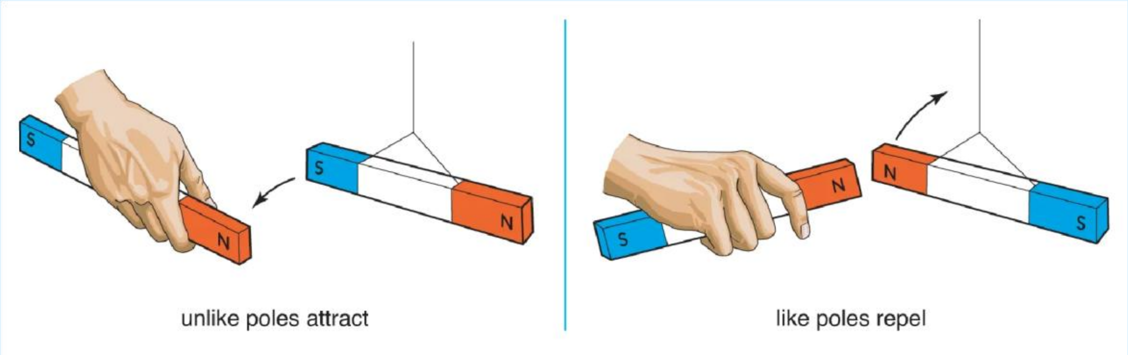
A circuit must be closed for electricity to flow. Current moves through conductors, and different circuit designs affect how devices work.

Lesson 7.3: Magnetism and Electromagnetism

Magnetism is a force produced by magnets. Electricity and magnetism are linked electric current can also create a magnetic field. This combination is known as electromagnetism.

Magnets and Magnetic Poles

- All magnets have two poles: **North** and **South**.
- Like poles repel; unlike poles attract.
- The force around a magnet is called the **magnetic field**.

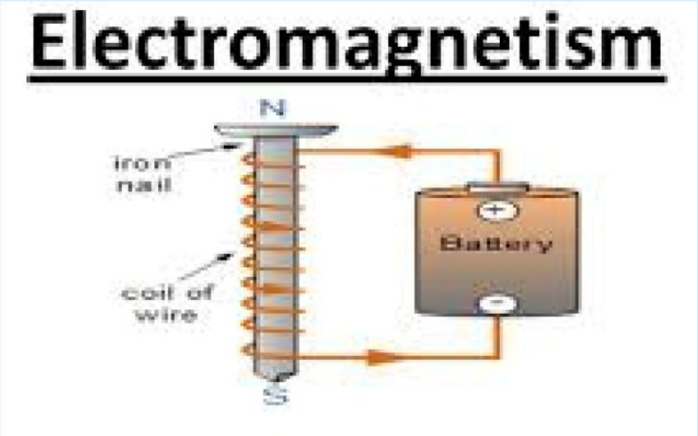


Magnetic Materials

Materials attracted to magnets include:

Electromagnetism

When electric current passes through a wire, it creates a magnetic field.
Wrapping the wire around an iron nail and connecting it to a battery creates an **electromagnet**.



Properties of an Electromagnet

- Works only when electricity flows
- Strength can be increased by adding more coils or using a stronger battery

Uses of Electromagnets

- Speakers
- Doorbells
- Electric motors
- Cranes in junkyards (lifting metal)

Key Concept

Magnetism and electricity are connected. Electric current can create a magnetic field, and electromagnets are important in many machines.

Activity Box

Static Balloon Experiment

Materials:
Balloon, small pieces of paper

Steps:

1. Blow up a balloon and rub it on your hair for 10–15 seconds.
2. Bring the balloon close to the paper pieces.
3. Watch how the paper jumps toward the balloon.

What You Learn:
Rubbing the balloon moves electric charges, creating **static electricity** that attracts the paper.

Question Review

What is electricity?

What are the two types of electric charges?

What happens when like charges are near each other?

Give one example of static electricity.

Name one conductor and one insulator.
What are the two poles of a magnet?

What is a magnetic field?

What is an electromagnet?

How can the strength of an electromagnet be increased?

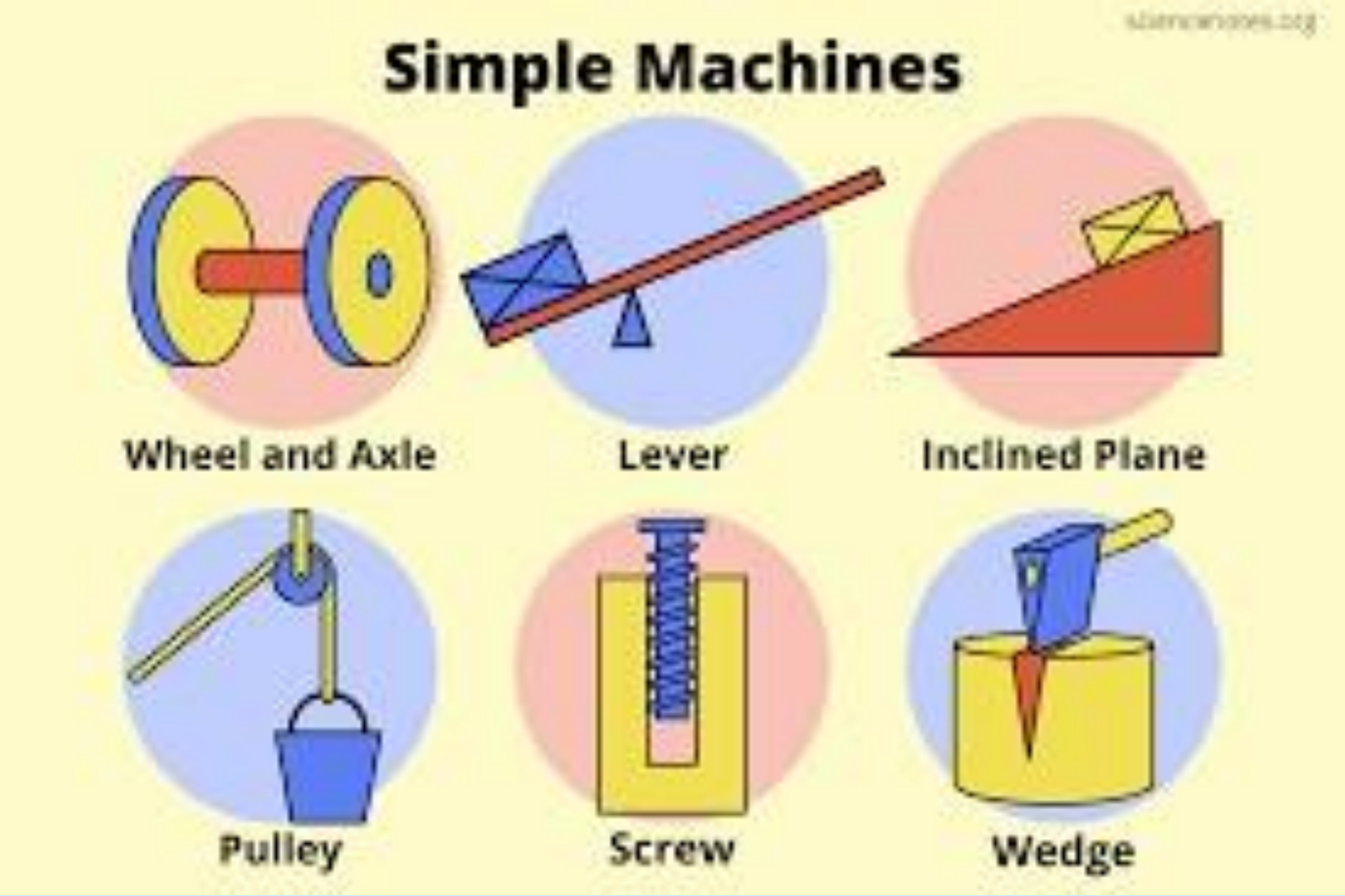
Name two uses of electromagnets in daily life.

Chapter 8

Simple Machines

Simple Machines

Simple machines are the most basic tools that help us make work easier. They do not decrease the amount of work done; instead, they allow us to apply force more efficiently. Simple machines appear in everyday life door handles, ramps, scissors, wheelbarrows, and even human joints all function as simple machines. In this chapter, we explore the six types of simple machines, learn how they give mechanical advantage, and examine their many applications in real life.

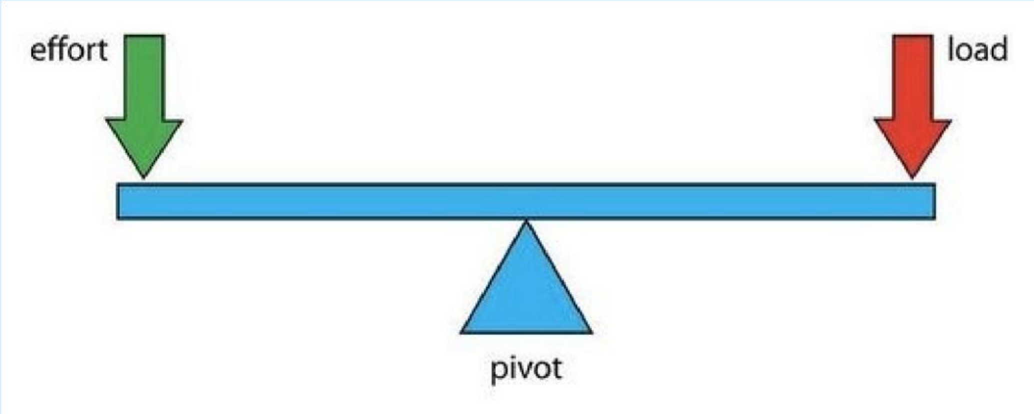


Lesson 8.1: Types of Simple Machines

Scientists classify simple machines into **six fundamental types**, each designed to make a task easier by changing the size or direction of a force. These six machines form the basis of all complex mechanical devices.

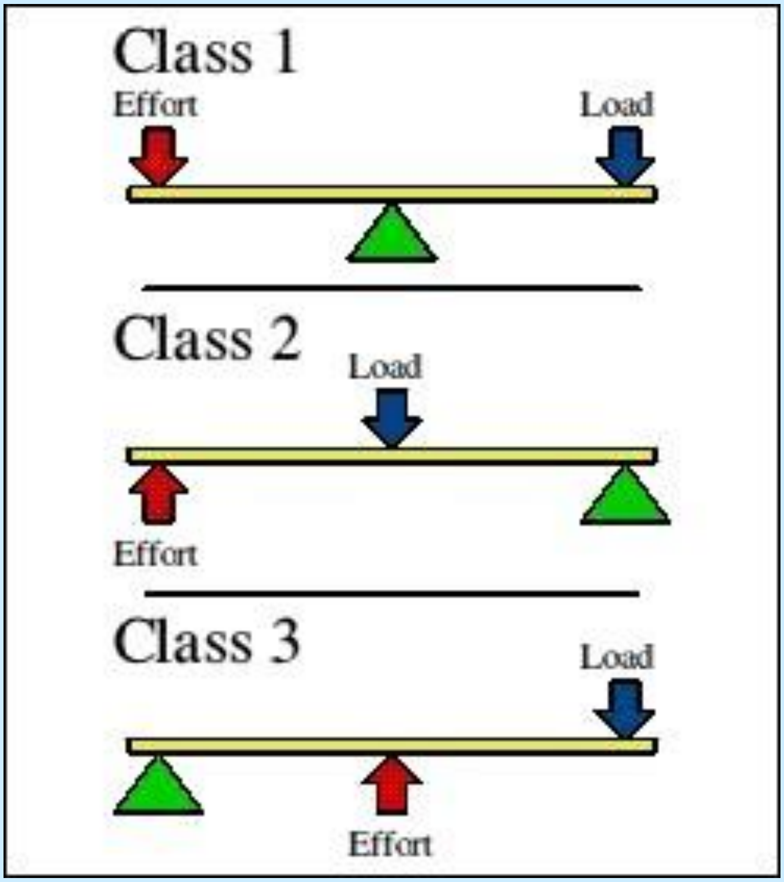
1. The Lever

A lever is a rigid bar that pivots around a fixed point known as the **fulcrum**.
Levers help lift or move heavy loads with less effort. Depending on the placement of the fulcrum, effort, and load, levers are divided into three classes.



Examples:

- A seesaw (Class 1 lever)
- A wheelbarrow (Class 2 lever)
- A fishing rod (Class 3 lever)

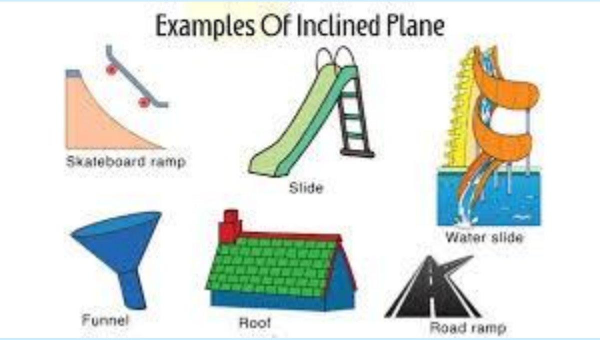


2. The Inclined Plane

An inclined plane is a flat surface set at an angle. Instead of lifting an object straight up, an inclined plane allows the user to push or pull the object over a longer distance, reducing the force needed.

Examples:

- Ramps used in loading trucks
- Slanted roads or wheelchair ramps

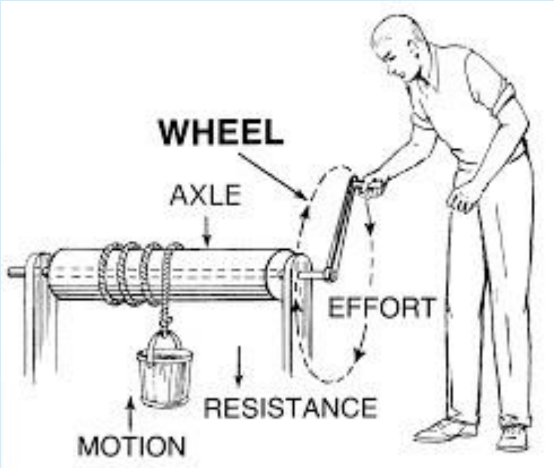


3. The Wheel and Axle

This device consists of a larger wheel attached to a smaller axle. When the wheel turns, the axle also turns, allowing the user to move or rotate objects with less force.

Examples:

- Steering wheel
- Door knobs
- Bicycle wheels

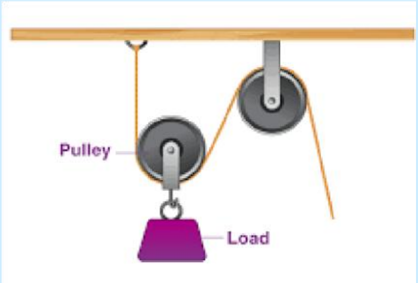


4. The Pulley

A pulley is a wheel with a groove for a rope or chain. When the rope is pulled, the wheel turns, allowing the user to lift heavy loads more easily.
A **fixed pulley** changes the direction of the force, while a **movable pulley** reduces the effort needed.

Examples:

- Flagpoles
- Construction cranes
- Window blinds



5. The Wedge

A wedge is made of two inclined planes joined together. It works by converting force applied on its wide end into a splitting or cutting force along its sharp edge.

Examples:

- Knives
- Axes
- Nails

6. The Screw

A screw is essentially an inclined plane wrapped around a cylinder. Turning the screw allows it to move into materials using less force. Screws also hold objects tightly together.

Examples:

- Bolts
- Jar lids
- Light bulbs

Lesson 8.2: Mechanical Advantage

A key purpose of simple machines is to provide **mechanical advantage**, which tells us how much a machine multiplies the input force.

Mechanical advantage (MA) is the ratio of the output force (force exerted by the machine) to the input force (force applied by the user).

- $MA = \dfrac{\text{output force}}{\text{input force}}$
- $\quad = \dfrac{\text{input arm distance}}{\text{output arm distance}}$
- $\text{output force} = MA \times \text{input force}$
- $\text{input force} = \dfrac{\text{output force}}{MA}$

Machines with a higher mechanical advantage make tasks easier.

Mechanical Advantage for Different Machines

- **Inclined Plane:**

Inclined Plane Formula

- $IMA = \dfrac{\text{length of slope}}{\text{height of slope}} = \dfrac{\Delta d_E}{\Delta d_R}$
- $AMA = \dfrac{F_R}{F_E} = \dfrac{mg}{F_E}$

- **Lever:**

$$MA = \frac{\text{effort arm length}}{\text{load arm length}} \qquad MA = \frac{\text{input distance}}{\text{output distance}}$$

$$\text{actual } MA = \frac{\text{measured output force}}{\text{measured input force}}$$

- **Pulleys:**
  MA=Number of supporting rope segments

Mechanical advantage does not reduce work; it simply allows the same work to be done with less force or in a more convenient direction.

