5

"In nature, nothing is created, nothing is lost, everything changes."

– Antoine Lavoisier

Changes Around Us: Physical and Chemical

The Big Question

Have you ever left your shiny new bicycle out in the rain for too long, only to find reddish-brown patches appearing on its metal parts? Or noticed how a piece of fruit left on the counter slowly changes its color, texture, and smell? The world around us is in a constant state of flux, with changes happening every second. What causes these transformations, and are all changes the same? Let's embark on a journey to explore the fascinating world of changes!

Meet EeeBee.AI

Hi explorers! I'm EeeBee, your curious science buddy! I love spotting how things change—melting, burning, mixing, or glowing! I'll share cool facts and fun tips as we explore physical and chemical changes together!

Learning Outcomes

By the end of this chapter, students will be able to:

- Identify and differentiate between physical and chemical changes.
- Describe the characteristics of physical changes with examples.
- Explain the characteristics of chemical changes and chemical reactions with examples.
- Investigate the process of combustion and identify the conditions necessary for it.

From Last Year's Notebook

- Reversible changes
- Irreversible changes

Science Around You

Changes are everywhere—from cooking food (a chemical change) and freezing water (a physical change) to changing seasons and growing plants. Understanding these changes helps us understand nature, create new materials and medicines, and care for the environment by studying processes like pollution and decomposition.

NCF Curricular Goals and Competencies

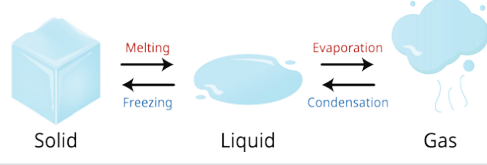
CG 5.1 Identify and classify changes in substances as physical (reversible) or chemical (irreversible).
CG 5.2 Observe signs of chemical change such as gas formation, color change, and new substance formation.

Mind Map

Changes Around Us – Physical and Chemical

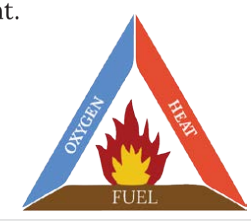
Physical Changes

- Only size/shape/state/appearance changes.
- No new substance, usually reversible.
- Minimal energy change.
- **Examples** → Melting ice, boiling water, dissolving salt, cutting paper.
- **Some irreversible** → Breaking glass, tearing clothes.



Combustion

- **Rapid reaction of fuel + O_2** → Heat & light.
- **Fire triangle** → Fuel, Oxygen, Heat.
- **Products** → CO_2, water vapor, ash.
- Fire extinguished by removing any one component.



Chemical Changes

- New substance formed, irreversible.
- Energy changes (heat, light, sound).
- **Indicators** → Gas, color change, precipitate, smell.
- **Examples** → Rusting, burning, digestion, cooking, curdling milk.

Natural Slow Changes

- **Weathering** → Breakdown of rocks.
  - ✓ Physical (temp, roots), Chemical (oxidation, carbonation).
- **Erosion** → Movement of weathered material (wind, water, ice).
- **Deposition** → Settling → Landforms.
- **Impact** → Shapes Earth's surface, forms soil.

Desirable vs Undesirable Changes

- **Desirable** → Cooking, germination, ripening.
- **Undesirable** → Rusting, food spoilage.
- **Context dependent** → Compost (useful) vs food rot (harmful).

In Focus

- Physical Changes
- Chemical Changes
- Combustion
- Desirable and Undesirable Changes
- Slow Natural Changes: Weathering and Erosion

Introduction

The world around us is in a constant state of transformation. These transformations, big or small, are referred to as changes. We observe changes in the color of leaves, the ripening of fruits, the cooking of food, the rusting of iron, and even in ourselves as we grow. Scientists classify these changes into two main categories: physical changes and chemical changes.

From History's Pages

Since ancient times, humans have observed and used chemical changes. The discovery of fire (combustion) helped early humans cook, stay warm, and stay safe. Smelting metals like iron and copper brought the Bronze and Iron Ages, changing tools and societies. Alchemists, early chemists, tried to turn base metals into gold. Though they failed, their work laid the foundation for modern chemistry. In the 18th century, Antoine Lavoisier, known as the "father of modern chemistry," performed detailed experiments. He established the law of conservation of mass and deepened our understanding of chemical reactions, especially combustion.

Physical Changes

A physical change is a change in which only the physical properties of a substance are altered, while its chemical composition remains the same. This means that no new substance is formed during a physical change. Physical properties include attributes like shape, size, color (if it's not due to a chemical reaction), state (solid, liquid, gas), texture, and density.

Characteristics of Physical Changes

- **No New Substance Formed:** The most crucial characteristic is that the chemical identity of the substance does not change. For example, when ice melts, it becomes water. Both ice and water are chemically H_2O; only their state has changed.
- **Change in Physical Properties:** Observable properties like shape, size, state, or appearance may change.
- **Often Reversible:** Many physical changes can be easily reversed. For instance, water can be frozen back into ice, or salt dissolved in water can be recovered by evaporating the water. However, not all physical changes are easily reversible (e.g., tearing paper or crushing a rock).

- **Temporary Nature (Usually):** The change is often temporary, and the original substance can be recovered by reversing the conditions that caused the change.
- **No Change in Mass:** The total mass of the substance remains constant during a physical change.
- **Energy Changes:** Energy changes (**absorption** or release) involved are usually small compared to chemical changes.

Examples of Physical Changes

Change of State

Melting (ice to water), Freezing (water to ice), Boiling/Evaporation (water to steam), Condensation (steam to water), Sublimation (dry ice to gas), Deposition (**frost formation**).

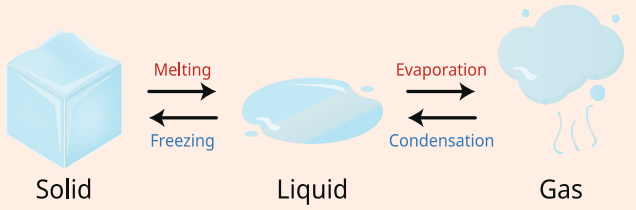


Fig. 5.1 Change of State of Water

Change in Shape/Size

Tearing paper, Crushing a can, Stretching a rubber band, Chopping wood, Grinding wheat into flour.

Fig. 5.2 Chopping Wood

Dissolving

Salt or sugar dissolv-ing in water—no new substance is formed, and it can be reversed.

