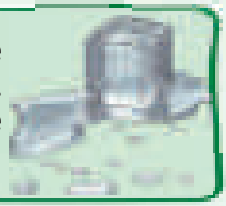
5 Changes Around Us: Physical and Chemical

I placed a cube of ice here half an hour ago. It has now become water!



A bud that I saw yesterday on this rose plant has become a flower today.

The bottle containing cold water is not cold anymore.

Yesterday, I saw some brown spots on a banana, but today it has more brown spots and a strong smell.

These students are describing some changes. What kinds of changes are they talking about?

Activity 5.1: Let us think and reflect

You might have **observed** various changes happening around you. Some of them are listed in Table 5.1, you may notice that something is changing in each case. Take a moment to **reflect** on the changes in each case. **Record** your observations in Table 5.1.

Table 5.1: Some changes observed around us

S.No.	Change	Observation(s)
1.	Melting ice cubes	
2.	Chopping vegetables	
3.	Boiling water	
4.	Making popcorn from corn	
5.	Cutting a piece of paper	
6.	Adding beetroot extract to water	
7.	Burning wood	
8.	Drying wet clothes	
9.	Making small balls of dough	
10.	Rolling small balls of dough into *chapatis*	
11.	Any other	

You might have noticed that these changes could be in the size, shape, smell, or other property of the substance or object. Can you think of some other changes that happen in your surroundings? Make a list of those changes too.

We observe the changes occurring around us with the help of our senses of sight, smell, touch, hearing, and taste.

Let us try to answer this question.

5.1 A Substance May Change in Appearance but Remain the Same!

Activity 5.2: Let us create and discuss

A. Creating some objects with paper

- Take a few sheets of paper and fold them to create new objects (Fig. 5.1).
- Do you get the same paper back when you unfold these objects?

Fig. 5.1: Objects made from paper

B. Playing with a balloon

- Take a balloon and inflate it. Now, loosen your grip and let the air escape out.
- Do you get the uninflated balloon back?
- Take another balloon; inflate it and grip the opening tightly. Now, prick it with a pin.

Caution — Be careful while using a pin.

- What happens? Will you be able to get the uninflated balloon back?

C. Crushing a piece of chalk

- Crush a small piece of chalk into powder.
- Can you get the chalk piece back from the powder?

Is there any similarity in the changes listed in A, B, and C?

During all these changes, materials, such as the paper, the rubber sheet of the balloon, and the chalk, remained the same, though their appearances (shape or size) may have changed. You may also recall from the Grade 6 Science textbook *Curiosity* that water can exist in different states (solid, liquid, and gas), and can change from one state to another.

In all these cases, although we observe a change in the appearance, no new substance is formed. Such changes in which only physical properties like shape, size, and state of substances change are called **physical changes**.

Let us **explore** a different type of change.

5.2 A Substance May Change in Appearance and Not Remain the Same!

Activity 5.3: Let us explore

- Take two glass tumblers or small transparent bottles. Mark them A and B.
- Fill one-fourth of glass tumbler A with tap water and one-fourth of glass tumbler B with lime water.
- Now, blow air (exhale) into each glass tumbler, one at a time, using separate straws (Fig. 5.2) and observe them.

Caution—Do not suck the water or lime water while doing this.

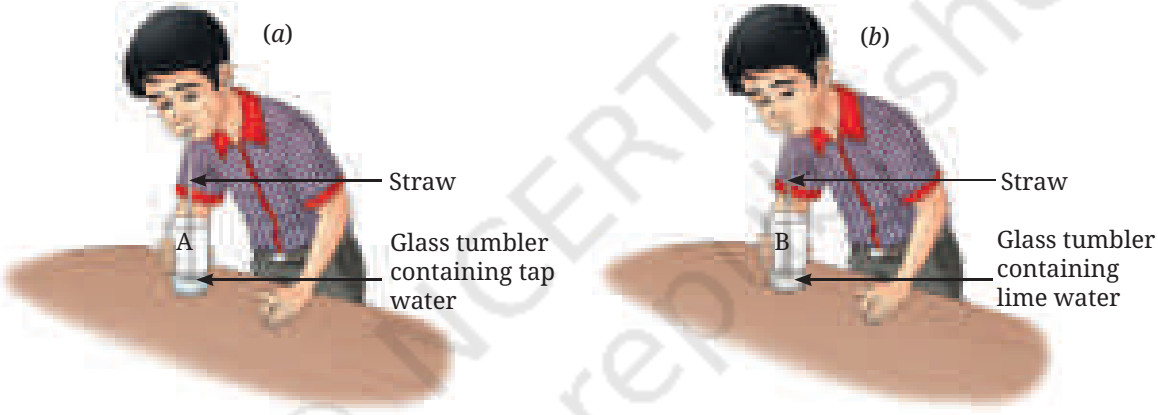


Fig. 5.2: Blowing air in (a) tap water; (b) lime water

Do you notice any changes?