Lesson 8.3: Applications of Simple Machines

Simple machines are used everywhere in homes, workplaces, transportation, construction, and even inside the human body.

In Everyday Life

- **Knife (wedge):** Helps cut materials.
- **Bottle opener (lever):** Lifts caps with minimal effort.
- **Ramps (inclined planes):** Allow carts or wheelchairs to move upward easily.

In Engineering and Construction

- **Cranes (pulleys):** Lift heavy building materials.
- **Wheelbarrows (lever + wheel and axle):** Move large loads efficiently.
- **Screws and bolts:** Hold structures firmly in place.

In the Human Body

- **Elbow joint (lever):** Acts as a fulcrum for arm movement.
- **Teeth (wedges):** Designed for cutting and grinding food.

Simple machines make life easier by reducing effort, improving efficiency, and enabling tasks that would otherwise require much greater strength.

Summary of Chapter 8

Chapter 8 explains that simple machines are basic tools that make work easier by reducing the force needed or changing the direction of force. There are six types: lever, inclined plane, wheel and axle, pulley, wedge, and screw. Each machine helps us do everyday tasks more easily, from lifting objects to cutting materials. The chapter also introduces mechanical advantage, which tells how much a machine multiplies our effort. Simple machines are used everywhere in tools, buildings, transportation, and even in the human body.

Activity Box

Choose one simple machine and create a model using household items.
Examples:

- A lever using a ruler and eraser
- A pulley using thread and a spool
- A ramp using books and cardboard

Write two sentences explaining how your model makes work easier.

Calculate the mechanical advantage for the following situations:

1. A ramp is 5 meters long and 1 meter high.
2. A lever has an effort arm of 40 cm and a load arm of 10 cm.
3. A pulley system has 4 supporting ropes.

Question Review

Lesson 8.1

1. What is a simple machine?
2. Name the six types of simple machines.
3. Explain how a lever works and give one real-life example.

Lesson 8.2

4. What is mechanical advantage?
5. How does an inclined plane reduce effort?
6. A lever has an effort arm twice as long as its load arm. What is its mechanical advantage?

Lesson 8.3

7. Describe two ways simple machines help in construction.
8. Identify the simple machine in each example:
    - A knife
    - A flagpole rope
    - A doorknob
    - A nail

Chapter 9

Introduction to Scientific Inquiry

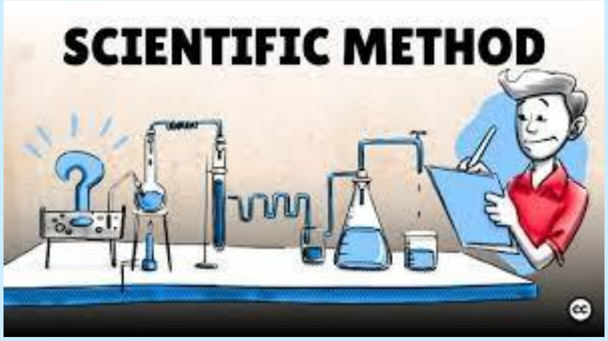
Introduction to Scientific Inquiry

Scientific inquiry is the process scientists use to investigate questions, gather evidence, and develop explanations about the natural world. It involves observing, asking questions, making predictions, conducting experiments, and analyzing results. Scientific inquiry helps us understand how and why things happen, and it forms the foundation of all scientific knowledge.

This chapter focuses on two important parts of scientific inquiry: the **scientific method** and **measurement in science**.

Lesson 9.1:

The Scientific Method



The scientific method is a systematic approach used to solve problems and study scientific phenomena. Although the steps may vary slightly depending on the situation, the process generally follows the same logical pattern.

1. Observation

Scientific inquiry begins with noticing something in the environment. Observations may be made using the senses or scientific tools.

2. Asking a Question

After observing, scientists ask a clear and testable question.
Example: *Does the amount of sunlight affect plant growth?*

3. Forming a Hypothesis

A hypothesis is an educated guess or prediction that answers the question.
It should be specific and testable.
Example: *If a plant receives more sunlight, it will grow taller.*

4. Experimentation

An experiment is designed to test the hypothesis. Scientists control variables to make sure that only one factor is tested at a time.

Key parts of an experiment:

- **Independent variable:** What the scientist changes
- **Dependent variable:** What is measured
- **Controlled variables:** Factors kept the same

5. Collecting and Analyzing Data

Data may be written in tables, charts, or graphs. Scientists analyze the results to look for patterns or differences.

6. Drawing Conclusions

A conclusion states whether the data supports the hypothesis.
If the hypothesis is not supported, scientists revise it and repeat the process.

7. Communication

Scientists share results with others through reports, presentations, or publications.

Lesson 9.2: Measurement in Science

Accurate measurement is essential in scientific inquiry. Without precise measurements, results can be misleading or incorrect.

The Importance of Measurement

Measurement allows scientists to compare results, repeat experiments, and communicate findings clearly. It also ensures that experiments are reliable and valid.

Units of Measurement

Scientists use the **International System of Units (SI)**, which is a universal standard used around the world. Some common SI units are:

Using SI units avoids confusion because everyone uses the same measurement system.

Tools Used in Measurement

Scientists use many tools to measure accurately:

- **Rulers and meter sticks:** length
- **Balances:** mass
- **Thermometers:** temperature
- **Graduated cylinders:** liquid volume
- **Stopwatches:** time

Accuracy and Precision

- **Accuracy:** How close a measurement is to the true value
- **Precision:** How consistent repeated measurements are

Good scientific data should be both accurate and precise.

Summary of Chapter

Chapter 9 explained that scientific inquiry is the process scientists use to study the natural world, answer questions, and develop explanations based on evidence. The chapter introduced the scientific method as a systematic way to conduct investigations, beginning with observations and questions, forming a hypothesis, designing an experiment, collecting and analyzing data, and drawing conclusions. It also emphasized the importance of communicating results so other scientists can repeat and verify the findings.

Another important idea in this chapter was measurement in science. Scientists use accurate and precise measurements to make sure their data is reliable. Standard SI units such as meters, kilograms, seconds, and liters help scientists around the world communicate using the same system. Measurement tools such as rulers, balances, thermometers, and graduated cylinders help ensure that scientific investigations are both accurate and consistent.

Activity Box

Create a small experiment using the scientific method.
Example topics:

- Does temperature affect how fast ice melts?
- Does the height of a drop affect how a ball bounces?

Write:

1. Your question
2. Hypothesis
3. Variables
4. Materials
5. Procedure
6. Expected results

Question Review

Lesson 9.1: The Scientific Method

1. What is the scientific method?
2. What is a hypothesis?
3. What is the difference between an independent and dependent variable?
4. Why do scientists communicate their results?

Lesson 9.2: Measurement in Science

5. Why is measurement important in science?
6. Name three SI units and what they measure.
7. What is the difference between accuracy and precision?
8. Which tools would you use to measure mass and temperature?

Chapter 10

Properties of Matter

Matter is anything that has mass and occupies space. Although all matter is made of particles, it can behave differently depending on its temperature, density, and internal structure. In this chapter, students learn about two important physical properties of matter: density and buoyancy, and how matter changes phase when energy is gained or lost.

Lesson 10.1: Density and Buoyancy

Density

Density describes how much mass is contained in a certain volume of a substance. It tells us how closely packed the particles of a material are.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

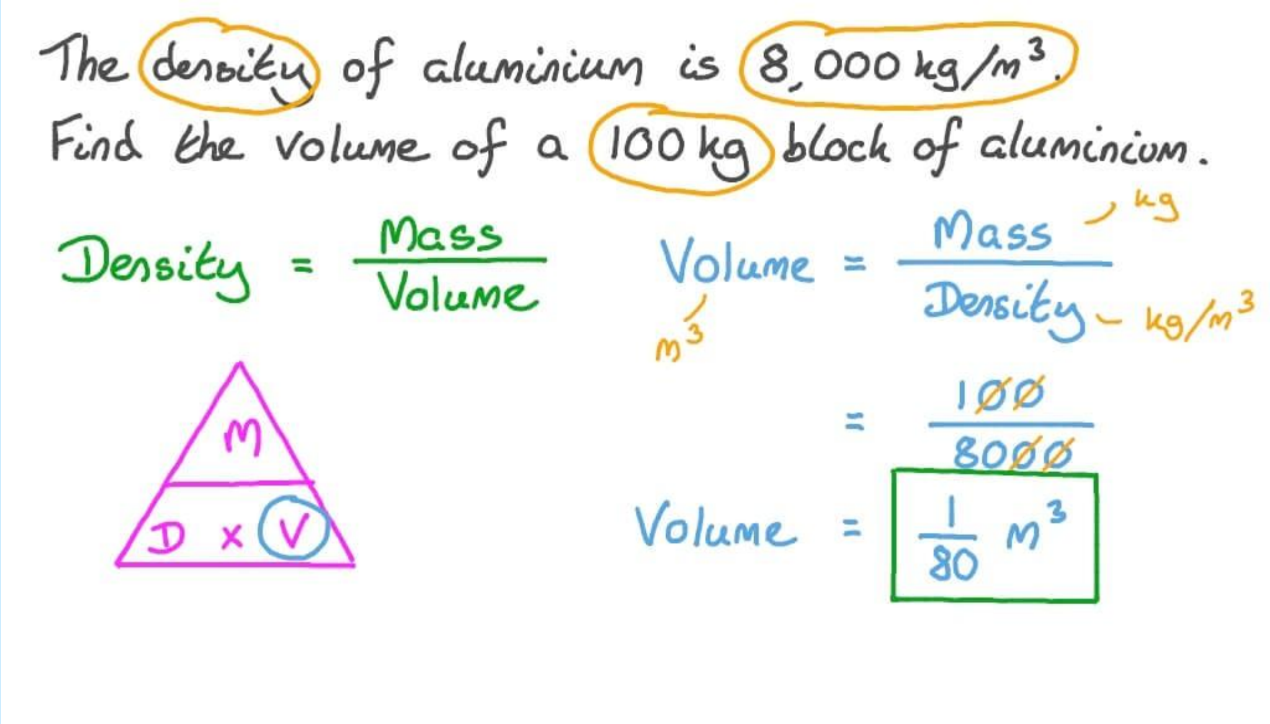
$$\text{Mass} = \text{density} \times \text{volume}$$

$$\text{Volume} = \frac{\text{mass}}{\text{density}}$$

A material with greater mass in a small space has a high density, while a material that spreads its mass over a larger volume has lower density.

Examples

- A metal block feels heavy because its particles are packed tightly (high density).
- Wood floats in water because it has a lower density than water.
- Or

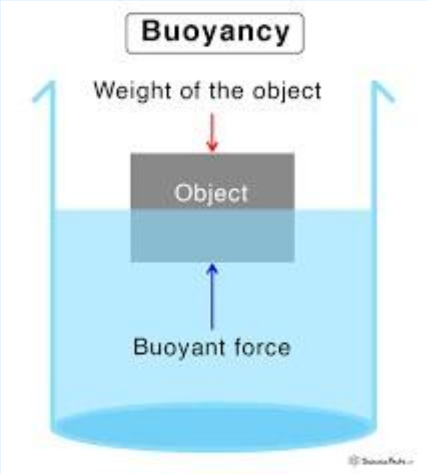


Measuring Density

To find density, scientists measure the mass using a balance and volume using a ruler or graduated cylinder. The SI units of density are kilograms per cubic meter (kg/m^3) or grams per cubic centimeter (g/cm^3).

Buoyancy

Buoyancy is the upward force exerted by a fluid that allows objects to float. When an object is placed in a liquid, it experiences an upward force. If this buoyant force is greater than the weight of the object, the object floats; if it is weaker, the object sinks.



Important Idea:
Objects float if they are *less dense* than the fluid they are placed in. **Examples**

- Ships float because their average density is lower than that of water.
- Oil floats on water because it is less dense.

Lesson 10.2: States of Matter and Phase Changes

Matter commonly exists in three physical states: **solid, liquid, and gas**. The state depends on how closely the particles are packed and how much energy they have.

Solids

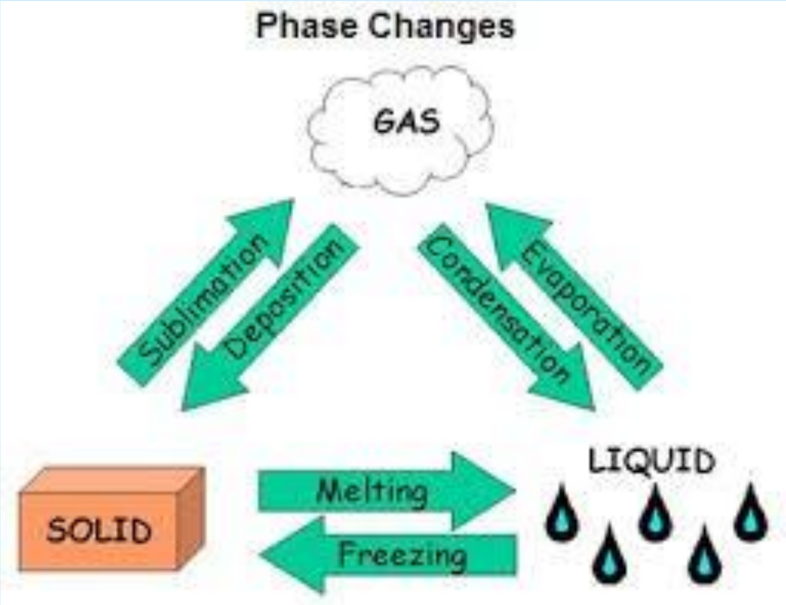
- Particles are closely packed
- Definite shape and volume

Liquids

- Particles are close but can move
- Definite volume
- No definite shape

Gases

- Particles move freely
- No definite shape or volume



Phase Changes

A phase change occurs when matter changes from one state to another. This happens when energy is absorbed or released.

Melting	solid → liquid (energy absorbed)
Freezing	liquid → solid (energy released)
Evaporation	liquid → gas (energy absorbed)
Condensation	gas → liquid (energy released)
Sublimation	solid → gas (energy absorbed)

Energy and Temperature

When heat energy is added, particles move faster and spread apart, changing the state from solid to liquid or gas. When heat is removed, particles slow down and move closer, changing gas to liquid or solid.

Summary of Chapter

Chapter 10 explained that matter has measurable physical properties that help us understand how substances behave. One important property is **density**, which describes how much mass is contained in a given volume. Objects with lower density than a fluid will float, while objects with greater density sink. This concept is closely related to **buoyancy**, the upward force exerted by a fluid that allows objects to float.

The chapter also discussed the **states of matter** solid, liquid, and gas and explained that matter can change from one state to another when heat energy is absorbed or released. Examples of these phase changes include melting, freezing, condensation, evaporation, and sublimation. These changes occur because the movement and arrangement of particles change with temperature and energy.

Activity Box

Measure the mass and volume of a rock or metal object. Calculate its density using the density formula.

Predict which objects in your classroom will float or sink in water (pencil, coin, eraser, plastic cap). Test your predictions and explain why each floated or sank.

List five examples of phase changes around you—for example, melting ice, boiling water, or condensation on a cold bottle.

Question Review

Lesson 10.1

1. What is density?
2. Why do some objects float while others sink?
3. Write the formula for density.
4. Name two objects that float and two that sink.

Lesson 10.2

5. What are the three states of matter?
6. What causes matter to change state?
7. Explain melting and freezing.
8. Which phase change requires energy to be absorbed?

Chapter 11

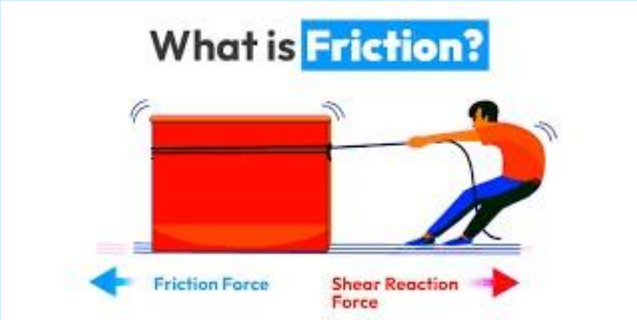
Forces and Motion

Forces and motion are some of the most important ideas in physics because they help explain how and why objects move. A force is simply a push or pull acting on an object. Motion describes how the position of an object changes over time. In this chapter, students learn about friction, gravity, circular motion, and momentum, and how these ideas affect everything that moves from falling objects to cars turning on a road.

Lesson 11.1: Friction and Gravity

Friction

Friction is a force that opposes motion when two surfaces rub against each other. Friction slows things down and can also stop movement completely. The rougher the surfaces are, the more friction there is.