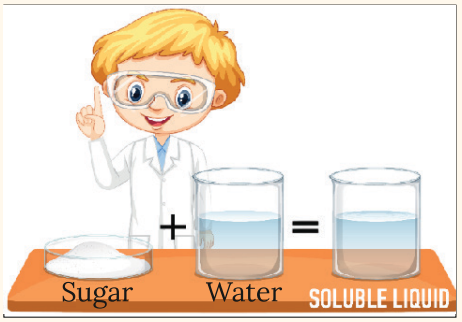


Fig. 5.3 Sugar Dissolve in Water

Making Mixtures

Mixing sand and sugar or preparing fruit salad—no chemical reaction, components retain their identity.

Fig. 5.4 Preparing Fruit Salad

Fact Flash

When you get a haircut, it's a physical change! The hair's chemical composition doesn't change, just its length and shape. And no, collecting the cut hair won't magically reattach it – some physical changes, while not forming new substances, are irreversible in practice!

Keywords

Absorption: The process by which one substance takes in or soaks up another, like a sponge absorbing water or roots absorbing nutrients from the soil.
Frost Formation: The process where water vapor in the air changes directly into ice crystals on cold surfaces, usually during clear, cold nights.

Common Misconceptions

× **Misconception:** All physical changes are easily reversible.

✓ **Correction:** Not always—some (like tearing paper) are hard to reverse, even though no new substance forms.

× **Misconception:** Big changes in appearance mean chemical change.

✓ **Correction:** Not necessarily—grinding or crushing can look dramatic but still be physical if the substance stays the same.

Science Around You

When you stretch a rubber band, you're seeing a physical change in action. It changes shape but goes back when released! Even blowing up a balloon is a physical change — the air gives it shape, but nothing new is formed. These changes may look dramatic, but the substance stays the same!

Activity

Observing Physical Changes

- **Objective:** To observe and identify examples of physical changes.

Materials Required: Paper, scissors, ice cube, plate, glass of water, teaspoon of salt, stirrer.

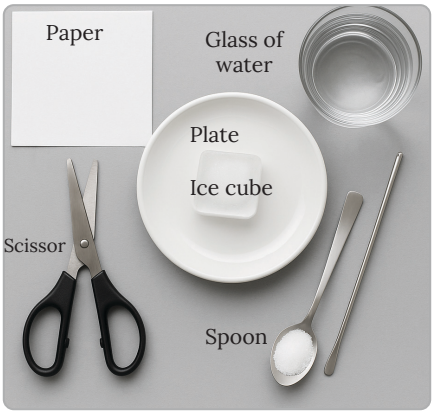


Fig. 5.5 Materials Required

- **Procedure:**
  1. **Paper Change:** Fold a paper into an airplane, then unfold it. Cut it into pieces. Is it still paper? Can you reverse these changes?
  2. **Melting Ice:** Place ice on a plate and let it melt. Does the melted water differ from ice? Can you refreeze it?
  3. **Salt Solution:** Dissolve salt in water. Taste it (with permission). Has a new substance formed? Try recovering the salt by evaporating the water.
- **Observation & Conclusion:**
  - Note what changes (shape, size, or state) occurred. Were the changes reversible? Was any new substance formed?

Knowledge Checkpoint

Gap Analyzer™ Homework | Watch Remedial

Remembering

Multiple Choice Questions:

1. Which of the following is a physical change?

a) Burning of wood ☐ b) Rusting of iron ☐

c) Melting of wax ☐ d) Digestion of food ☐

Understanding

2. In a physical change, which of the following generally occurs?

a) New substance formed ☐ b) Chemical composition changes ☐

c) Physical properties change ☐ d) Always irreversible ☐

3. Dissolving sugar in water is a physical change because:

a) Sugar disappears ☐ b) New substance forms ☐

c) Sugar recovered later ☐ d) Produces heat ☐

Applying

Short Answer Question:

4. Why is the tearing of paper considered a physical change, even though it's hard to get the original sheet back?

5. Give two examples of physical changes that are reversible and two that are not easily reversible.

Analyzing

Long Answer Question:

6. Explain with three different examples how a change in state of matter is a physical change. Describe the characteristics that confirm these are physical changes.

Chemical Changes

A chemical change is a process where one or more substances (reactants) are transformed into one or more new and different substances (products). These new substances have different chemical compositions and different physical and chemical properties compared to the original substances. Chemical changes are often accompanied by observable signs and involve the breaking and forming of chemical bonds. They are also known as chemical reactions.

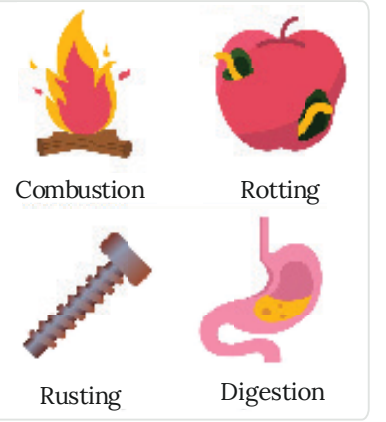


Fig. 5.6 Chemical Changes

Characteristics of Chemical Changes:

- **New Substance(s) Formed:** This is the defining characteristic. The products have properties distinct from the reactants. For example, when iron rusts, iron reacts with oxygen and water to form iron oxide (rust), which is a completely different substance from iron.
- **Change in Chemical Composition:** The atoms of the reactants rearrange to form new molecules or compounds.
- **Usually Irreversible:** Most chemical changes are difficult to reverse. For example, once wood is burnt to ash, it's very hard to get the wood back from the ash.
- **Permanent Nature:** The change is generally permanent.
- **Energy Changes:** Chemical changes are almost always accompanied by a significant energy change, either releasing energy (exothermic reaction, e.g., burning) or absorbing energy (**endothermic reaction**, e.g., some types of photosynthesis or cold packs).
- **Change in Mass (Conservation of Mass):** While new substances are formed, the total mass of the reactants equals the total mass of the products in a closed system (Law of Conservation of Mass).

Keywords

Endothermic Reaction: A chemical reaction that absorbs heat from its surroundings, causing a drop in temperature (e.g., photosynthesis or dissolving ammonium nitrate in water).

Indications of a Chemical Change (often observed)

- **Production of a gas:** Bubbles forming (effervescence), e.g., vinegar and baking soda.
- **Formation of a precipitate:** A solid substance forming from a solution, e.g., when lime water turns milky.
- **Change in color:** A distinct color change that is not just due to mixing, e.g., iron turning reddish-brown when it rusts.
- **Change in smell or production of an odor:** e.g., food spoiling, burning substances.
- **Production of heat and/or light:** e.g., burning of a matchstick, explosion of fireworks.
- **Production of sound:** e.g., a popping sound when certain gases ignite.