In glass tumbler A, blowing air into water creates bubbles only, and there is no change in the appearance of the water. In glass tumbler B, blowing air into lime water creates bubbles, and turns the lime water milky (or cloudy). If we leave it for some time, a white substance settles at the bottom of the glass tumbler, indicating something new has formed. Such changes, in which one or more new substances are formed, are called **chemical changes**. New substances are formed through a process called **chemical reaction**. In this case, carbon dioxide from the air you breathe out (exhale) reacts with lime water, and forms a new white-coloured substance (calcium carbonate) that is insoluble in water. Therefore, the liquid in the bottle appears milky. Along with this a small amount of water is also formed. This formation of a new substance indicates a chemical change. The chemical reaction involved in this change can be represented in short form as a chemical equation.

Calcium hydroxide + Carbon dioxide → Calcium carbonate + Water
(Lime water) (Insoluble substance)

The turning of lime water milky is also used as a test for carbon dioxide. Let us explore this with another activity using some substances from our kitchen.

Activity 5.4: Let us experiment

- Take a teaspoonful of vinegar or lemon juice in a test tube.
- Add a pinch of baking soda (sodium hydrogen carbonate) to it.
- What do you observe?
- You would hear a fizzing bubbling sound and see the gas bubbles forming.
- Pass this gas through freshly prepared lime water kept in another test tube, as shown in Fig. 5.3a.
- What do you observe?
- The lime water turns milky. What do you **infer** about the gas formed by mixing vinegar and baking soda?

This indicates that the gas formed is carbon dioxide.

This activity can also be performed using two small used bottles instead of test tubes and a flexible straw, as shown in Fig. 5.3b.

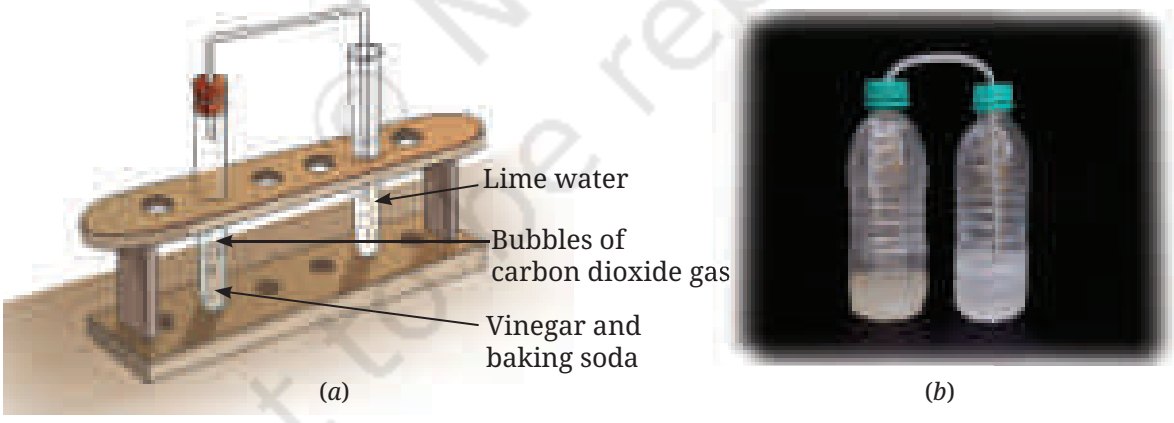


Fig. 5.3: Reaction of vinegar and baking soda

Since a new substance, carbon dioxide, is formed in this reaction, we say that a chemical change has occurred here as well. It can be represented as—

Vinegar + Baking soda → Carbon dioxide + Other substances

Repeat the above activity using baking soda and water. Do you observe any bubble formation? Is this a physical or a chemical change?