Examples

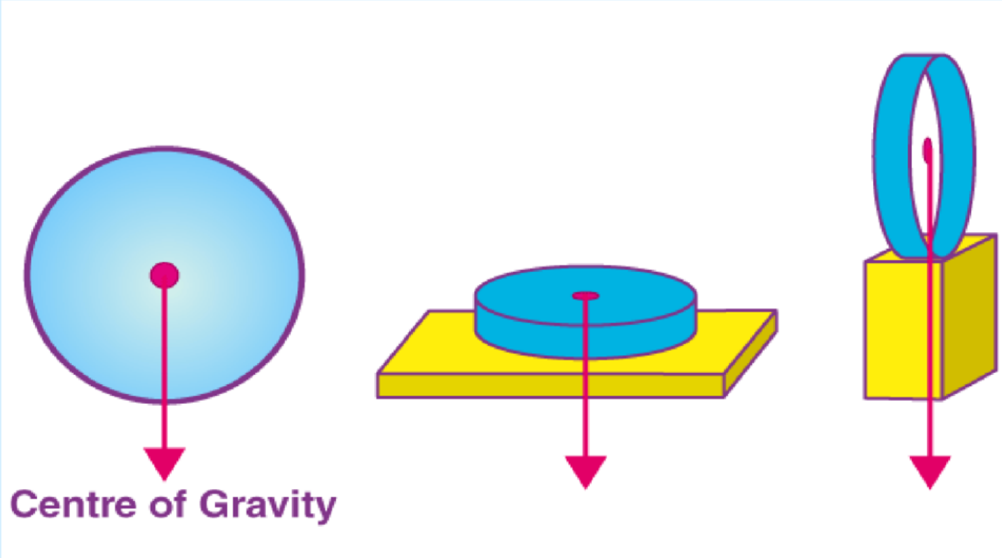
- A bicycle stops when the brakes create friction on the wheel.
- Shoes help us walk by creating friction between our feet and the ground.

Types of Friction

- **Sliding friction** (object slides on a surface)
- **Rolling friction** (wheels or balls rolling)
- **Air resistance** (objects moving through air)

Gravity

Gravity is a force that pulls objects toward each other. On Earth, gravity pulls everything toward the ground. When something falls, like a rock or a raindrop, it is gravity that causes the downward motion.

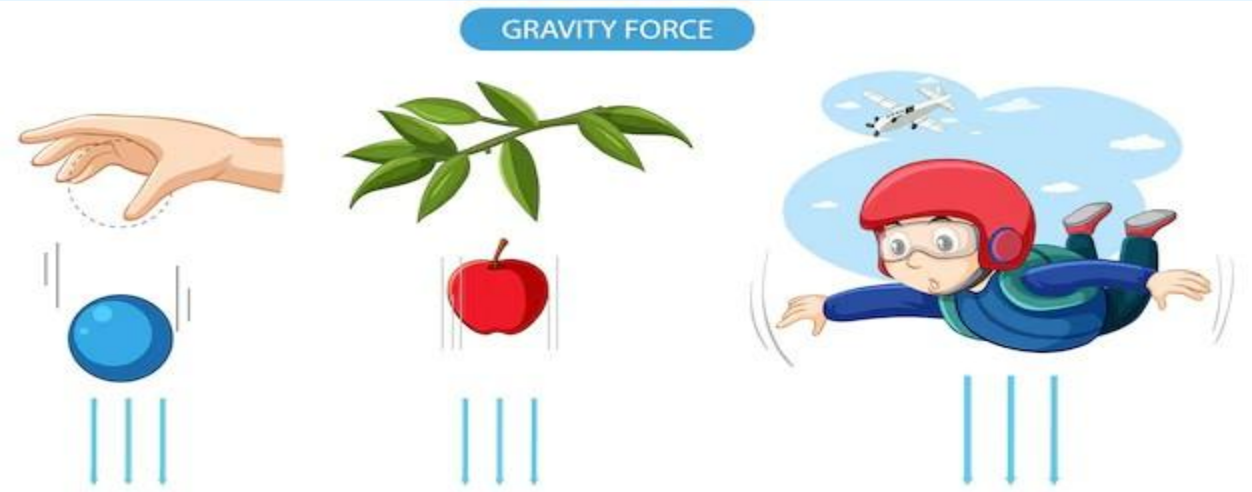


Important Idea

Gravity gives everything weight and keeps us on Earth instead of floating into space.

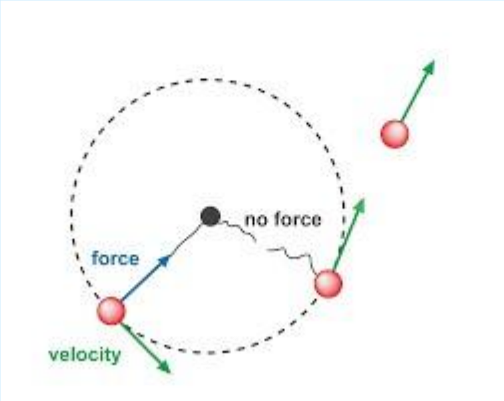
Examples

- An apple drops from a tree due to gravity.
- The Moon stays in orbit around Earth because of gravity.



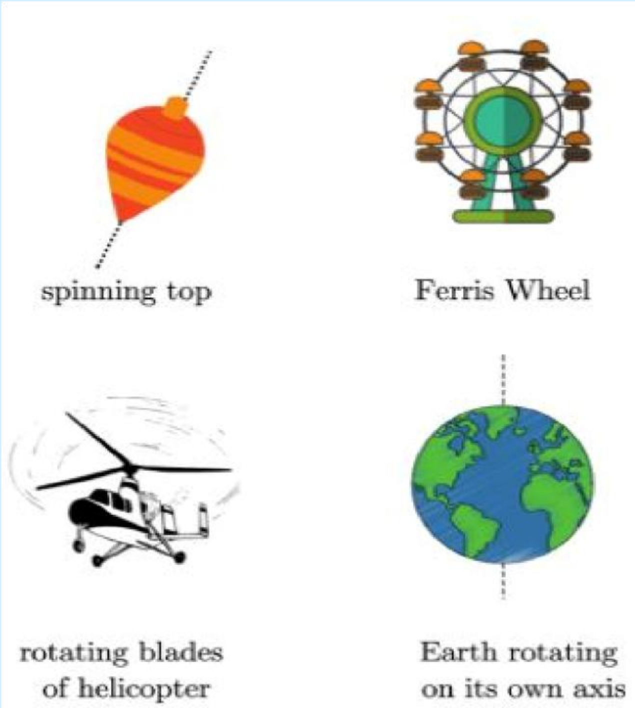
Lesson 11.2: Circular Motion

Circular motion describes the movement of an object that travels along a circular path. When something moves in a circle, there must be a force pulling it toward the center. This inward force is called **centripetal force**.



Examples

- Planets orbiting the Sun
- A ball tied to a string being swung around
- Cars turning around a curved road



Important Idea

Without centripetal force, objects moving in a circle would fly off in a straight line.

Lesson 11.3: Momentum

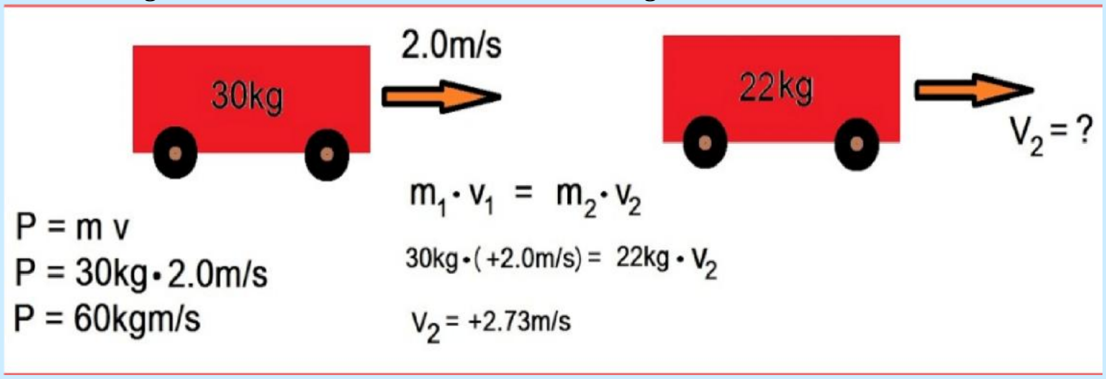
Momentum describes how hard it is to stop a moving object. It depends on two things:

- the mass of the object
- the speed of the object

Objects with more mass and higher speed have greater momentum.

Examples

- A truck has more momentum than a small car moving at the same speed.
- A fast-moving ball is harder to catch than a slow-moving one.



Important Idea

Greater momentum = harder to stop.

Summary of Chapter 11

Chapter 11 explains that forces are pushes or pulls that can change the motion of an object. Two important forces in everyday life are **friction** and **gravity**. Friction is a force that slows down moving objects by rubbing surfaces together, while gravity is the force that pulls objects toward Earth.

The chapter also introduces **circular motion**, which happens when an object moves in a curved or circular path, such as planets orbiting the Sun or a ball being swung on a string. Another key idea is **momentum**, which depends on an object's mass and speed. Momentum explains why heavier or faster objects are harder to stop.

Activity Box

Push a book across different surfaces (table, carpet, floor).
Compare how far it slides.

Question:
On which surface did friction seem strongest? Why?

Drop two objects of different sizes from the same height.
Observe which one reaches the ground first.

Question:
Did size or mass matter? What does this tell you about gravity?

Tie a small object to a string and swing it in a circle.
Release the object while swinging.

Question:
What direction did the object move after released? Why?

Question review

What is friction and how does it affect motion?

List two everyday examples of friction.

What force causes objects to fall towards the ground?

Define circular motion.

What force keeps planets in orbit around the Sun?

What two factors determine momentum?

Why is a heavy moving object harder to stop than a light one?

How are friction and gravity similar? How are they different?

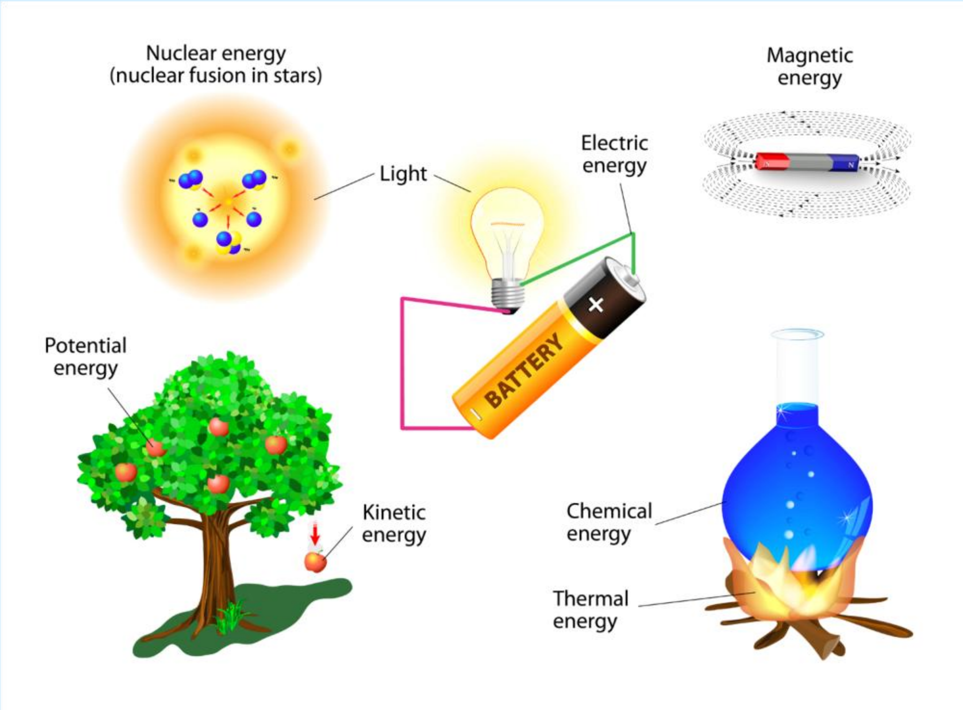
Chapter 12

Energy Transformations

Energy is the ability to do work. It exists in many forms such as heat, light, sound, motion, and electricity. In this chapter, students learn how energy changes from one form to another and how these changes affect everything from machines to living organisms.

Lesson 12.1: Forms of Energy

Energy comes in different forms. The two main types are:



Kinetic Energy

Energy of motion.
Anything that moves has kinetic energy. (example: moving car, running water)

Potential Energy

Stored energy based on position or condition. (example: stretched rubber band, lifted object)

Examples of other forms:

- electrical energy
- chemical energy
- thermal (heat) energy
- light energy
- sound energy

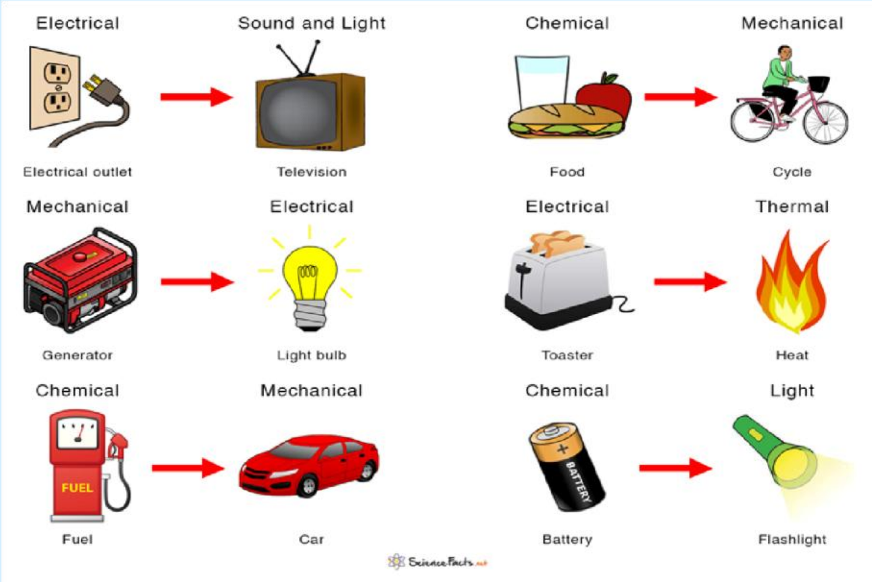
Lesson 12.2: Energy Transfer and Transformation

Energy can move (transfer) or change forms (transform).

Energy Transfer

Energy moves from one object to another. Example:

- Heat moves from hot soup to a spoon.



Energy Transformation

Energy changes from one form to another. Examples:

- A toaster changes electrical energy into heat.
- Plants change sunlight into chemical energy.
- A falling rock changes potential energy into kinetic energy.

Important Idea

Energy is never destroyed it only moves or changes forms.

Summary of chapter

Chapter 12 explained that energy exists in different forms and can change from one type to another. The two main forms of energy are kinetic energy (energy of motion) and potential energy (stored energy). Other types include electrical, thermal, chemical, sound, and light energy.

The chapter also explained the difference between **energy transfer** and **energy transformation**. During energy transfer, energy moves from one object to another (like heat moving from hot metal to a cooler object). During energy transformation, energy changes from one form to another, such as electrical energy changing into light in a lamp, or chemical energy turning into motion in our bodies.

An important idea is that energy is **never created or destroyed** it only changes form or moves to another place. This is why machines, living things, and even natural systems depend on the continuous transfer and transformation of energy.

Activity Box

List different devices at home (fan, heater, phone).
Write what form of energy they use and what form they produce.

Hold a metal spoon in hot water.
Observe heat moving from the water to the spoon.

Question:
Which direction is heat moving?

Place a plant near sunlight for several days.

Question:
What type of energy does the plant receive?
What type of energy is produced inside the plant?

Drop a book from a height.

Question:
How does potential energy change as the book falls?

Question Review
What is kinetic energy? What is potential energy? Give two examples of energy transformation. What is the main difference between energy transfer and transformation? Name three different forms of energy besides kinetic and potential. What does the law of conservation of energy mean? Explain how a toaster shows energy transformation. What form of energy does a flashlight start with and end with?

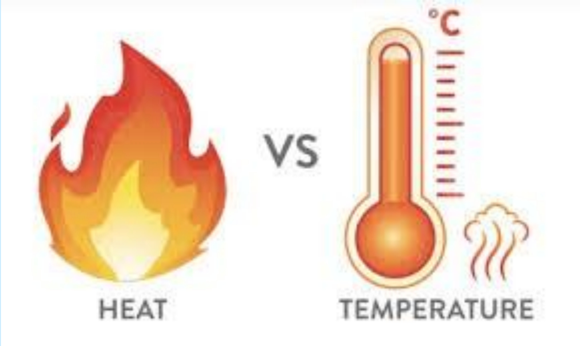
Chapter 13

Thermal Energy

Thermal energy is the energy of moving particles inside matter. All substances solid, liquid, or gas contain tiny particles that are always in motion. When these particles move faster, the temperature increases, and when they slow down, the temperature decreases. In this chapter, students learn about heat, temperature, and the different ways heat can be transferred from one object to another.