Chemical Changes – Examples:

- **Burning (Combustion):**
  - ✦ Burning wood or magnesium forms new substances (ash, CO_2, MgO) with heat and light.
  - ✦ A magnesium ribbon being held by tongs and burning with a bright white flame over a watch glass where white powder (magnesium oxide) is collecting.

Fact Flash

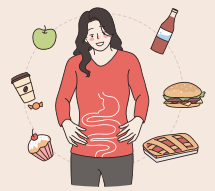
The beautiful colors of fireworks are due to chemical changes! Different metal salts are used, and when they burn (a chemical reaction with oxygen and other components), they emit light of specific colors. For example, strontium salts produce red, barium salts produce green, and copper salts produce blue.

Rusting of Iron

Iron reacts with air and moisture to form reddish-brown rust.

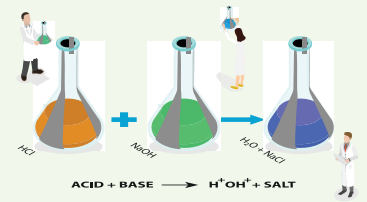
Cooking & Digestion

Cooking eggs, baking cakes, or digesting food involves irreversible chemical changes with new substances formed.



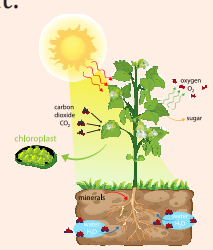
Acid-Base Reactions

Vinegar and baking soda react to release CO_2 gas.
Neutralization forms salt and water.



Photosynthesis

Plants convert CO_2 and water into glucose and oxygen using sunlight.



Ripening of Fruits

Fruits change in color, taste, and smell due to chemical changes (starch to sugar).

Curdling of Milk

Bacteria turn milk sugar into lactic acid, forming curd.

Common Misconceptions

× **Misconception:** If there's a color change, it's always a chemical change.

✓ **Correction:** Not necessarily. Dissolving a colored substance (like potassium permanganate) in water causes a color change due to **dispersion**, but it's a physical change. A chemical color change involves the formation of a new colored compound (e.g., rusting).

× **Misconception:** All chemical changes release heat.

✓ **Correction:** While many do (exothermic), some chemical changes absorb heat from their surroundings, making them feel cold (endothermic). An example is the reaction in instant cold packs.

Science Around You

When you cook an egg, rust iron, or burn wood, a chemical change happens — a new substance forms that can't easily change back. The egg can't turn raw again, and ashes can't become wood! These changes are permanent and often involve heat, color change, or gas release.

Activity

Investigating a Chemical Change – Vinegar and Baking Soda

- **Objective:** To observe a chemical change and identify its indicators.
- **Materials Required:** A test tube or small glass, vinegar, baking soda (sodium bicarbonate), a balloon, a small bottle (optional, for collecting gas), limewater (calcium hydroxide solution).
- **Procedure:**
  1. Pour a small amount of vinegar (about 20 ml) into the test tube or glass.
  2. Add a teaspoon of baking soda to the vinegar. Observe carefully. What do you see and hear?

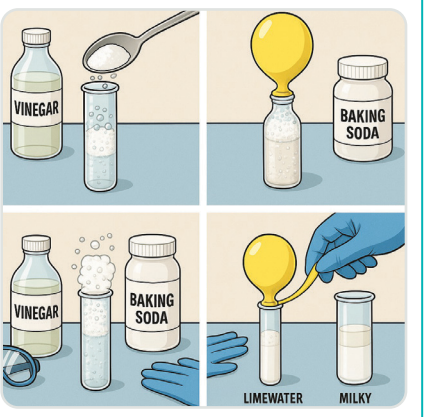


Fig. 5.7 Materials Required

  3. (Optional) Quickly stretch the opening of the balloon over the mouth of the test tube/bottle to collect the gas.
  4. If you collected the gas, carefully remove the balloon, pinch its opening, and then pass the gas from the balloon through freshly prepared limewater. Observe any change in the limewater.
- **Observation & Conclusion:**
  - ✦ Did you see bubbles? This indicates gas formation.
  - ✦ Did you hear a fizzing sound?
  - ✦ If you used limewater, did it turn milky? This confirms the gas is carbon dioxide.
  - ✦ Discuss whether a new substance was formed and why this is a chemical change.

Keywords

The process in which white light splits into its component colors (spectrum) when it passes through a prism or other medium.

Knowledge Checkpoint

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Understanding

Multiple Choice Questions:

1. Which of the following is a definite sign of a chemical change?

   a) Change in state ☐ b) Change in size ☐

   c) Formation of a new substance ☐ d) The change is easily reversible ☐

2. The process of converting milk into curd is a:

   a) Physical change because the state changes. ☐

   b) Chemical change because a new substance (lactic acid) is formed. ☐

   c) Reversible physical change. ☐

   d) Physical change because it can be cooled. ☐

Remembering

3. When iron rusts, it reacts with:

   a) Nitrogen and hydrogen ☐ b) Oxygen and moisture ☐

   c) Carbon dioxide only ☐ d) Sulphur ☐

Short Answer Question:

4. List three indicators that suggest a chemical change might have occurred.
5. Why is burning of paper a chemical change, while tearing paper is a physical change?

Analyzing

Long Answer Question:

6. Describe an experiment to show that carbon dioxide is produced when vinegar reacts with baking soda. Explain how this experiment demonstrates a chemical change. What are the new substances formed in this reaction?

Combustion

Combustion is a specific type of chemical change, a rapid reaction between a substance and an oxidant, usually oxygen, to produce heat and light. The substance that undergoes combustion is called a **combustible substance** or **fuel.**

Key Aspects of Combustion

1. **Chemical Reaction:** It's a chemical process where the combustible substance reacts with oxygen. For example, when wood burns, cellulose (the main component of wood) reacts with oxygen from the air.

- Wood (mainly C, H, O) + O_2 → CO_2 + H_2O + Ash + Heat + Light

2. **Production of Heat and Light:** A hallmark of combustion is the release of energy in the form of heat and often light (flame). This makes combustion an **exothermic reaction.**
3. **Combustible Substances (Fuels):** These are substances that can burn.

- **Examples:** Wood, paper, cloth (cotton, wool), kerosene, petrol, diesel, LPG (liquefied petroleum gas), CNG (compressed natural gas), coal, charcoal, candle wax, magnesium.
- **Non-combustible substances** do not burn, e.g., stone, glass, metals like iron (though some metals like magnesium burn readily).

4. **Supporter of Combustion:** Oxygen is the most common supporter of combustion. Without an adequate supply of oxygen, combustion cannot occur or will be incomplete. Air contains about 21% oxygen.