Lesson 13.1 – Temperature and Heat

Temperature



Temperature tells us how hot or cold something is. It measures how fast the particles of a substance are moving.

If particles move faster → temperature goes up
If particles move slower → temperature goes down

Heat

Heat is a type of energy that moves from a hotter object to a colder object. Heat always flows from warm areas to cooler areas until both reach the same temperature.

Example:
Ice melts in a warm drink because heat moves from the drink to the ice.

Lesson 13.2 – Methods of Heat Transfer

Heat can move in three different ways:

1. Conduction

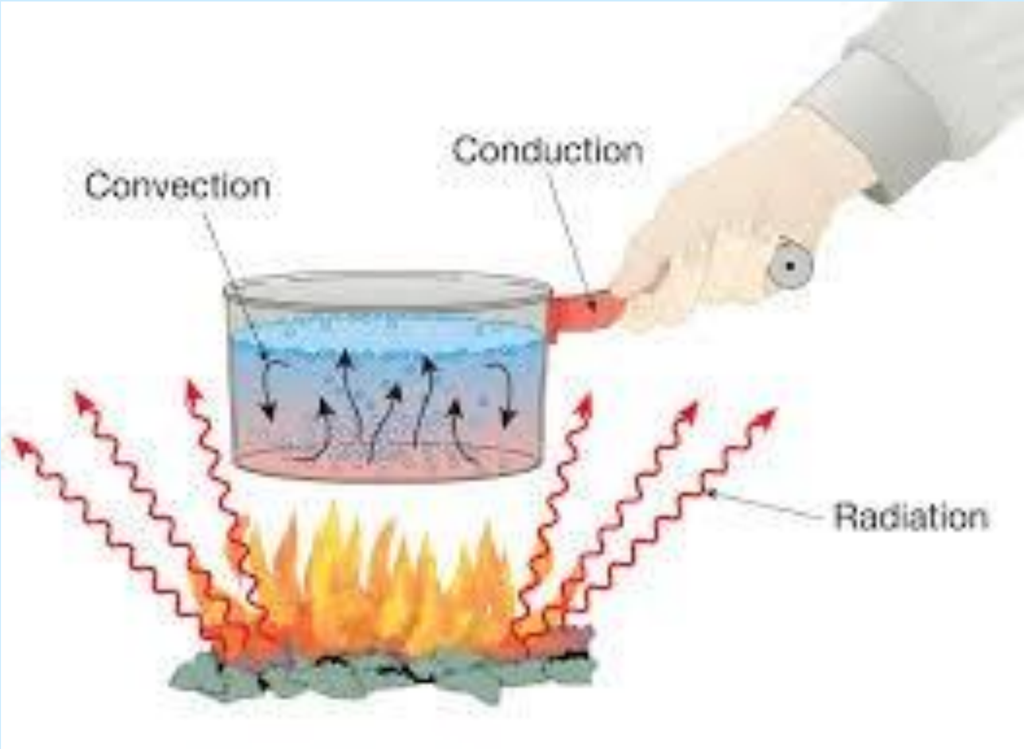
Heat transfer by direct contact.
Example: a spoon becomes hot in soup.

2. Convection

Heat transfer through movement of liquids or gases. Example: warm air rising, cool air sinking.

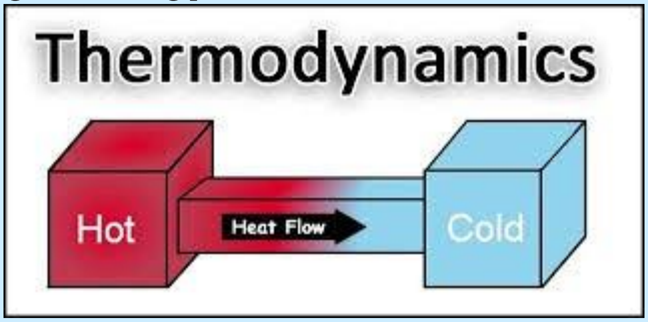
3. Radiation

Heat transfer without touching through waves. Example: sunlight warming the Earth.



Lesson 13.3 – Thermodynamics

Thermodynamics is the study of heat and energy. It explains how heat energy affects matter and how energy changes during heating and cooling processes.

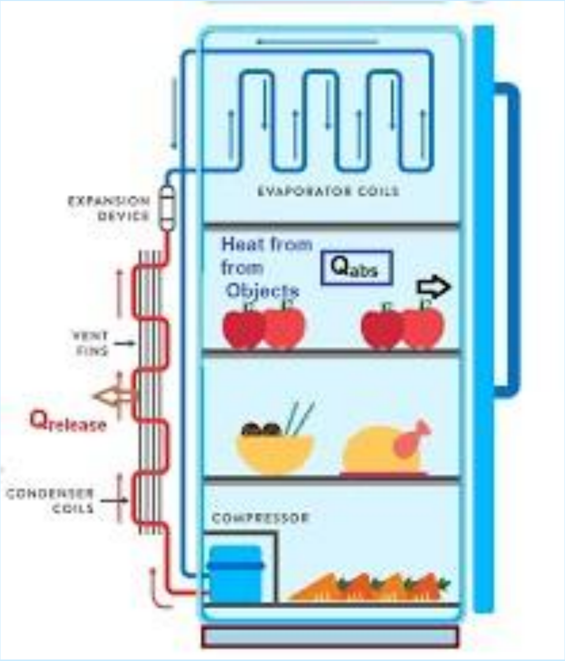


Important ideas of thermodynamics:

- Heat flows naturally from hot objects to cold objects
- Energy is conserved
- Thermal energy can be transformed into other forms (like mechanical energy in engines)

Example:

A refrigerator removes heat from inside to keep food cold.



Summary of Chapter 13

Chapter 13 explained that all matter contains particles that move, and this movement creates thermal energy. Temperature tells us how fast these particles are moving, while heat is energy that moves from a warmer object to a cooler one.

The chapter also introduced the three main ways heat transfers: conduction (touching objects), convection (movement in liquids and gases), and radiation (heat traveling through waves, like sunlight). Finally, students learned that thermodynamics studies how heat behaves in systems, including how energy changes during heating and cooling. All of these ideas help us understand everyday things such as cooking, weather, heating systems, refrigerators, and many natural processes.

Activity Boxes

Place a metal spoon and a wooden spoon in hot water.
Observe which gets hotter faster.
Question: Why does this happen?

Stand in sunlight and then in the shade.

Question: How does radiation warm objects?

Place an ice cube in a bowl.
Record how quickly it melts in warm air.

Question: Where does the heat come from?

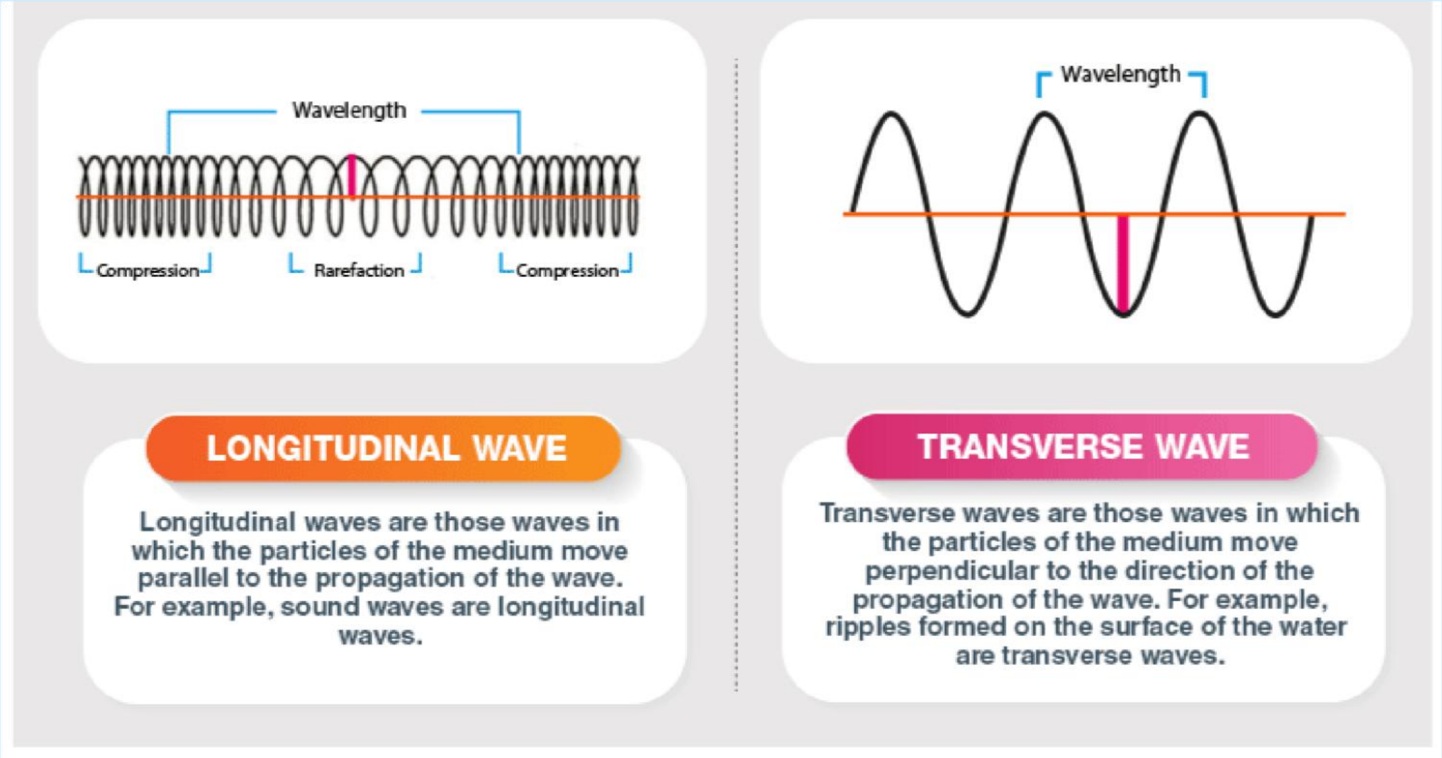
Question Review
What is thermal energy? How are heat and temperature different? What happens to particle movement when temperature increases? What direction does heat always flow? What is conduction? Give one example. What is convection? Give one example. What is radiation? Give one example. What does thermodynamics study? How does a refrigerator use thermodynamics?

Chapter 14

Waves and Their Applications

Waves are disturbances that transfer energy from one place to another without transferring matter. Waves are found everywhere in water, sound, light, and even in technologies like radios and medical imaging. In this chapter, students learn how waves move, what types exist, and how waves are used in everyday life.

Lesson 14.1 – Types of Waves (Transverse and Longitudinal)



Transverse Waves

In transverse waves, particles move **up and down** while the wave moves forward.
Examples:

- water waves
- light waves

Key Idea

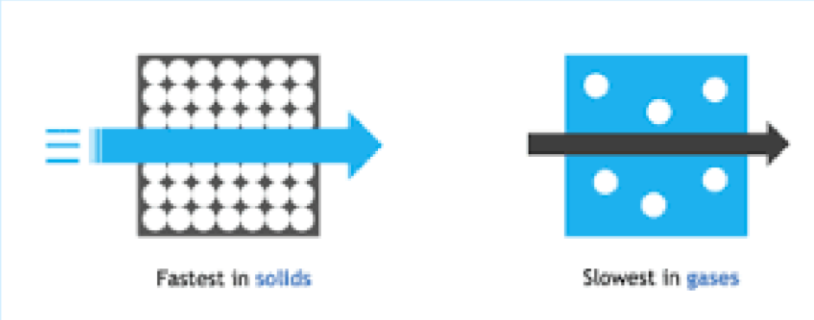
Both waves transfer energy, not matter.

Lesson 14.2 – Sound and Its Applications

Sound is a longitudinal wave that travels when particles of matter vibrate back and forth.

Properties of sound

- travels faster in solids
- slower in gases
- cannot travel in a vacuum (no particles)



Uses and Applications

- communication
- music
- medical imaging (ultrasound) ● sonar used underwater

Summary of Chapter 14

Chapter 14 explained that waves carry energy without moving matter. Waves come in two main types: transverse waves (like light waves) and longitudinal waves (like sound waves). Sound waves need matter to travel, while electromagnetic waves can travel through empty space.

The chapter also showed that waves are important in everyday life from hearing music and talking on phones, to medical imaging and satellite communication. Waves help us communicate, observe space, treat illnesses, and use modern technology.

Activity Box

Shake a rope up and down.
Observe wave motion.

Press your ear on a table while someone taps on it.
Question: Does sound travel faster through the table or air?

List devices that use electromagnetic waves (radio, phone, Wi-Fi).

Label which waves they use.

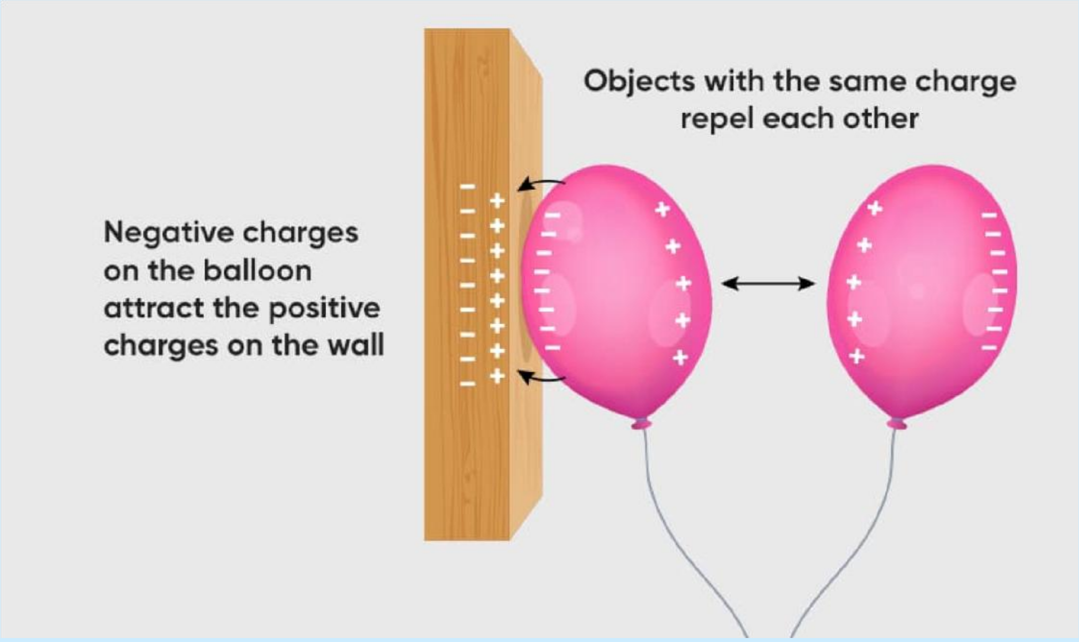
Question Review
What is a wave?
What do waves transfer?
What is a transverse wave?
What is a longitudinal wave?
Is sound a transverse or longitudinal wave?
Why can’t sound travel in space?
Name three electromagnetic waves.
Give two uses of electromagnetic waves.
How do waves help technology?

Chapter 15

Electricity

Electricity is a form of energy caused by the movement of electric charges. Almost everything we use today lights, computers, phones, and appliances works because of electricity. In this chapter, students learn about static electricity, electric current, and basic circuit components.

Lesson 15.1 – Static Electricity



Static electricity happens when electric charges build up on the surface of an object. This happens when electrons move from one material to another and stay there temporarily.

Example:
Rubbing a balloon on your hair makes it stick because electrons transferred from hair to balloon.

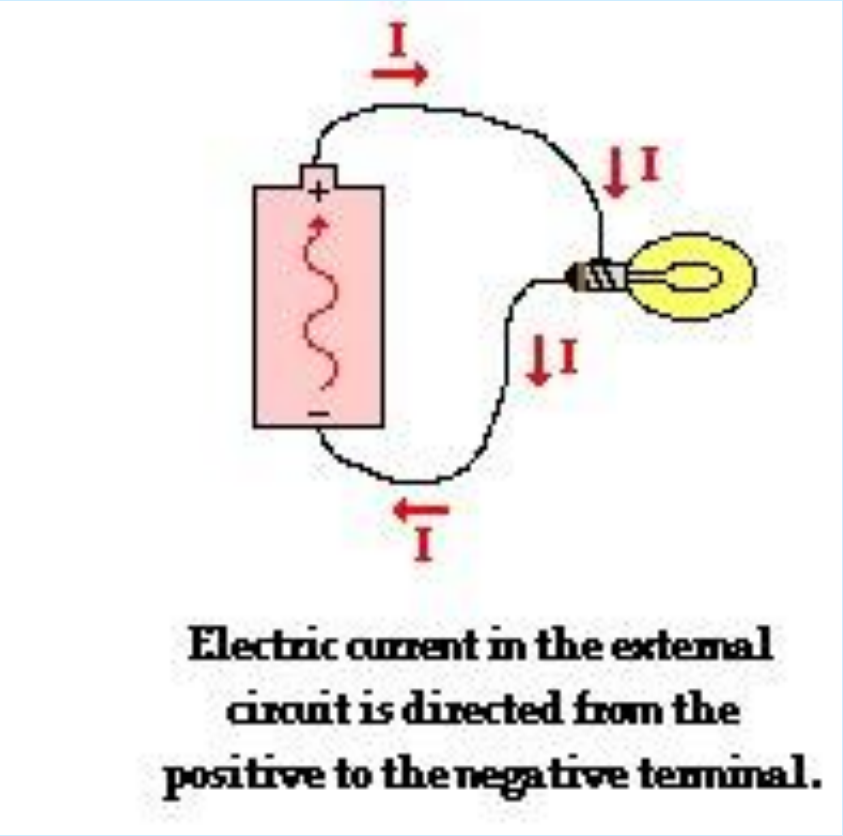
Key ideas:

objects can become positively or negatively charged	opposite charges attract	like charges repel

Example:
When you walk on carpet then touch metal, you feel a small shock caused by charge moving suddenly.

Lesson 15.2 – Current Electricity

Current electricity is the flow of electric charges through a conductor like copper wire. This moving charge is called an electric current.



Important terms:

Voltage	pushes electrons (electric potential difference)
Current	amount of charge flowing
Resistance	slows the flow of electrons

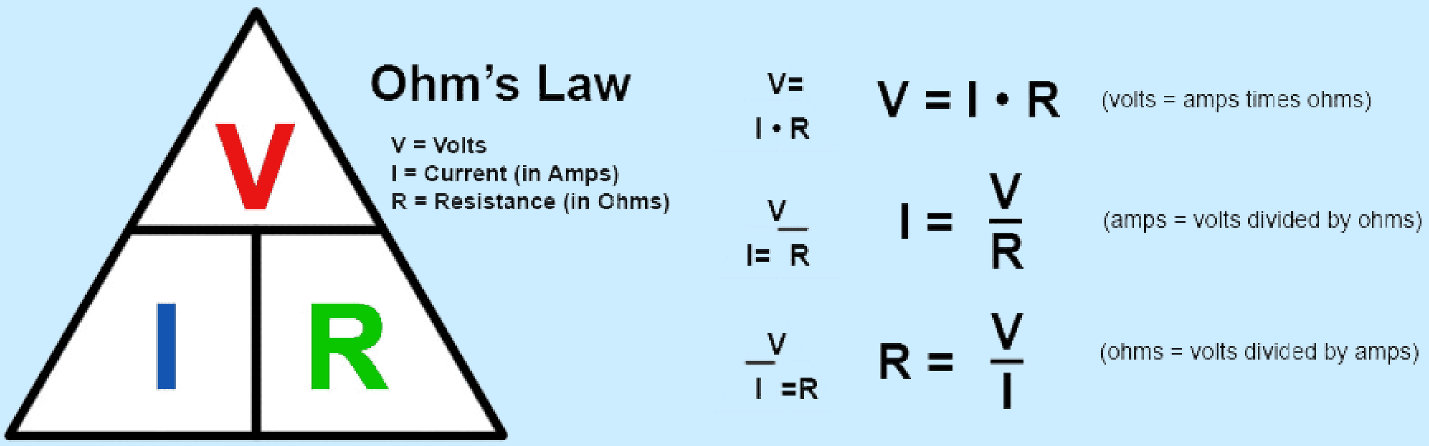
Example:

A battery provides voltage that moves electrons through a wire.

Lesson 15.3 – Ohm's Law and Circuit Components

Ohm's Law

Ohm's law explains how voltage, current, and resistance are connected:

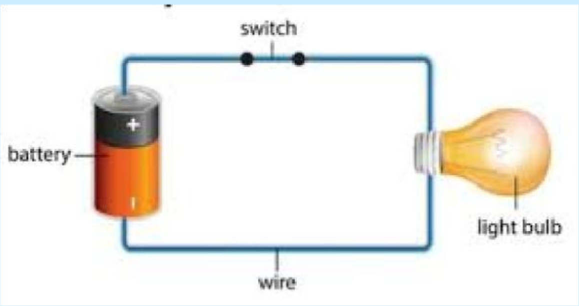


Where:

- VVV = voltage
- III = current
- RRR = resistance

Basic circuit components

- **Battery** — provides voltage
- **Wires** — carry current
- **Switch** — opens or closes the circuit
- **Bulb** — converts electricity to light



When a switch is closed, electricity flows. When it's open, electricity cannot flow.

Summary of Chapter 15

Chapter 15 taught that electricity is the movement or interaction of electric charges. Static electricity happens when charges build up, while current electricity is a continuous flow of charges through a conductor.

Students also learned about voltage, current, and resistance, and how these three relate through Ohm's law. Finally, the chapter described basic electrical components such as batteries, switches, wires, and bulbs, which combine to form simple and useful electric circuits.

Activity Box

Rub a balloon on your hair.
Observe attraction.
Question: Why do opposite charges attract?

Use a battery and a bulb.
Connect wires and see the bulb light.

Open and close a switch in the circuit.

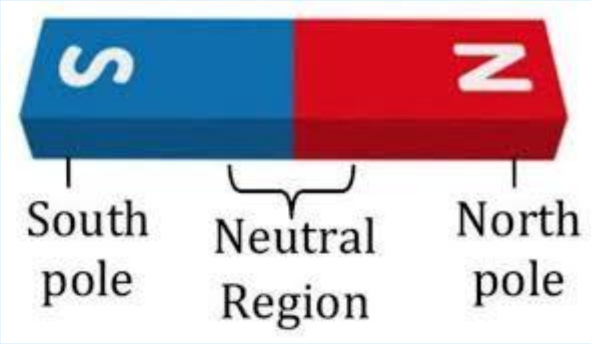
Observe how the bulb reacts.

Question Review
What is static electricity?
What causes static electricity?
What is electric current?
What is voltage?
What is resistance?
Write the formula for Ohm's law.
Name four basic circuit components.
What happens when a switch is open?
How does a battery cause current to flow?

Chapter 16

Magnetism

Lesson 16.1 Magnetic Fields



A **magnet** has two poles:

- North pole (N)
- South pole (S)

Similar poles repel (N vs N)
Opposite poles attract (N + S)

A **magnetic field** is an invisible region around a magnet where magnetic force acts.

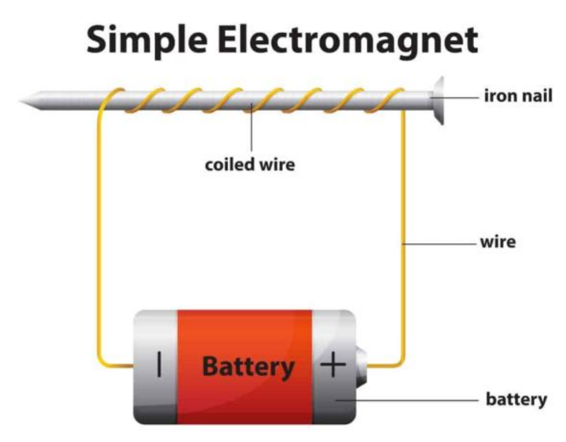
➞ strongest at the poles
➞ field lines go *from North to South*

Examples of magnetic materials:

- iron
- nickel
- cobalt

Lesson 16.2 Electromagnets & Applications

A simple electromagnet is made of:



- a coil of wire
- around an iron core
- connected to a battery

When electric current flows → it becomes magnetic Turn off electricity → magnetism disappears

Uses of electromagnets:

- speakers
- motors
- MRI medical machines
- cranes lifting metal
- doorbells

Electromagnets are important because their strength can be controlled by electric current.

Summary of chapter 16

Magnetism is a physical force produced by moving electric charges. Every magnet has two poles called the North Pole and the South Pole. Magnetic forces cause **opposite poles to attract** and **like poles to repel**, which explains why magnets stick to metals like iron but not to plastic or wood.

Magnetic fields are invisible areas around a magnet where magnetic forces act. These fields are strongest at the poles and are represented using field lines that flow from the north pole toward the south pole. Magnetic fields exist not only in magnets, but also around electric currents, which helps scientists understand the link between electricity and magnetism.

In addition to natural (permanent) magnets, there are **electromagnets**, which are created by passing electric current through a coil of wire. Their magnetic power can be increased by adding more coils or using a stronger current. Electromagnets are widely used in everyday life, including in loudspeakers, motors, computers, and medical devices such as MRI scanners. Because they can be turned on and off, they have become useful in many modern technologies.

Activity Box

Look around your house and list **3 things that use magnets or electromagnets**, for example:

- speaker
- refrigerator door
- phone speaker
- headphones

Write how magnet is being used.

Question Review

Q1: Where are magnetic fields the strongest?
Q2: How is an electromagnet different from a permanent magnet?
Q3: Give 2 common uses of electromagnets.
Q4: What material are magnets usually made of?

Chapter 17

The Universe

Lesson 17.1: Introduction to Astronomy

Astronomy is the scientific study of space, planets, stars, galaxies, and everything beyond Earth's atmosphere. Scientists use telescopes and space probes to observe objects in space. The Universe contains billions of galaxies, and each galaxy contains billions of stars.

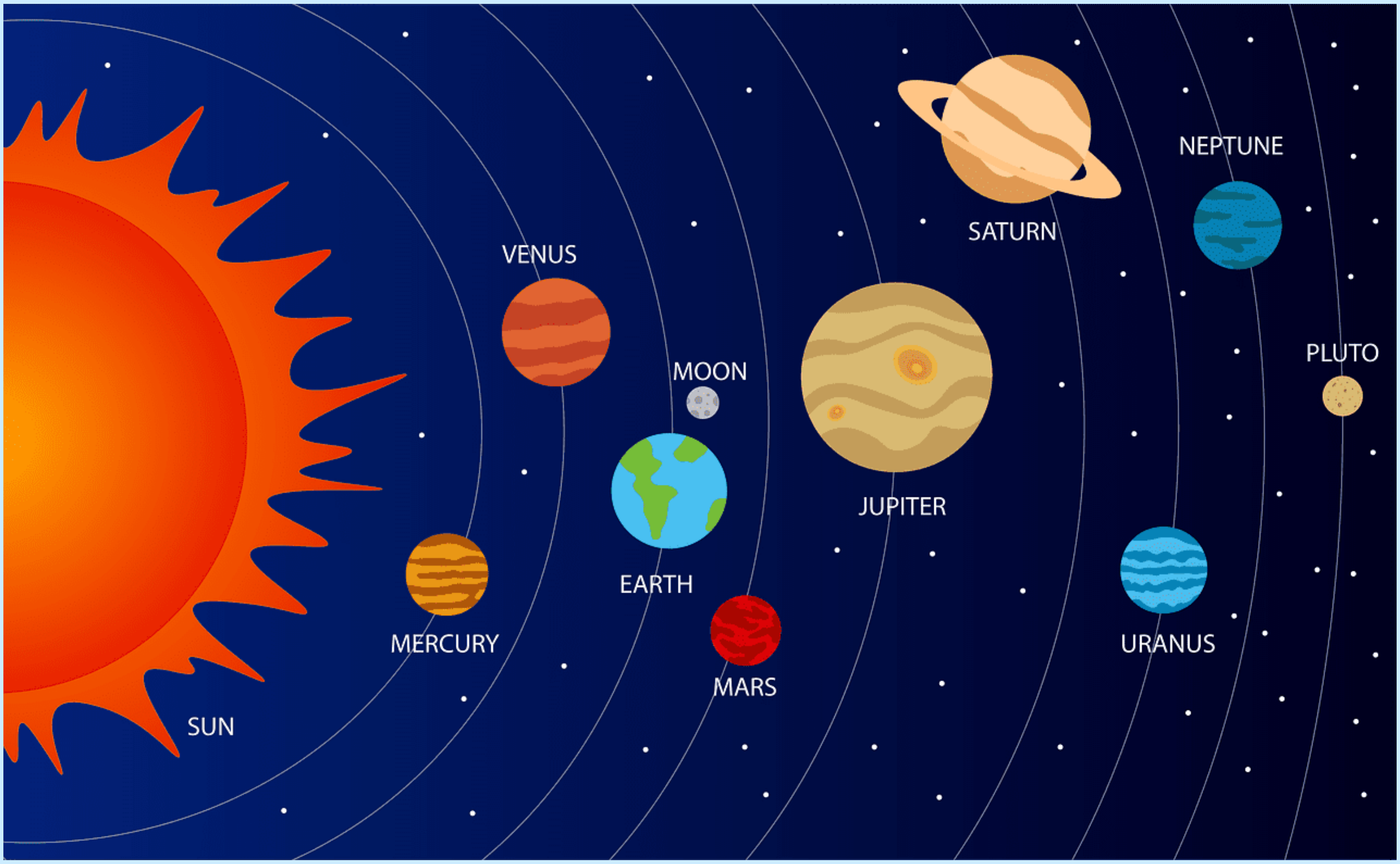
Lesson 17.2: The Solar System

Our Solar System consists of the Sun and the objects orbiting it, including eight planets, dwarf planets, moons, asteroids, and comets.

The order of planets from the Sun:

Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.

The Sun is the center of the Solar System and provides the heat and light needed for life on Earth.



Lesson 17.3: Basic Concepts of Space Exploration

Space exploration includes sending satellites, astronauts, and robots into space to learn more about the Solar System. Space agencies such as NASA send spacecraft to explore planets and gather scientific information. Exploration helps humans understand space weather, planet surfaces, and the possibility of life on other planets.

Summary of Chapter 17

Chapter 17 explained that the Universe contains billions of galaxies, each made of stars, planets, and cosmic objects. Astronomy helps scientists study space and learn about the origin and structure of the Universe. The Solar System includes the Sun and eight planets, with Earth being the only known planet that supports life. Space exploration allows humans to collect scientific data, travel beyond Earth, and discover new information about planets and distant space.

Activity Box

Try this simple activity:

1. Draw a diagram of the Solar System.
2. Label all eight planets in order from the Sun.
3. Write one fact about each planet under your drawing.

Optional:
Look at the night sky and identify at least one star or planet (if visible).

Question Review

What is astronomy?

Name the eight planets in our Solar System in order.

What is the purpose of space exploration?

Which object is at the center of the Solar System?

Why is Earth special compared to other planets?