Conditions Necessary for Combustion (The Fire Triangle)

For combustion to take place, three conditions must be met simultaneously. These are often represented as the **"Fire Triangle."** If any one of these is removed, the fire will be extinguished.

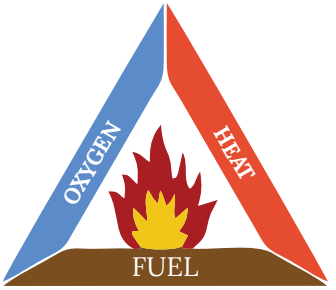


Fig. 5.8 Fire Triangle

(i) Presence of a Combustible Substance (Fuel): There must be something that can burn.

(ii) Presence of a Supporter of Combustion (Usually Oxygen): Oxygen from the air is typically required.

(iii) Attainment of Ignition Temperature (Heat): The fuel must be heated to a certain minimum temperature before it can catch fire. This minimum temperature is called its ignition temperature.

Ignition Temperature

The **ignition temperature** is the lowest temperature at which a combustible substance catches fire and continues to burn when exposed to air.

For **example**, paper has an ignition temperature of about 230°C, while petrol ignites at a much lower temperature. A material will not burn until it reaches this point. That is why we need a spark, flame, or heat source to start a fire. Understanding ignition temperature helps us handle flammable materials safely.

Fact Flash

The sun is a giant ball of fire, but its "burning" is not chemical combustion like we see on Earth! It's a **nuclear fusion** process where hydrogen atoms fuse to form helium, releasing enormous amounts of energy as heat and light. It doesn't need oxygen!

Common Misconceptions

× **Misconception:** All burning is the same.

✓ **Correction:** There are different types of combustion (rapid, spontaneous, explosion, complete, incomplete) with varying characteristics and products.

× **Misconception:** Metals don't burn.

✓ **Correction:** While many common metals like iron or copper don't burn easily under normal conditions, some metals like magnesium burn vigorously, and even iron can burn if in a finely powdered form with enough heat and oxygen (like in steel wool).

Science Around You

Combustion is a chemical change that happens when substances like wood, petrol, or gas burn in air, producing heat and light. It's what powers cars, cooks our food on gas stoves, and even lights fireworks! Once something burns, it turns into new substances like ash, smoke, and gases.

Keywords

Nuclear fusion: A process in which two light atomic nuclei combine to form a heavier nucleus, releasing a huge amount of energy — this is how the Sun produces energy.

Activity

Identifying Combustible and Non-Combustible Substances

- **Objective:** To classify common materials as combustible or non-combustible.
- **Materials Required:** Small samples of paper, wood, cotton cloth, a small stone, a glass piece, an iron nail, a candle, matchbox, tongs. (Perform under adult supervision).
- **Procedure:**

Fig. 5.9 Materials Required

1. Using tongs, hold a small piece of paper over a lit candle flame (or use a matchstick carefully). Observe if it catches fire.
2. Repeat the process with other materials: wood shaving, cotton thread, stone, glass piece, iron nail.
3. Record your observations in a table: Material | Catches Fire (Yes/No) | Combustible/Non-Combustible.

Safety: Be extremely careful while handling fire. Perform in a safe area away from flammable materials. Have water nearby.

Conclusion: Classify the substances based on your observations.

Knowledge Checkpoint

Gap Analyzer™ Homework | Watch Remedial

Understanding

Multiple Choice Questions:

1. Which of the following is NOT essential for combustion?

   a) Fuel ☐ b) Oxygen ☐

   c) Nitrogen ☐ d) Heat (to reach ignition temperature) ☐

2. A fire can be extinguished by:

   a) Adding more fuel ☐ b) Increasing oxygen supply ☐

   c) Removing heat ☐ d) Increasing the temperature ☐

Remembering

3. The lowest temperature at which a substance catches fire is called its:

   a) Melting point ☐ b) Boiling point ☐

   c) Ignition temperature ☐ d) Critical temperature ☐

Short Answer Question:

4. What are the three components of the “Fire Triangle”?
5. Why does a piece of paper burn easily, but a thick log of wood requires more effort to ignite?

Analyzing

Long Answer Question:

6. Explain the term combustion. Describe an experiment to show that oxygen is necessary for combustion. How can the principle of the fire triangle be used to extinguish a fire?

Desirable and Undesirable Changes

Changes can also be categorized based on their usefulness or harm to us or the environment.

Desirable Changes

These are changes that are useful, beneficial, or wanted by humans. They often serve a purpose or improve our lives.

Examples:

- **Ripening of fruits:** Makes them sweet and edible.
- **Cooking of food:** Makes food digestible, palatable, and kills harmful germs.
- **Changing of milk into curd:** Curd is a nutritious food product.
- **Germination of seeds:** Leads to the growth of plants, which provide food and oxygen.
- **Photosynthesis in plants:** Produces food for plants and oxygen for animals.
- **Formation of compost from waste:** Creates nutrient-rich manure for plants.
- **Rainfall:** Provides water for agriculture and drinking (though excessive rain can be undesirable).
- **Charging a phone battery:** Restores its ability to power the device.

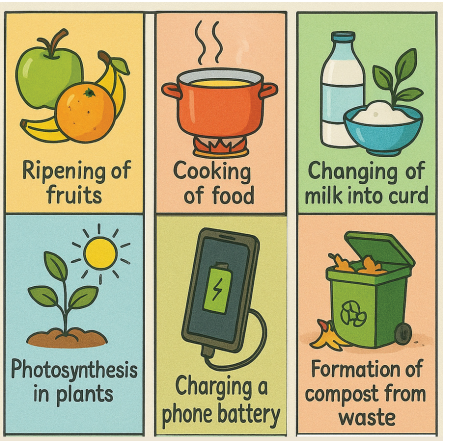


Fig. 5.10 Desirable changes

Undesirable Changes

These are changes that are harmful, not useful, or unwanted. They can cause damage, loss, or inconvenience.

Examples:

- **Rusting of iron:** Damages iron objects, making them weak.
- **Spoilage of food:** Makes food unfit for consumption.
- **Souring of milk:** If not intended for curd, it's spoilage.
- **Wearing out of clothes or shoes:** Requires replacement.
- Breaking of glass objects.
- Floods or droughts (extreme weather changes).
- **Pollution of air, water, or soil:** Harmful to health and ecosystems.
- Forest fires (uncontrolled).
- Earthquakes or volcanic eruptions.
- Decay of teeth.

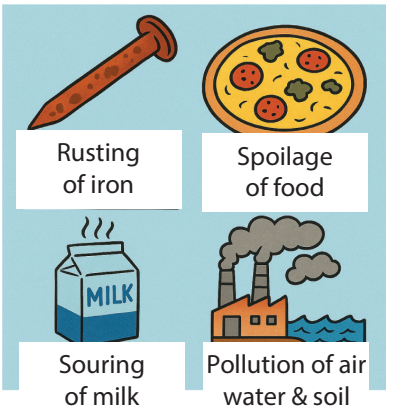


Fig. 5.11 Undesirable changes

Fact Flash

Volcanic eruptions are often seen as highly destructive and undesirable. However, over long periods, the volcanic ash and lava break down to form very fertile soil, which is highly desirable for agriculture!

Human Impact on Changes

Human activities can cause many changes, some desirable (like building infrastructure) and many undesirable (like pollution, deforestation leading to soil erosion, climate change due to increased greenhouse gases from burning fossil fuels).

- The increased consumption of fuels in cars, trains, and industries (combustion) is increasing carbon dioxide levels in the atmosphere, contributing to global warming – an undesirable large-scale change.
- Drying of paints on walls releases **volatile organic compounds** (VOCs) into the air, causing atmospheric pollution (undesirable).

Common Misconceptions

× **Misconception:** All natural changes are desirable.

✓ **Correction:** Not true. Natural disasters like earthquakes, floods, and diseases are natural but highly

× **Misconception:** All man-made changes are undesirable.

✓ **Correction:** Also not true. Many man-made changes like building homes, developing medicines, and advancements in agriculture are highly desirable.

Science Around You

Desirable changes are helpful, like baking a cake, cooking food, or freezing water to make ice. We want these changes because they benefit us. Undesirable changes are harmful, like food spoiling, iron rusting, or milk turning sour — we don't want them to happen!

Activity

Listing Desirable and Undesirable Changes in Daily Life

- **Objective:**

  To identify and categorize changes as desirable or undesirable.

- **Materials Required:** A piece of paper, a candle, matchbox, an ice cube in a dish, a small amount of sugar, a spoon, water in a glass, a raw egg.

- **Procedure:**

  1. Think about your daily routine from morning to night.
  2. List at least 10 different changes you observe or experience.
  3. For each change, decide if it is desirable or undesirable for you or your surroundings. Explain your reasoning.
  4. Can any of the undesirable changes be prevented or controlled? How?
  5. Can any change be both desirable and undesirable depending on the situation? Give an example.

Fig. 5.12 Materials Required

Example Table:

Listing Desirable and Undesirable

Change Observed	Desirable/Undesirable	Reason
Milk turning into curd	Desirable Curd is good for health.	
Iron gate rusting	Undesirable	Gate weakens and looks bad.
Food getting cooked	Desirable	Becomes edible and tasty.
A glass cup breaking	Undesirable	The cup is lost, can cause injury.

Knowledge Checkpoint

Gap Analyzer™ Homework | Watch Remedial

Understanding

Multiple Choice Questions:

1. Which of the following is generally considered a desirable change?
   a) Spoilage of cooked rice ☐ b) Rusting of a bicycle chain ☐
   c) Ripening of a banana ☐ d) A landslide ☐
2. An undesirable change is one that is:
   a) Always a chemical change. ☐ b) Always a physical change. ☐
   c) Harmful or not useful. ☐ d) Always reversible. ☐
3. The formation of compost from kitchen waste is a desirable change because:
   a) It produces a bad smell. ☐
   b) It reduces waste andcreates useful manure. ☐
   c) It is a very fast process. ☐ d) It uses up a lot of energy. ☐

Applying

Short Answer Question:

4. Give two examples of desirable changes and explain why they are desirable.
5. Give two examples of undesirable changes and suggest one way to prevent or minimize one of them.

Analyzing

Long Answer Question:

6. "Some changes can be desirable in one situation but undesirable in another." Explain this statement with two different examples, detailing the context for each. Also, discuss one large-scale undesirable change caused by human activities and its impact.

Slow Natural Changes: Weathering and Erosion

Many changes in nature occur very slowly, over hundreds or even thousands of years. Weathering and erosion are two such significant natural processes that shape the Earth's surface.

Weathering of Rocks

Weathering is the process of breaking down rocks, soil, and minerals into smaller pieces or altering their chemical composition through direct contact with the Earth's atmosphere, water, and biological organisms. It is a slow process that occurs **in situ** (in place), meaning there is no movement of the broken material involved in weathering itself.

A split image. Left side: A large, intact rock face. Right side: The same rock face showing cracks, some fragmentation at the base, and possibly some discoloration indicating chemical weathering.

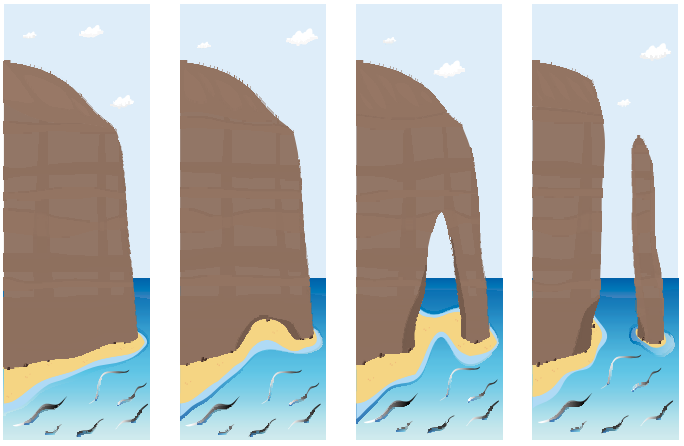


Fig. 5.13 Weathering of Rocks

Types of Weathering

Physical Weathering (Mechanical): Breaks rocks into smaller pieces without changing their chemical composition.

Main Causes:

- **Temperature changes:** Expansion and contraction crack rocks.
- **Frost wedging:** Water freezes in cracks and expands, breaking rocks.
- **Root action:** Growing plant roots widen cracks.
- **Abrasion:** Rocks scrape against each other by wind, water, or ice.
- **Pressure release:** Deep rocks crack and peel as surface pressure reduces.

Chemical Weathering

Breaks down rocks by changing their chemical makeup, forming new substances.

Main Causes:

- **Oxidation:** Oxygen reacts with iron in rocks, forming rust.
- **Hydrolysis:** Water reacts with minerals (e.g., feldspar to clay).
- **Carbonation:** CO_2 in rainwater forms carbonic acid, dissolving limestone.
- **Acid rain:** Pollutants form strong acids that speed up weathering.
- **Solution:** Minerals like rock salt dissolve directly in water.