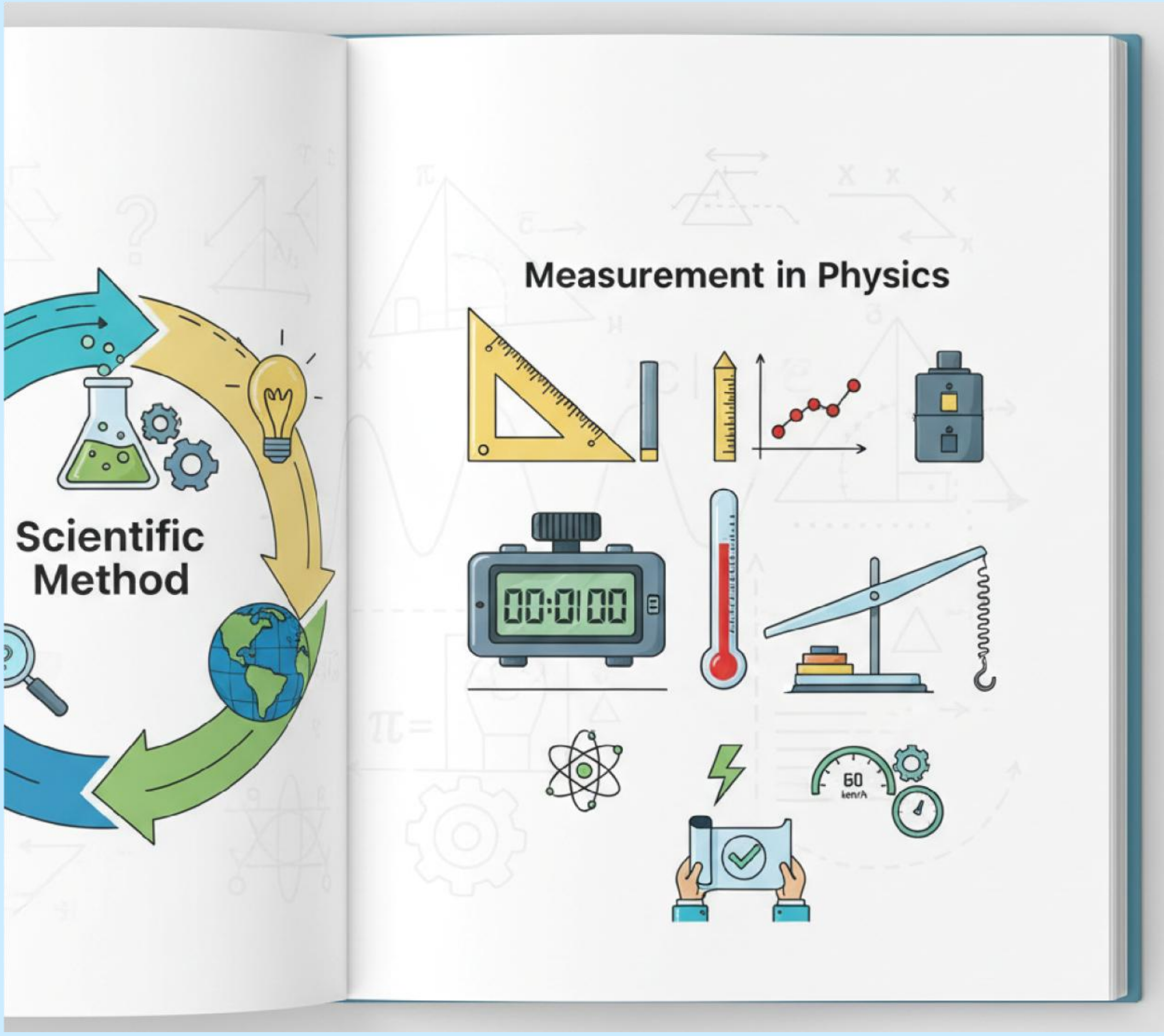
Chapter 18

Scientific Method and Measurement

Lesson 18.1: Importance of Measurement in Physics

Measurement is a key part of all scientific work. In physics, scientists measure length, mass, time, temperature, force, speed, and many other quantities. Accurate measurements allow scientists to compare results, test hypotheses, and make scientific conclusions.

Without measurement, experiments could not be repeated or verified by other scientists. This is why standard units and tools like rulers, timers, and thermometers are used in physics experiments.



Lesson 18.2: Units of Measurement

Scientists use a standard system of measurements called the SI system (International System of Units). Important SI units include:

Property	Unit	Abbreviation
Length	meter	m
Mass	kilogram	kg
Time	seconds	s
Amount	mole	mol
Temperature	kelvin	K
electric current	ampere	amp
luminous intensity	candella	cd

Using the same units worldwide helps scientists communicate clearly and avoid confusion in scientific data.

Summary of Chapter 18

This chapter explained that measurement is essential in physics because it allows scientists to collect accurate data, compare results, and share findings. The scientific method depends on reliable measurements. The SI system provides a universal way of measuring physical quantities, including length, mass, time, temperature, and force. By using standardized units, scientists can perform experiments accurately and communicate results all over the world.

Activity Box

Try this simple activity:

1. Draw a diagram of the Solar System.
2. Label all eight planets in order from the Sun.
3. Write one fact about each planet under your drawing.

Optional:
Look at the night sky and identify at least one star or planet (if visible).

Question Review

What is astronomy?

Name the eight planets in our Solar System in order.

What is the purpose of space exploration?

Which object is at the center of the Solar System?

Why is Earth special compared to other planets?

Chapter 19

Kinematics

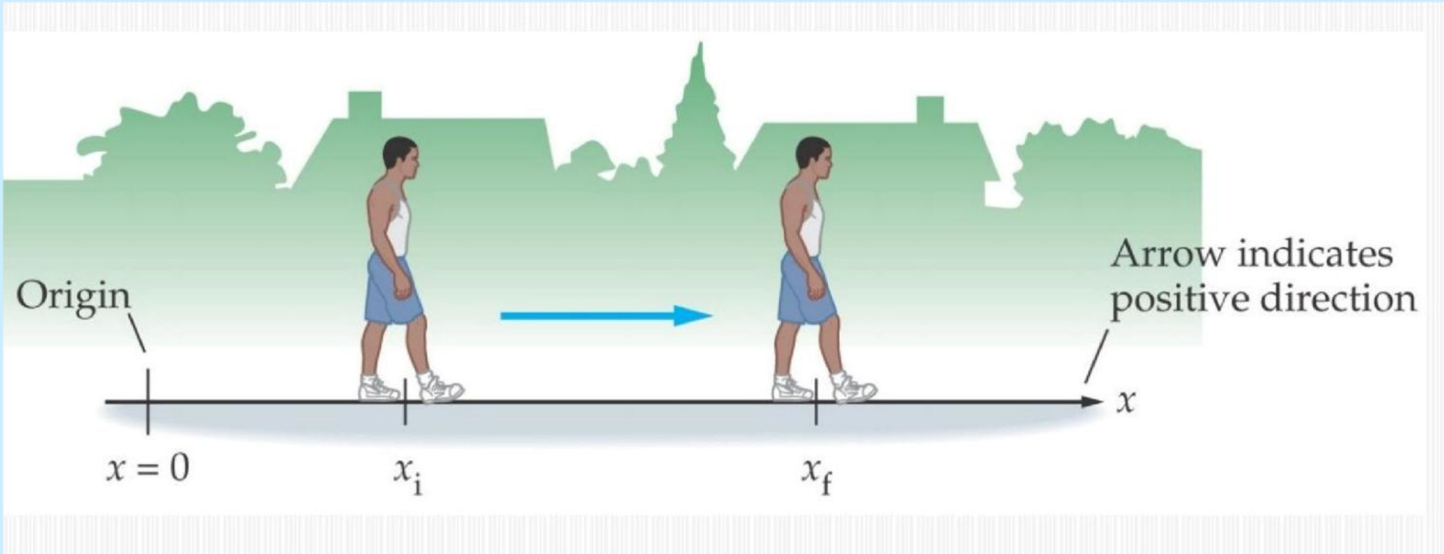
Kinematics is the study of **motion** without worrying about the forces that cause it. In this chapter, you learn how to describe motion using distance, time, speed, velocity, acceleration, and motion graphs.

Lesson 19.1: Motion in One Dimension

Motion in one direction (forward/backward, up/down) is called **1-D motion**.

Important ideas:

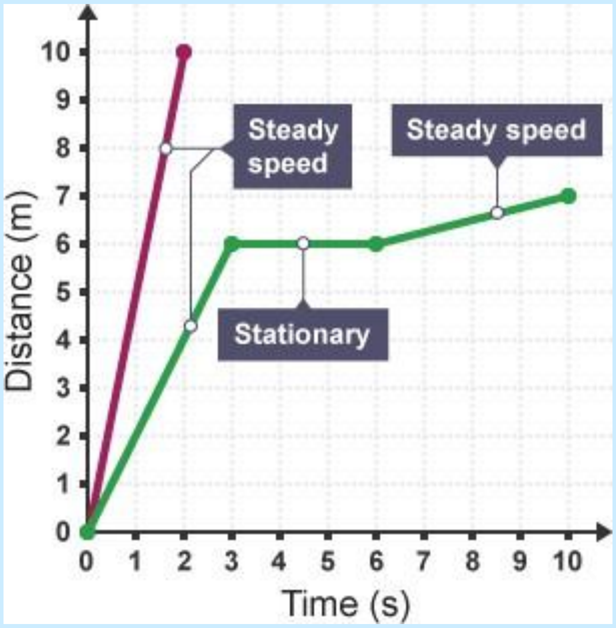
- **Distance** – how far an object moves
- **Displacement** – change in position (with direction)
- **Speed** – distance per time
- **Velocity** – speed with direction



Example:
A car going 60 km/h north → this is velocity because it includes direction.

Lesson 19.2: Graphs of Motion

Motion can be shown with graphs:



Distance–time graph:

- straight rising line = moving at constant speed
- flat line = not moving

Speed–time graph:

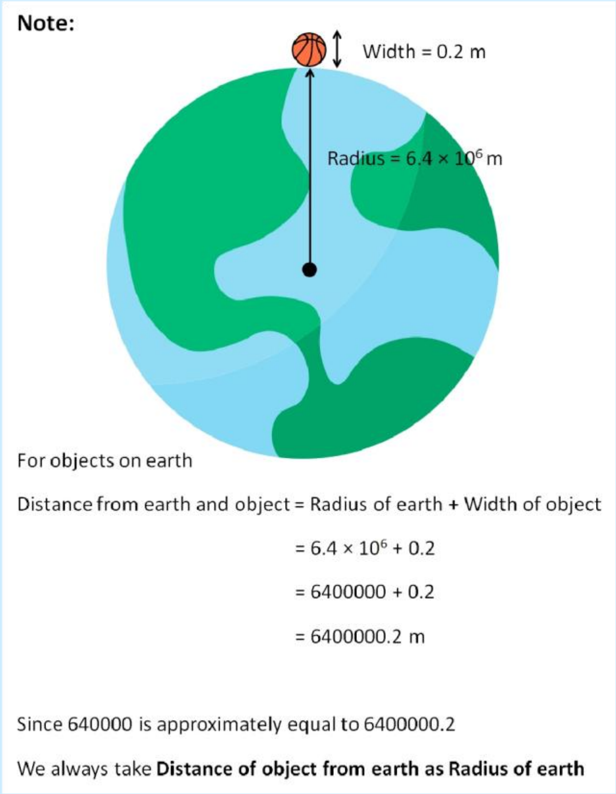
- horizontal line = constant speed
- upward slope = acceleration
- downward slope = slowing down

Graphs help us “see” movement over time.

Lesson 19.3: Free Fall and Projectile Motion

Free fall: When objects fall only under gravity.

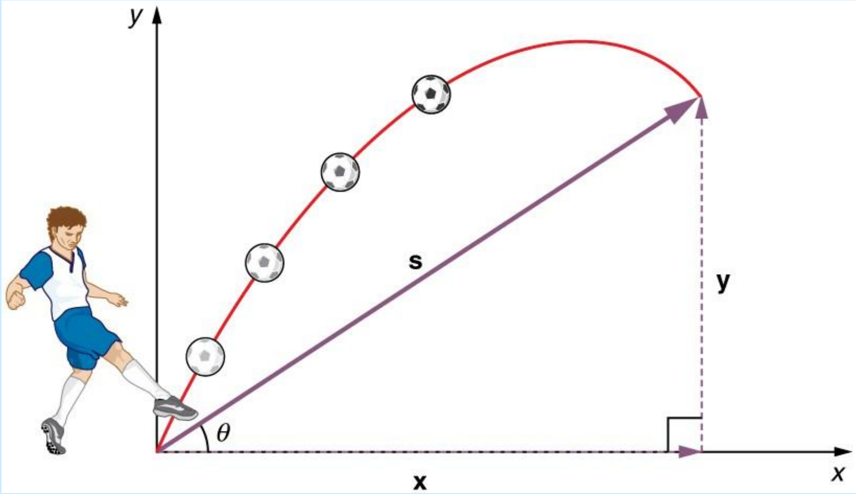
- acceleration = 9.8 m/s² downward (approximately)



Projectile motion: any object thrown or launched into the air.

- moves in a curved path (parabola)
- horizontal + vertical motion happen at the same time

Example:
Throwing a ball → goes up, slows, then falls down.



Summary of Chapter 19

Chapter 19 explains how to describe and measure motion using displacement, speed, velocity, and acceleration. Motion graphs help show how objects move over time. The chapter also covers free fall, where objects accelerate downward due to gravity, and projectile motion, which combines vertical falling motion and horizontal movement to form a curved path.

Activity Box

Pick a small object (like a ball):

1. Drop it from shoulder height
2. Record how long it takes to reach the ground
3. Repeat 3 times and compare results

Think:

- Did it fall at the same time each try?
- Why might small differences happen?

Question Review
What is displacement? How is velocity different from speed? What does a flat line on a distance-time graph mean? What is acceleration due to gravity? Why do projectiles follow a curved path?

Chapter 20

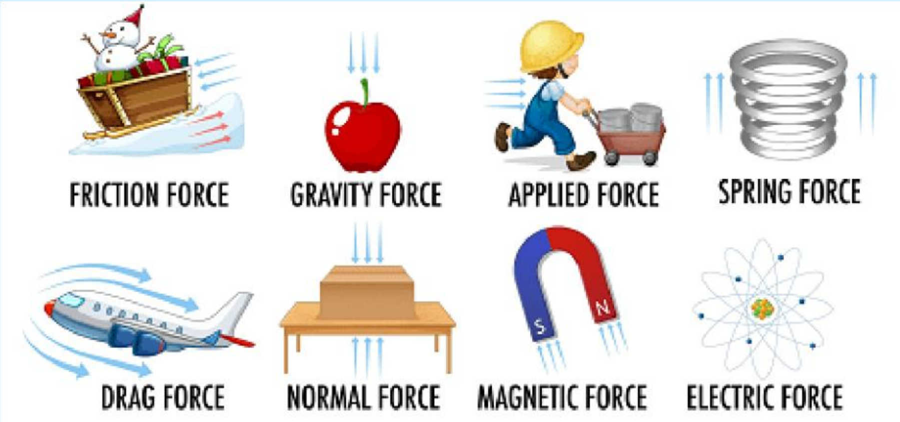
Dynamics

Dynamics is the branch of physics that explains **why objects move**. Unlike kinematics (which only describes motion), dynamics studies the **forces** that cause motion. This chapter focuses on forces in nature and explains Newton’s Laws more deeply, showing how they apply to everyday life.

Lesson 20.1: Forces in Nature

A force is a push or a pull that can change an object's motion.
Examples of forces:

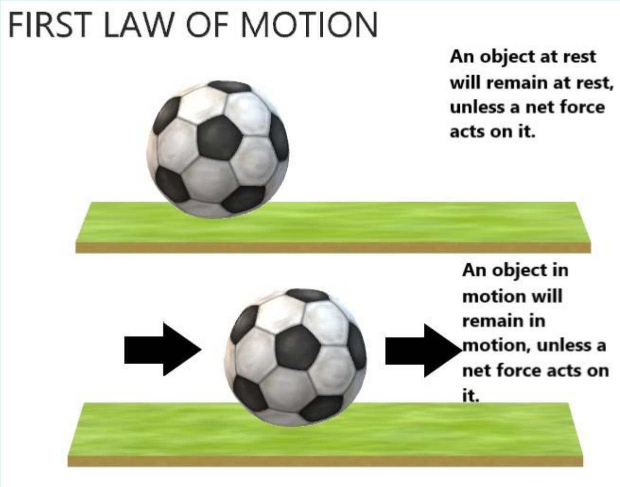
- gravity
- friction
- tension
- normal force
- applied force



If forces are balanced → no change in motion If forces are unbalanced → acceleration happens

Example:
When you push a shopping cart, it accelerates because of an unbalanced force.

Lesson 20.2: Newton’s Laws in Depth



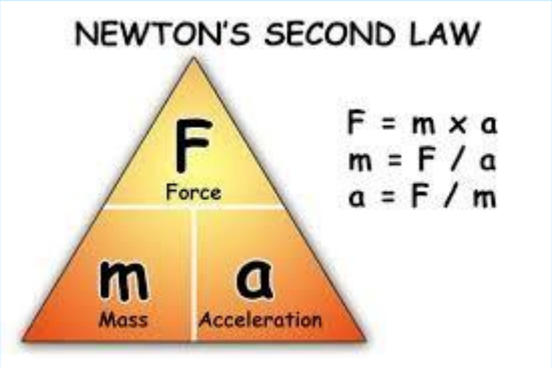
Newton’s Laws explain the behavior of objects when forces act on them.

First Law: Law of Inertia

Objects resist changes in motion.

- at rest stays at rest
- moving stays moving unless a force acts

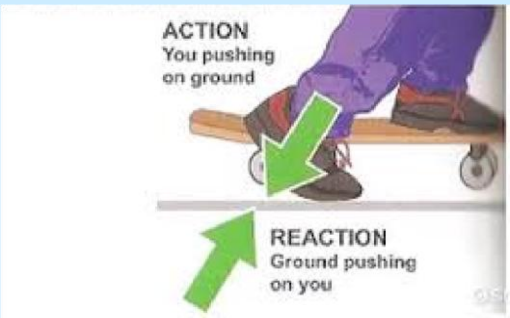
Example: A soccer ball won’t move unless you kick it.



Second Law: F = ma

Force = mass × acceleration
More force → more acceleration
More mass → harder to accelerate

Example: Pushing a heavy box requires more force than pushing a light one.



Third Law: Action–Reaction

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

Example: When you jump, the ground pushes you upward.

Lesson 20.3: Applications of Newton's Laws

Newton's laws explain everyday things:

- why seat belts protect you in a car
- how rockets launch
- why heavier objects need more force
- why objects fall the same in a vacuum

Technology based on Newton's laws:

- cars
- airplanes
- space rockets
- industrial machines

Summary of Chapter

Chapter 20 explains that forces cause motion and acceleration. Newton's laws describe how objects respond when forces act on them. These laws are the foundation for understanding motion in everyday life from walking to launching rockets. By applying Newton's laws, scientists and engineers design transportation systems and machines used today.

Activity Box

Try pushing two objects:

- a small object (like an eraser)
- a heavy object (like a book)

Compare:

- which moves faster?
- which needs more force?

Explain using Newton's 2nd Law.

Question Review
What is a force?
What happens if forces are balanced?
State Newton’s First Law.
What is the equation F = ma used for?
Give an example of Newton’s Third Law.

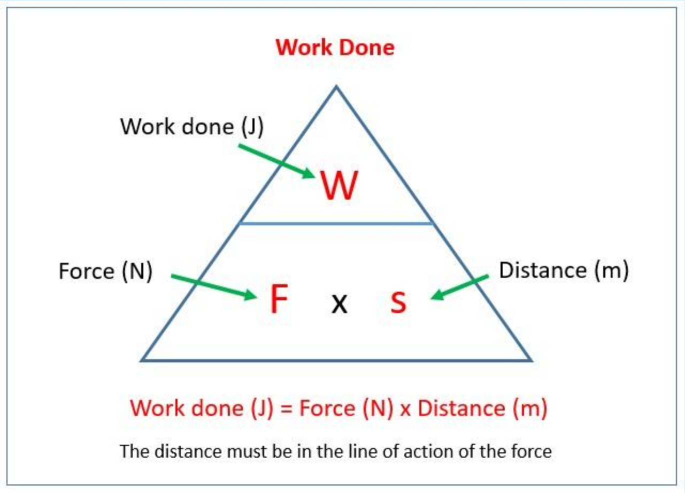
Chapter 21

Work, Energy, and Power

This chapter explains how forces do work, how energy changes from one form to another, and how power shows the rate at which work is done. Understanding these ideas helps us explain machines, engines, and everyday physical activities.

Lesson 21.1: Calculating Work Done

Work happens when a force moves an object in the direction of the force.

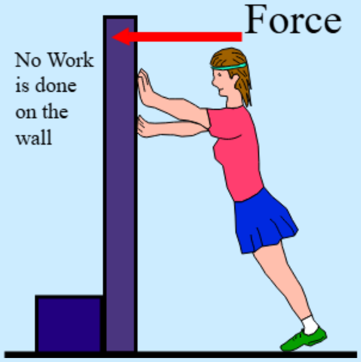


Units of work → **Joules (J)**

Examples:

- **lifting a box**
- **pushing a door**
- **pulling a cart**

If an object does not move → **no work is done** (even if you're tired!)



Lesson 21.2: Power and Efficiency

Power

Power is the **rate** at which work is done.

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Force} \cdot \text{Displacement}}{\text{Time}}$$

$$\text{Power} = \text{Force} \cdot \frac{\text{Displacement}}{\text{Time}}$$

$$\boxed{\text{Power} = \text{Force} \cdot \text{Velocity}}$$

Unit → **Watt (W)**

Example:
Two people lift the same weight, but the faster person uses more power.

Efficiency

Efficiency shows how much of the input energy is actually converted to useful output energy.

Example:

- light bulbs
- car engines
- electric motors

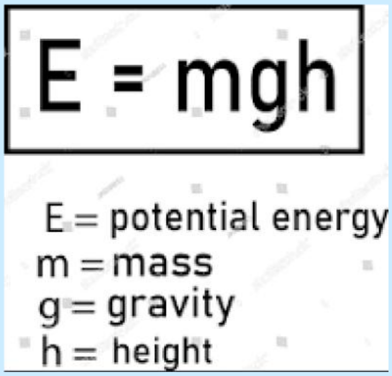
A machine with high efficiency wastes less energy.

Lesson 21.3: Potential Energy vs. Kinetic Energy

Potential Energy (PE)

Stored energy Example:

- a stretched rubber band
- water behind a dam

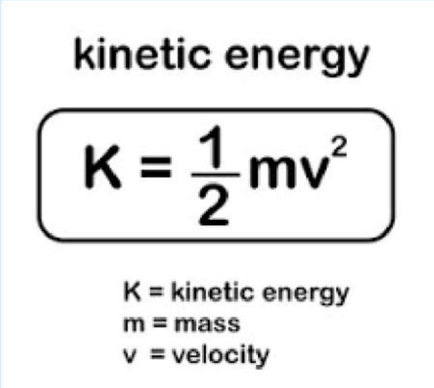


Kinetic Energy (KE)

Energy of motion

Example:

- moving car
- running athlete



Summary of Chapter

Chapter 21 explains that whenever a force moves an object, work is done, and the energy stored in the object can change into other forms like kinetic or potential energy. Power measures how fast work is done, and efficiency tells us how much of the energy is used usefully. These ideas help us understand machines, motors, vehicles, and many kinds of physical systems.

Activity Box

Try lifting a book:

- slowly
- then quickly

Which required more **power**?
Which had more **work** (same or different)?

Think about why!

Question Review
What is the formula for work?
What is the unit of power?
What is potential energy?
What is kinetic energy?
What does efficiency mean?

Chapter 22

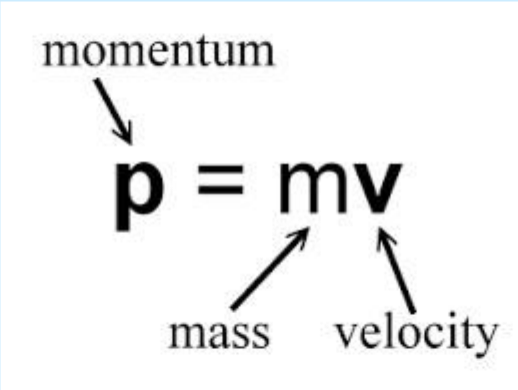
Momentum and Collisions

Momentum helps us understand how moving objects interact. Collisions happen everywhere from cars and balls to atoms and particles. In this chapter, students will explore what momentum is, how it is conserved, and what happens when objects collide.

Lesson 22.1: Conservation of Momentum

What is momentum?

Momentum is the motion of a moving object.



Unit → **kg·m/s**

Heavier or faster objects have greater momentum.

Examples:

- **a fast bicycle has more momentum than a slow one,**
- **a heavy truck moving slowly can have more momentum than a fast bicycle.**

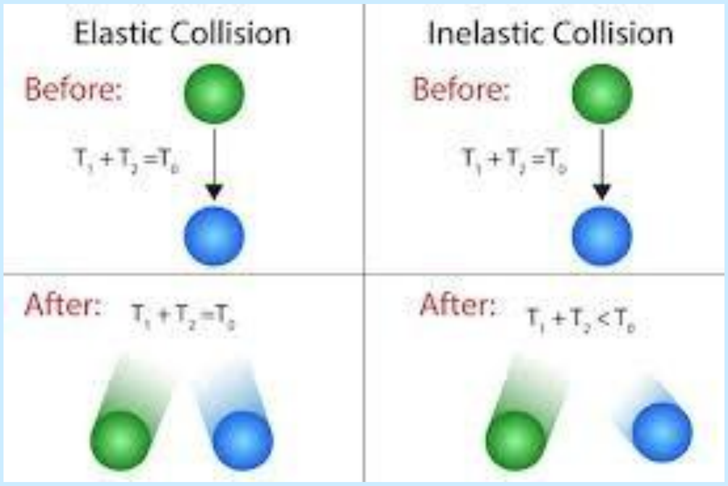

Unit: kg·m/s
more
momentum
faster bicycle
slower bicycle
more
less mometum
heavy truck (slow)
fast bicycle

Lesson 22.2: Types of Collisions (Elastic and Inelastic)

Elastic Collision

Objects bounce off each other without losing kinetic energy. Example:

- billiard balls
- rubber balls bouncing



Inelastic Collision

Objects stick together or lose energy during the collision.

Example:

- **car crashes**
- **clay hitting the ground and staying there**

Energy is changed into:

- sound
- heat
- deformation

Summary of Chapter

Chapter 22 explains that momentum depends on an object’s mass and velocity. When collisions happen, momentum is conserved, meaning the total momentum before and after a collision remains the same. Collisions can be elastic (objects bounce) or inelastic (objects stick or lose energy). These ideas are important in understanding motion, transportation, safety designs, and scientific experiments.

Activity Box

Roll two balls toward each other (light ball + heavy ball).
Observe:

- which one changes speed more?
- does the lighter ball move more after impact?

Write a short note on what happened and why.

Question Review

What is the formula for momentum?

What does conservation of momentum mean?

What is an elastic collision?

What is an inelastic collision?

Give one example of each type of collision.

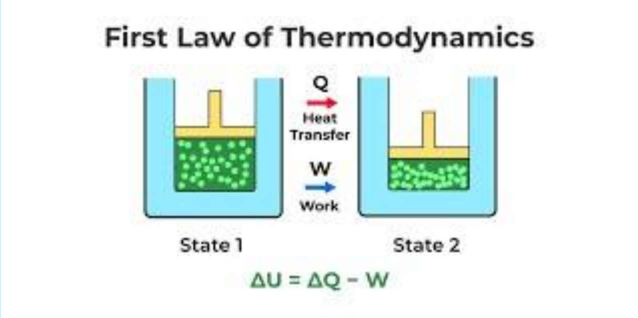
Chapter 23

Thermodynamics

Thermodynamics is the study of heat, temperature, and energy and how they move. This chapter explains the main laws of thermodynamics and how machines use heat energy in everyday life such as refrigerators, engines, and heating systems.

Lesson 23.1: Laws of Thermodynamics

There are **three main thermodynamic laws** (we learn them in simple form):

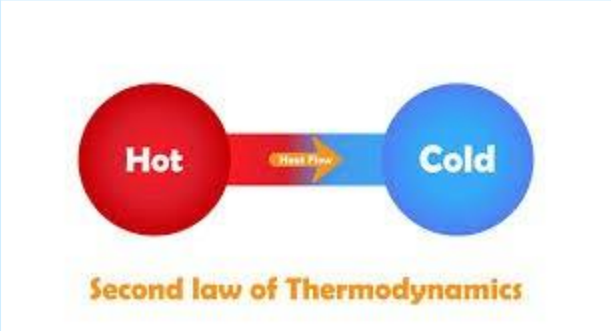


First Law of Thermodynamics

Energy cannot be created or destroyed.
It can only change from one form to another.

Example:

- **electrical energy → heat (oven)**
- **chemical energy → mechanical energy (car engine)**



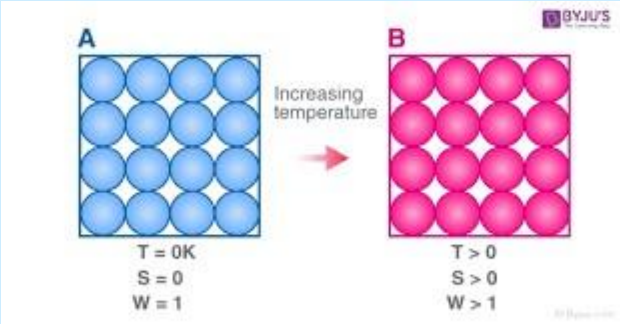
Second Law of Thermodynamics

Heat always moves from a hotter object to a colder one unless forced.

Example:

- **hot tea cools down**
- **warm hands melt an ice cube**

Heat naturally spreads out!



Third Law of Thermodynamics

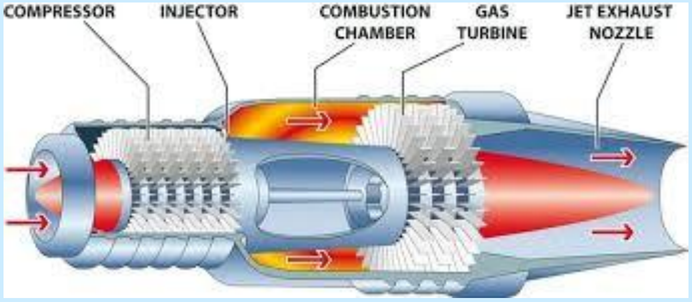
As temperature approaches *absolute zero*, the motion of particles becomes extremely small.

Absolute zero: **−273°C**
At this temperature, particles almost stop moving.

Lesson 23.2: Heat Engines and Refrigerators

Heat Engines

Machines that convert heat into work.



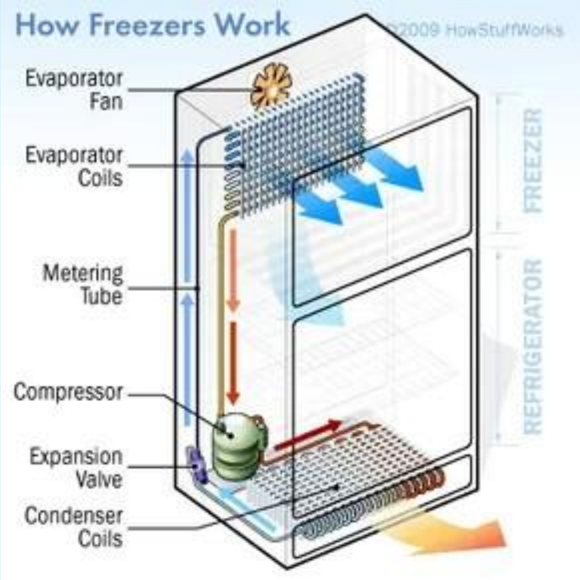
Examples:

- **cars**
- **Trucks**
- **power plants**

Fuel burns → heat produced → expands gas → pushes engine parts → work!

Refrigerators

Refrigerators remove heat from inside and move it **outside**. They keep inside cold by pushing warm air out.



Example:

- refrigerator
- freezer
- air conditioner

Summary of Chapter

This chapter explained that thermodynamics studies how heat moves and changes into other forms of energy. The laws of thermodynamics describe energy conservation, heat movement, and extremely low temperatures. Heat engines convert heat into useful work, while refrigeration systems remove heat from inside and release it outside.

Activity Box

Put a metal spoon in hot tea.
Observe what happens.

✓ Does the handle get warm?
✓ Why does heat move toward the handle?

Write 3–4 lines explaining your observation.

Question Review

What does thermodynamics study?

State the First Law of Thermodynamics.

How does heat naturally move?

What is absolute zero?

What does a refrigerator do with heat?

Chapter 24

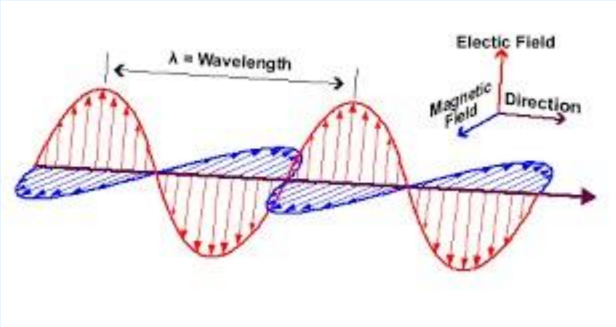
Waves and Sound

This chapter explains how waves move energy from one place to another. Students learn important wave properties, the Doppler effect, and how sound waves are used in daily life and modern technology.

Lesson 24.1: Wave Properties (Amplitude, Frequency, Wavelength)

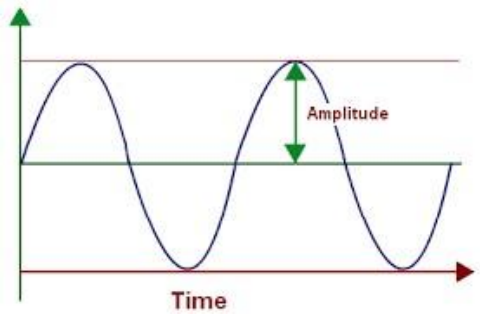
Waves

A wave is a disturbance that transfers energy through a medium or space.



Amplitude

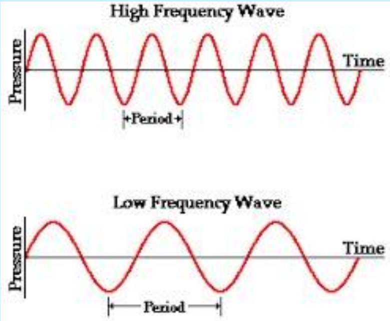
The height of the wave.
More amplitude → louder or stronger wave.



Frequency

How many waves pass a point per second Unit → Hertz (Hz)

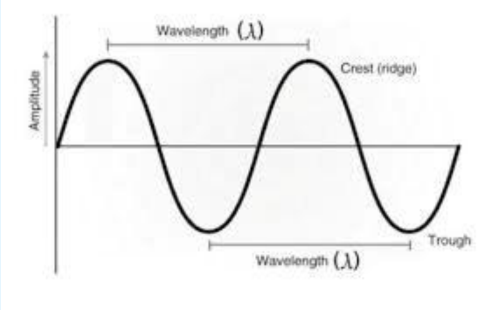
Higher frequency → higher pitch or more energy.