Fig. 5.14 Chemical Weathering

Erosion

Erosion is the geological process in which earthen materials (like soil, rock fragments, and sediments) are worn away and transported from one location to another by natural forces such as wind, water (rivers, rain, sea waves), or ice (glaciers).

A landscape showing signs of erosion. E.g., a river valley carved by water, or sand dunes shaped by wind, or a coastal cliff being undercut by waves.

- **Key Difference from Weathering:** Weathering breaks down rocks; erosion moves the broken pieces. Often, they work together.
- Erosion is primarily a **physical change** as it involves the movement and further breaking down of materials, but the chemical composition of the transported particles largely remains the same during the transport process itself (though they might have been chemically weathered prior to erosion).

Agents of Erosion

1. Water Erosion:

- **Rain splash:** Raindrops dislodge soil.
- **Sheet erosion:** Water removes thin layers of soil.
- **Rill & gully erosion:** Small water channels grow and erode land deeply.
- **River erosion:** Rivers cut valleys and carry sediments.
- **Coastal erosion:** Waves and tides wear away shorelines.

2. Wind Erosion:

- Happens in dry, open areas.

Fact Flash

The Grand Canyon in the USA is one of the most spectacular examples of erosion! The Colorado River has been cutting through layers of rock for millions of years, carving out the massive canyon. This showcases the immense power of water erosion over geological time.

- Wind lifts and carries fine soil and sand, forming dunes and causing rock abrasion.

3. Glacial Erosion:

- Moving glaciers scrape land, pluck rocks, and form U-shaped valleys.

4. Gravity (Mass Wasting):

- Downhill movement of soil and rocks (e.g., landslides, mudflows), often after rain or quakes.

Deposition:

- When erosion agents slow down, they drop sediments:
- Rivers form deltas.
- Wind forms sand dunes.
- Glaciers leave till.

Over time, these sediments can become sedimentary rocks like sandstone or limestone.

Impact of Weathering & Erosion:

- **Positive:** Soil formation, scenic landscapes, nutrient release.
- **Negative:** Soil loss, landslides, siltation, infrastructure damage—often worsened by deforestation

Common Misconceptions

× **Misconception:** **Weathering** and erosion are the same thing.

✓ **Correction:** They are distinct but related. Weathering is the breaking, erosion is the taking (moving).

× **Misconception:** **Erosion** is always bad.

✓ **Correction:** While accelerated erosion due to human activity is often detrimental (soil loss), natural erosion is a fundamental geological process that creates diverse landscapes like valleys, beaches, and deltas.

× **Misconception:** Erosion only happens during heavy rainfall or floods.

✓ **Correction:** Erosion can occur even during light rain or regular water flow. Over time, small amounts of moving water can gradually carry away soil and reshape the land.

Science Around You

The Grand Canyon was carved over 5–6 million years by river erosion.Wind can move millions of tons of sand each year in deserts like the Sahara.Rocks break down slowly through weathering due to rain, wind, and freezing water over hundreds of years. Glaciers also erode land by dragging rocks across the surface as they move. These natural forces shape mountains, valleys, and coastlines over long periods of time.

Keywords

Weathering: The breaking down of rocks and minerals on Earth's surface into smaller pieces by natural forces like wind, water, temperature changes, or biological activity.
Erosion: The movement or carrying away of weathered rock particles by agents like water, wind, or ice.

Activity

Simulating Erosion by Water

- **Objective:** To observe how water can cause erosion.
- **Materials Required:** tray or shallow pan, a pile of loose soil or sand at one end of the tray, a watering can or cup with a spout, some small pebbles or twigs (optieonal).
- **Procedure:**

  1. Make a small hill of soil at one end of the tray. Add pebbles/twigs if you like.
  2. Pour water slowly from the top of the hill.
  3. Watch how the soil moves.
  4. Try with more water or faster pouring.
  5. Notice if pebbles/twigs change the result.

Fig. 5.15 Materials Required

Observations and Conclusion: Describe how the water moved the soil. Did more water or faster flow cause more erosion? What role did the "vegetation" (twigs) play, if any? This demonstrates how water erodes and transports soil.

Knowledge Checkpoint

Gap Analyzer™ Homework | Watch Remedial

Remembering

Multiple Choice Questions:

1. The breaking down of rocks into smaller pieces without changing their chemical composition is called:
   a) Chemical weathering ☐ b) Physical weathering ☐
   c) Erosion ☐ d) Deposition ☐
2. The process of carrying away weathered rock material by wind or water is known as:
   a) Weathering ☐ b) Erosion ☐
   c) Compaction ☐ d) Sedimentation ☐

Understanding

3. Which of the following is an example of chemical weathering?
   a) Water freezing in rock cracks and breaking the rock. ☐
   b) Plant roots widening cracks in rocks. ☐
   c) Iron in rocks reacting with oxygen to form rust. ☐
   d) Wind blowing sand against a rock surface. ☐

Short Answer Question:

4. Differentiate between weathering and erosion.
5. Describe two ways in which physical weathering occurs.

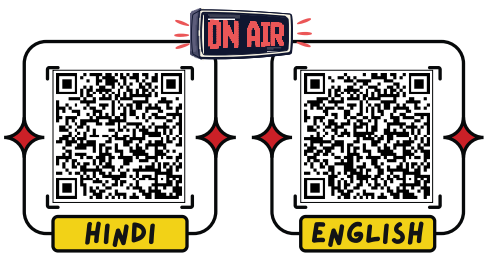
Analyzing

Long Answer Question:

6. Explain how weathering (both physical and chemical) and erosion contribute to the formation of soil and the shaping of landscapes. Give one example of how human activities can accelerate erosion and one way to prevent it.