Wavelength

The distance between two identical points on a wave (crest to crest).

Long wavelength → low pitch
Short wavelength → high pitch

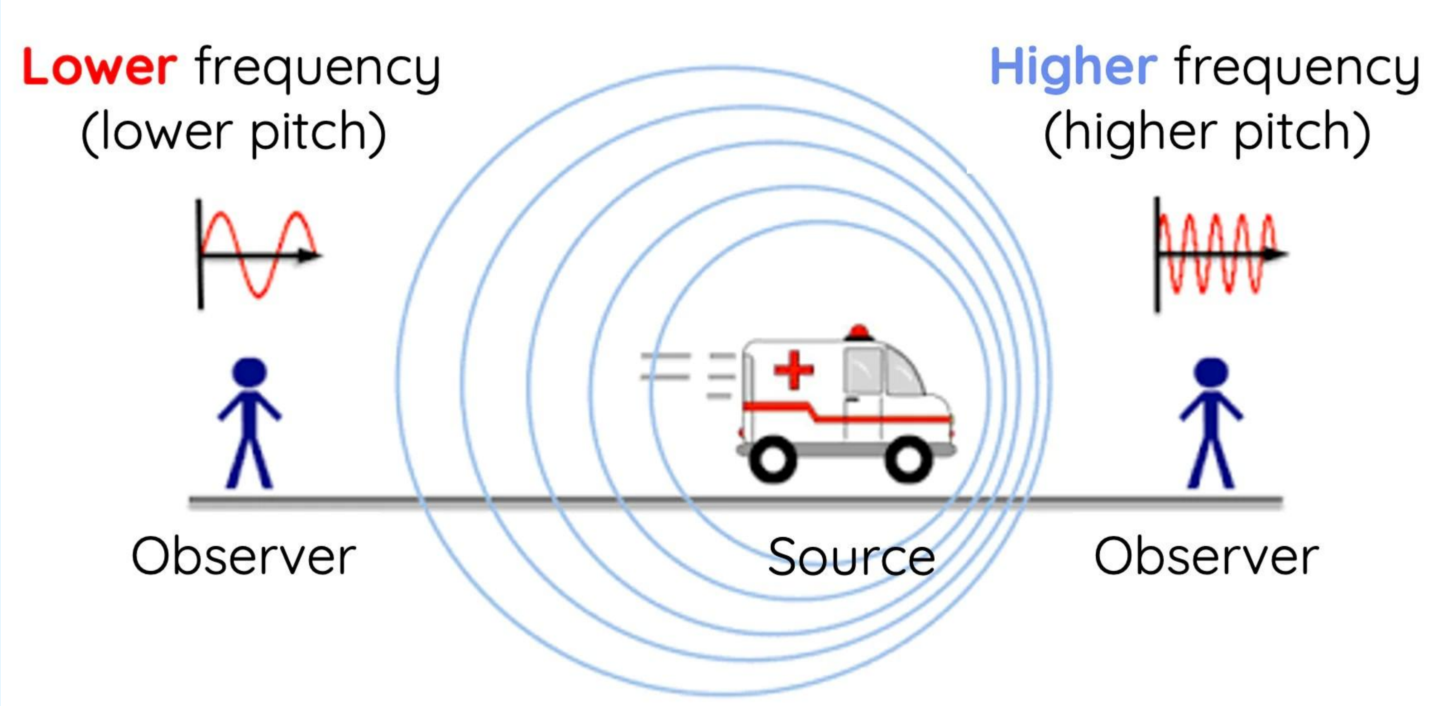


Lesson 24.2: Doppler Effect

The Doppler Effect happens when the source of sound moves.

Example:
When an ambulance with siren passes:

- approaching → higher pitch
- moving away → lower pitch

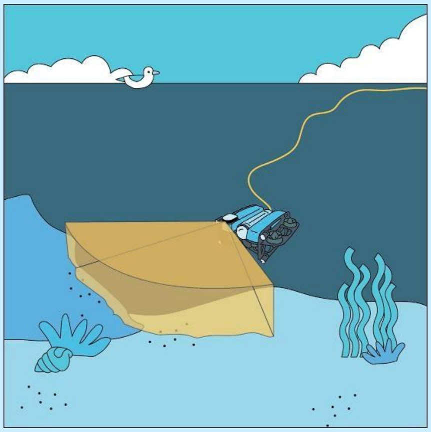


This happens because sound waves stretch or get squeezed depending on movement.

Used in:

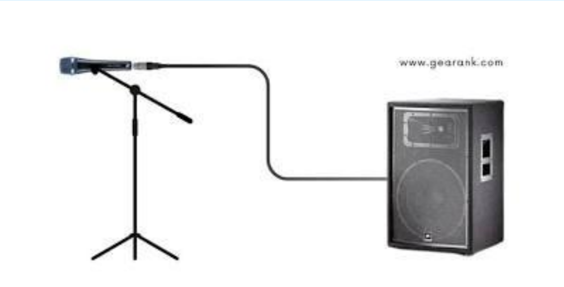
- weather radar
- police speed control
- space observations

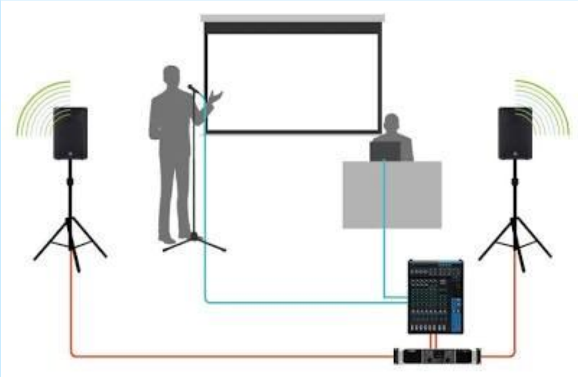
Lesson 24.3: Sound Applications in Technology

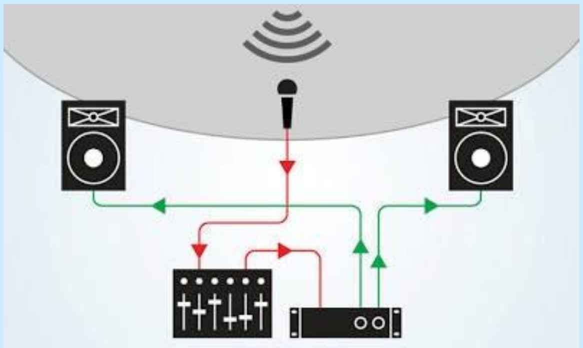


Sound is used in many modern technologies:

✓ ultrasound (medical imaging)
✓ sonar (underwater navigation)
✓ speakers and microphones
✓ communication systems
✓ noise control







Summary of Chapter

Chapter 24 teaches that waves carry energy and have basic properties such as amplitude, frequency, and wavelength. The Doppler Effect explains why sounds change pitch when objects move. Sound waves also play an important role in technologies like medical ultrasound, sonar, and modern communication systems.

Activity Box

Hold a metal spoon and tap it lightly.
Listen carefully:

- louder sound or softer sound?
- high pitch or low pitch?

Observe what happens when you strike harder or softer.

Write a short note on what you noticed.

Question Review

What is a wave?

Define amplitude.

What is frequency measured in?

What is the Doppler Effect?

Name one modern use of sound waves.

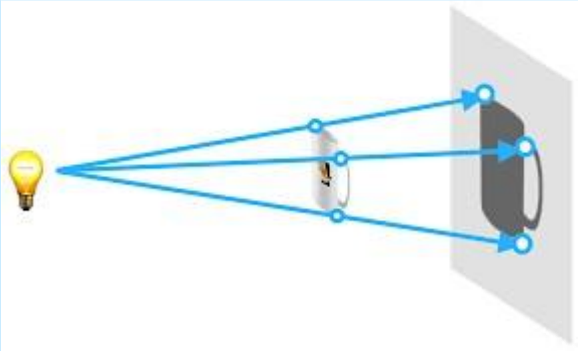
Chapter 25

Light and Optics

Light is a form of energy that travels in waves and allows us to see objects. Optics is the study of how light behaves when it interacts with materials such as mirrors, lenses, and transparent objects. This chapter helps students understand the basic properties of light and how they are used in everyday life and technology.

Lesson 25.1: Properties of Light

Here are the most important basic ideas about light:



Light travels in straight lines

That’s why shadows appear and why laser beams don’t curve.

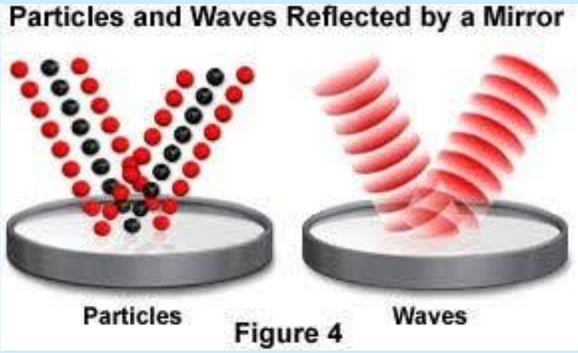
Light travels very fast

Speed of light = **300,000 km per second**
Fastest thing in the universe!

Light can travel without a medium

Unlike sound, light does not need matter. It can travel through empty space.

That’s why sunlight reaches Earth from space.



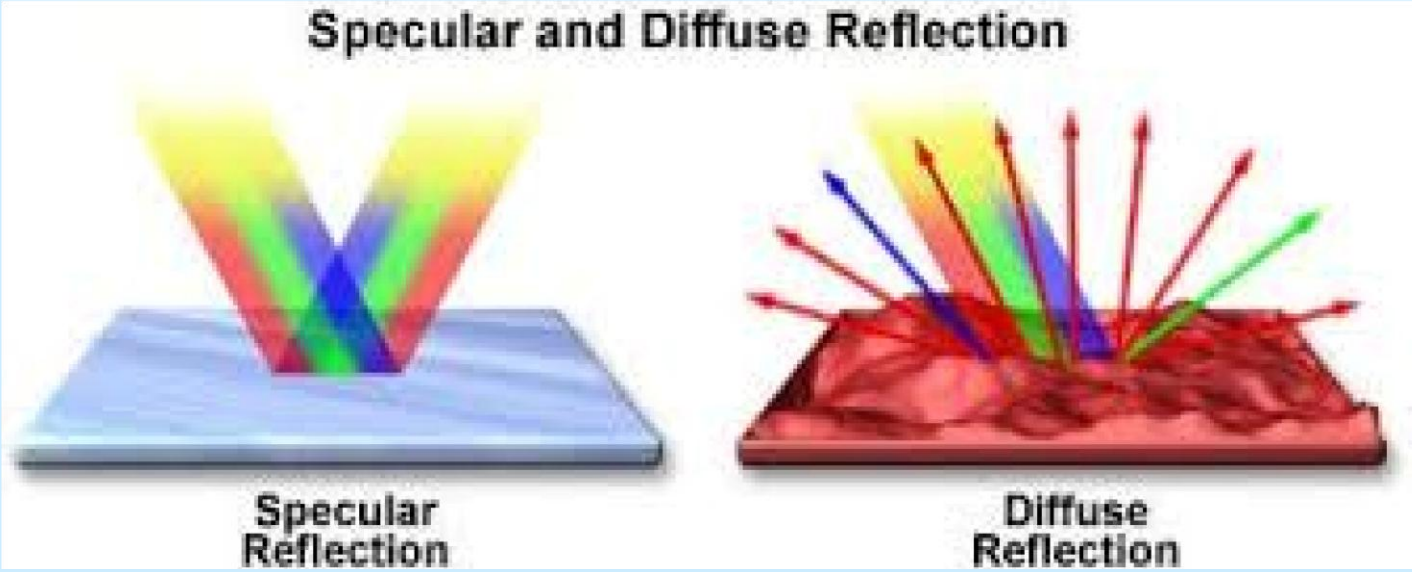
Light behaves like both a wave and a particle

Light has wave behavior (interference, diffraction) and particle behavior (photons).

Light can be reflected and refracted

Reflection
 Light bounces off a surface
mirrors

Refraction
 Light bends when passing through different materials
lenses, glasses, prisms


Specular and Diffuse Reflection
Specular Reflection
Diffuse Reflection

Summary of Chapter

Chapter 25 explains that light is a form of energy that travels in waves and moves extremely fast, even through empty space. Light can reflect from surfaces, bend when passing through different materials, and shows both wave-like and particle-like behaviors. These properties allow mirrors, lenses, and optical devices like glasses, microscopes, and telescopes to work.

Activity Box

Shine a flashlight at a mirror in a dark room.

Try:
- ✓ changing the angle
- ✓ moving the light
- ✓ moving the mirror

Write down how the reflection changes each time.

Question Review

1. What type of energy is light?
2. Does light need matter to travel?
3. What is the speed of light?
4. What is reflection?
5. What is refraction?

End The Book

Summary of Book

This book introduced students to the major concepts of physics and how they shape our everyday world. Beginning with **the nature of physics**, we explored matter, motion, energy, and the forces that govern the universe. Students learned how objects move, why things fall, how light travels, and how energy is transformed and conserved.

We studied **motion and forces**, including speed, velocity, acceleration, and Newton's Laws which explain why objects move the way they do. We also investigated **waves, sound, and light**, and discovered how they travel and interact with matter.

Students learned the basics of **electricity, magnetism, and circuits**, gaining understanding of electrical charges, electromagnets, and real-life applications. We explored **thermal energy and thermodynamics**, including the laws of heat transfer and their applications in engines and refrigerators.

The book also introduced **astronomy, space exploration, measurement, scientific methods**, and built strong scientific thinking skills. Finally, we reviewed **kinematics, dynamics, power, energy, momentum, and collisions**, and saw how scientific laws apply to real-world technology.

By the end of this course, students gained understanding of how physics explains natural events from falling objects to planets in space and how physics technology improves human life.

Glossary of Key Terms

Acceleration – The change in velocity over time.
Atom – Smallest unit of matter.
Buoyancy – Upward force that causes objects to float.
Circuit – A closed path for electric current.
Collision – Interaction of two bodies that exchange force.
Conduction – Heat transfer through direct contact.
Convection – Heat transfer through moving fluids.
Density – Mass per unit volume of a substance.
Doppler Effect – Change in frequency when source moves.
Electric current – Flow of electric charges.
Electromagnet – Magnet produced by electricity.
Energy – Ability to do work.
Force – A push or pull acting on an object.
Friction – Contact force acting opposite direction of motion.
Gravity – Force pulling objects toward Earth.
Heat – Thermal energy transferred between objects.
Kinetic energy – Energy of motion.
Light – Electromagnetic wave visible to human eye.
Momentum – Mass multiplied by velocity.
Newton's Laws – Laws explaining motion and forces.
Potential energy – Stored energy based on position.
Refraction – Bending of light when changing medium.
Static electricity – Build-up of electric charges.
Thermodynamics – Study of heat, work, and energy.
Velocity – Speed in a specific direction.
Wave – Repeated disturbance transferring energy.

Review Questions

1. What is physics and why is it important?
1. How does energy change from one form to another?
2. What is the difference between mass and weight?
3. Describe Newton's three laws of motion.
4. Explain how friction affects motion.
5. What is the law of conservation of energy?
6. How do conduction, convection, and radiation transfer heat?
7. What is the Doppler Effect?
8. How are electricity and magnetism related?
9. What are examples of simple machines in daily life?

Laboratory Skills and Safety

General Lab Rules:

- Always wear safety equipment (goggles, gloves, apron).
- Read experiment instructions carefully.
- Never taste or smell chemicals directly.
- Report spills or accidents immediately.
- Do not run or play in the laboratory.
- Keep workspace clean and organized.
- Handle glassware with care.
- Use heat sources only with supervision.

Scientific Skills:

- Accurate measurement (units and tools)
- Data recording in tables
- Observing and describing results
- Drawing conclusions
- Using graphs to represent results
- Writing scientific reports

Extra Learning Resources

You can explore physics more deeply using these recommended sources:

Books

- "Conceptual Physics" by Paul Hewitt
- "Physics for Beginners" DK Publishing

Online Learning

- Khan Academy (Physics)
- NASA Education Portal
- National Geographic Kids – Space & Science

Videos

- TED-Ed Science
- Crash Course Physics
- Kurzgesagt – In a Nutshell (Universe topics)

End of Book Message

Congratulations!

You completed a full introduction to physics, one of the most important foundations of modern science. Understanding physics helps you understand the natural world, future technologies, and how scientific discoveries improve our lives.

Keep exploring, experimenting, and asking questions… because science never ends.

Thank you