SUMMARY

1. **Physical Changes**
   - Physical changes affect a substance's appearance, size, shape, or state without changing its chemical composition. No new substance is formed. Most are reversible (e.g., melting ice, dissolving salt), though some (like breaking glass) are practically irreversible. Energy change is minimal.
   - **Examples:** Melting, boiling, freezing, cutting, mixing (without reaction).
   - **Key Idea:** The substance remains the same—only its form or state changes.
2. **Chemical Changes (Chemical Reactions)**
   - These result in the formation of new substances with different chemical properties. They involve a change in composition and are generally irreversible. Often, there's a noticeable energy change (heat, light, sound).
   - **Indicators:** Gas release, color change, precipitate formation, change in smell.
   - **Examples:** Rusting, burning, digestion, cooking, curdling of milk.
   - **Key Idea:** Original substances are chemically transformed into new ones.
3. **Combustion:**
   - A rapid chemical reaction where a fuel reacts with oxygen, releasing heat and light.
   - Requirements (Fire Triangle):
   - Fuel,
   - Oxygen,
   - Heat (to reach ignition temperature).
   - **Products:** Carbon dioxide, water vapor, ash.
   - Fire can be extinguished by removing any one of the three components.
4. **Desirable vs. Undesirable Changes:**
   - **Desirable:** Beneficial (e.g., cooking food, seed germination).
   - **Undesirable:** Harmful (e.g., rusting, food spoilage).
   - Some changes depend on context—what is desirable in one case may be undesirable in another (e.g., decomposition in compost vs. food spoilage).
5. **Natural Slow Changes: Weathering & Erosion**
   - **Weathering:** Breakdown of rocks in place by physical (temperature, root action) or chemical (oxidation, carbonation) means.
   - **Erosion:** Movement of weathered materials by wind, water, ice.
   - **Deposition:** Settling of eroded material forming landscapes.
   - These slow processes shape Earth's surface and contribute to soil formation.



Example Based Questions

Multiple Choice Questions

1. **Which of the following is a physical change?**
   (a) Burning of paper
   (b) Melting of ice
   (c) Rusting of iron
   (d) Souring of milk
   Answer: (b) Melting of ice
   Explanation: Melting of ice only changes the state of water from solid to liquid, without forming a new substance.

2. **Which process shows a chemical change?**
   (a) Boiling water
   (b) Breaking glass
   (c) Dissolving sugar in water
   (d) Cooking rice
   Answer: (d) Cooking rice
   Explanation: Cooking rice leads to the formation of a new substance with a change in taste, smell, and texture—an irreversible chemical change.

3. **Which of the following is NOT a characteristic of a chemical change?**
   (a) Formation of a new substance
   (b) Irreversibility
   (c) Change in color, smell, or heat produced
   (d) Change in size and shape only
   Answer: (d) Change in size and shape only
   Explanation: A change in size or shape without forming a new substance is physical, not chemical.

Short Answer Questions

4. **Why is dissolving salt in water considered a physical change?**
   Answer: When salt dissolves in water, no new substance is formed. Salt can be obtained back by evaporating the water, making it a reversible physical change.

5. **Mention two examples of desirable changes and two of undesirable changes.**
   Answer: **Desirable Changes:** Ripening of fruits, Germination of seeds.
   Undesirable Changes: Rusting of iron, Spoilage of food.

6. **Why is burning of magnesium ribbon considered a chemical change?**
   Answer: When magnesium burns, it reacts with oxygen to form magnesium oxide, a new substance with different properties. It also produces heat and light, and the change is irreversible—hence chemical.

7. **Differentiate between physical and chemical changes with examples. Why is it important to understand the difference between the two?**
   Answer: Physical Changes: In a physical change, the form, shape, or state of a substance is altered, but no new substance is formed. The identity of the substance remains the same. For example:
   - **Ice melting into water:** It is still water, only the state changes.
   - **Breaking a piece of chalk:** The chalk remains chalk, just in smaller pieces.
   - **Folding paper:** The shape changes but the substance is unchanged.
   - **Chemical Changes:** In a chemical change, the original substance undergoes a transformation to form one or more new substances with entirely different properties. For example:
   - **Burning of wood:** Wood changes into ash, carbon dioxide, and water vapor.
   - **Rusting of iron:** A reddish-brown flaky substance, iron oxide, forms and weakens the iron.
   - **Souring of milk:** Fresh milk turns into sour curd due to bacterial action.

   Key Differences:
   - Physical changes are usually reversible, while chemical changes are mostly irreversible.
   - Physical changes do not produce new substances, but chemical changes always do.
   - Physical changes often involve changes in state, shape, or size, whereas chemical changes involve changes in color, smell, heat, gas production, or formation of precipitates.

Gap Analyzer™
Complete Chapter Test

EXERCISE

A. Choose the correct answer.

1. Which of the following is an example of a physical change?
   (a) Burning of wood ☐ (b) Rusting of iron ☐
   (c) Melting of ice ☐ (d) Digestion of food ☐
2. A chemical change is generally characterized by the formation of:
   (a) A new substance ☐ (b) A change in state only ☐
   (c) A change in shape only ☐ (d) A change in size only ☐
3. The process of burning a substance in the presence of oxygen to produce heat and light is called:
   (a) Melting ☐ (b) Evaporation ☐
   (c) Combustion ☐ (d) Dissolving ☐
4. Which of these is an example of an undesirable change?
   (a) Ripening of fruits ☐ (b) Growth of a plant ☐
   (c) Souring of milk ☐ (d) Cooking of food ☐
5. Weathering and erosion are examples of:
   (a) Rapid changes ☐ (b) Reversible changes ☐
   (c) Undesirable changes ☐ (d) Slow natural changes ☐

B. Fill in the blanks.

1. A change in which only the physical properties of a substance change, but no new substance is formed, is called a _____ change.
2. The formation of curd from milk is an example of a _____ change.
3. Burning of fuels like petrol and diesel involves the chemical process of _____.
4. Changes that can be undone or reversed are known as _____ changes.
5. The breaking down of rocks due to wind, water, or ice is called _____.

C. Write True or False.

1. Cutting a log of wood into smaller pieces is a chemical change. _____
2. Digestion of food is a chemical change because new substances are formed. _____
3. All undesirable changes are irreversible. _____
4. Erosion is the process of rocks breaking down in place, while weathering is the movement of broken rock material. _____
5. Inflating a balloon is a reversible change. _____

D. Define the following terms.

1. Physical Change
2. Chemical Change
3. Combustion
4. Erosion
5. Weathering

E. Match the columns.

	Column A		Column B
1.	Burning of a candle	A.	Reversible Change
2.	Freezing of water	B.	Irreversible Change
3.	Rusting of a metal gate	C.	Chemical Change & Desirable
4.	Ripening of mango	D.	Physical Change
5.	Crumpling a paper	E.	Chemical Change & Undesirable

F. Assertion and Reason

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.
(e) Both A and R are false.

1. **Assertion (A):** Burning a piece of paper is a chemical change.
   Reason (R): When paper burns, it produces ash and smoke, which are new substances.
2. **Assertion (A):** Melting of wax is a reversible change.
   Reason (R): The liquid wax can be solidified back into solid wax by cooling.
3. **Assertion (A):** Rusting of iron is a rapid chemical change.
   Reason (R): Rusting requires the presence of both oxygen and moisture to occur.

G. Give reasons for the following statements.

1. Sugar dissolving in water is a physical change because no new substance is formed.
2. Water should not be used on oil fires as it can make the fire spread.
3. A firecracker burst is irreversible because we can't get it back once it explodes.
4. Coastal areas face more erosion due to strong waves and salty air.

H. Answer in brief.

1. What is the difference between a physical and a chemical change with one clear example of each?
2. What are the required conditions for combustion, and what happens if one is missing?
3. How can you show a reversible and an irreversible change through simple activities?
4. How do weathering and erosion slowly shape the Earth's surface over time?

I. Answer in detail.

1. Differentiate physical and chemical changes by discussing characteristics, energy, products, and reversibility, with two examples for each.
2. Explain the Fire Triangle, how removing a side extinguishes fire, and different extinguishing methods based on this principle.
3. Distinguish desirable/undesirable and reversible/irreversible changes; can a change be both desirable and irreversible? Justify with examples.
4. Explain how rocks break down through physical changes (like freezing water) and chemical changes (like rusting), and how these processes contribute to weathering and erosion.

SKILL-BASED PRACTICE

Activity Time

STEM

Observing Changes: Burning a Candle

Materials Needed:

- A small candle,
- A matchstick or lighter,
- A glass jar (that can cover the candle),
- A small ceramic plate or non-flammable surface

Materials Required

Activity Steps:

1. Place the candle on the ceramic plate. Light the candle carefully with a matchstick.
2. Observe the candle flame, the melting wax near the wick, and the solid wax below.
3. After a few minutes, gently cover the burning candle with the glass jar. Observe what happens.
4. Carefully remove the jar once the flame extinguishes. Observe any residue inside the jar.

Questions:

- What physical changes did you observe in the candle during burning? (Hint: Think about the wax).
- What chemical changes did you observe in the candle during burning? (Hint: Think about the flame and the wick).
- Why did the flame go out when you covered the candle with the glass jar? Relate this to the conditions for combustion.

Skills Covered: Observation, Classification of changes, Understanding combustion

Creativity

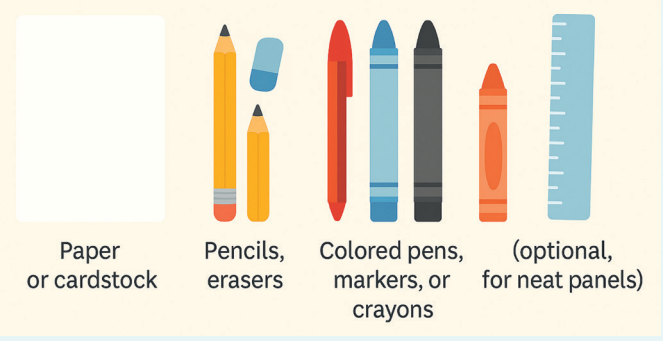
Art

Change" Comic Strip

Task: Create a short comic strip (4-6 panels) illustrating everyday examples of physical and chemical changes. Use characters and speech bubbles to explain what is happening in each change.

Materials to Use:

- Paper or cardstock,
- Pencils, erasers,
- Colored pens, markers, or crayons,
- Ruler (optional, for neat panels)



Materials Required

Questions:

- What examples of physical changes did you include, and how did your characters explain them?

- What examples of chemical changes did you include, and how did your characters explain them?
- How did the comic strip format help you convey the concepts of physical and chemical changes in an engaging way?

Skills Covered: Creativity, Visual Representation, Communication, Conceptual Understanding

Detecting New Substances

Group Activity

Identifying Chemical Changes

Activity Instructions: For each pair of materials below, combine them and observe closely for any signs of a chemical change (e.g., gas bubbles, color change, temperature change, precipitate formation, light/sound).

1. Baking soda + Vinegar
2. Lemon juice + Milk
3. Sugar + Heat (carefully heat a small amount in a spoon over a candle, if supervised)
4. Iron filings + Salt water (leave for a day in an open container)

Questions:

- For each combination, describe your observations. Which combinations showed signs of a chemical change?
- What evidence did you use to conclude that a chemical change occurred?
- Which combination resulted in a physical change (or no observable change initially), and why?

Skills Covered: Scientific Testing, Observation, Classification, Teamwork, Analysis

The Disappearing Lemonade

Case Study

A group of friends made a big pitcher of lemonade for a hot summer day. They added sugar, lemon juice, and water, stirring until the sugar was completely dissolved. They left the pitcher outside. After a few hours, they noticed that some of the lemonade had evaporated, leaving behind a sticky residue of sugar on the bottom of the pitcher. The remaining lemonade, however, had started to taste slightly fizzy and strange, and there were small bubbles forming.

Questions:

1. When the sugar dissolved in the water to make lemonade, was that a physical or chemical change? How do you know?
2. What type of change occurred when some of the lemonade evaporated, leaving sugar behind? Is this change reversible?
3. If the friends wanted to prevent the “fizzing” and “strange taste,” what simple action could they have taken?
4. Relate the “sticky residue of sugar” to a specific type of change or separation process.

Skills Covered: Classification, Analysis, Teamwork, Communication, Scientific Investigation

Physical and Chemical Changes in the Bhopal Gas Tragedy

Source Based Question

Source Passage (Bhopal Disaster Reports, 1984):

Image Credit: DNA INDIA

"On the night of 2–3 December 1984, a deadly industrial accident occurred in Bhopal, Madhya Pradesh, when a toxic gas called methyl isocyanate (MIC) leaked from a pesticide plant. MIC reacted with water inside the storage tank, producing heat and poisonous by-products — a chemical change. The leaked gas then spread rapidly through the air due to wind and temperature differences, which was a physical process as it involved only the mixing and movement of gas particles. Thousands of people were exposed to this toxic cloud, leading to immediate deaths and long-term breathing and eye problems. Later investigations revealed that poor maintenance, lack of safety systems, and careless handling of reactive chemicals had made the disaster worse. The Bhopal Gas Tragedy remains one of the world's worst industrial accidents and highlights the importance of understanding and controlling physical and chemical changes in industries."

Questions:

1. **Understanding Physical vs. Chemical Changes**
   - Which part of the tragedy involved a chemical change?
   - Which part was a physical change and why?
2. **Cause and Consequence**
   - What property of methyl isocyanate made the incident extremely dangerous?
   - How did the combination of chemical and physical processes worsen the disaster?
3. **Critical Thinking**
   - Why is it important for industries to understand the difference between physical and chemical changes when storing hazardous substances?
   - Suggest one safety measure that could have prevented or reduced the harmful effects of the tragedy.

Skills Covered: Observation, Curiosity, Critical thinking, Connecting real-life observations