5.3 Some Other Processes Involving Chemical Changes

5.3.1 Rusting

In the rusting of iron, which you studied in the chapter 'The World of Metals and Non-metals', a new brown-coloured substance called rust is formed. Thus, rusting is also a chemical change because it involves the formation of a new substance, iron oxide (Fig. 5.4).

Fig. 5.4: Rusted iron nails

5.3.2 Combustion

Fig. 5.5: Burning magnesium ribbon

Let us recall the burning of a magnesium ribbon (Fig. 5.5) learnt in the chapter 'The World of Metals and Non-metals'. Can you **predict** if this is a physical or a chemical change?

When the magnesium ribbon is burnt, a new substance, magnesium oxide, is formed. So, the burning of magnesium ribbon also involves a chemical change. We observed that heat and light are also produced along with the formation of a new substance in this reaction.

The burning of magnesium ribbon can be represented as—

Magnesium + Oxygen → Magnesium oxide + Heat + Light
(Ribbon) (Air) (White powder)

A chemical reaction in which a substance reacts with oxygen and produces heat and/or light is called **combustion**. Substances that undergo combustion reactions are called **combustible substances**. For example, wood, paper, cotton, kerosene, etc., are combustible substances.

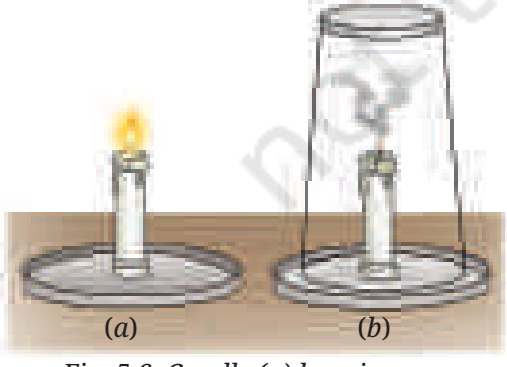


Fig. 5.6: Candle (a) burning (b) covered with a glass tumbler

Let us find out whether the presence of oxygen is essential for combustion.

Activity 5.5: Let us investigate

- Place two identical candles on two separate petri dishes and light them.
- Cover one of these with a glass tumbler, as shown in Fig. 5.6.
- What happens to the candle flames in the two cases?

We observe that the candle that was not covered (Fig. 5.6a) continues to burn, whereas the candle that was covered with a glass tumbler (Fig. 5.6b) stops burning after some time. Why does this happen?

Since the candle covered by the glass tumbler does not have a continuous supply of air, the flame gets extinguished soon. The component of air that supports combustion is oxygen. This can be confirmed by the presence of carbon dioxide in the glass tumbler inverted on the candle. How can you test the presence of carbon dioxide gas?

You can test the carbon dioxide gas by adding a small amount of lime water in the petri dish. You will notice that it turns milky. This carbon dioxide was formed by the carbon from the wax and the oxygen from the air. In other words, oxygen is required for combustion.

Science and Society

If a person's clothes catch fire, what is the best way to extinguish the fire?

Wrap a blanket or cloth around the person. This cuts off the supply of air, and the fire gets extinguished.

Caution—Synthetic blanket or cloth should never be used to put out a fire, as these can melt and stick to the skin.

Fascinating Facts

Nature's wonders: You might have seen some insects emitting light in a garden or a field in late evenings. These insects are called fireflies, and their light is produced by a chemical change. This type of light production (without heat) in living organisms is called bioluminescence.

Fireflies

Is the Presence of Air Enough for Combustion?

We learnt above that combustible substances and oxygen are necessary for combustion. We also know that paper is a combustible substance, but we can keep it in the air for any length of time without it catching fire. What else is needed to start combustion?

Let us learn about this.

Activity 5.6: Let us investigate

Caution—Perform this activity under the supervision of your teacher or an adult.

Fig. 5.7(a): Focusing the sunrays using a magnifying glass

Fig. 5.7(b): Paper catching fire

- Hold a piece of paper with a pair of tongs and bring a lighted matchstick to it. It quickly catches fire. Do we say that we need a fire to start the burning process?
- Take another piece of paper. Using a magnifying glass, focus the sunrays to make the smallest and brightest spot on the paper, as shown in the Fig. 5.7a. Hold it there for some time.

What do you observe?

We observe that the paper starts to emit smoke, and then catches fire (Fig. 5.7b). Thus, we find that a substance can burn even without fire. How do we explain this change?

Focusing sunrays on the paper heats it. The temperature of the paper increases with time. After some time, the paper becomes so hot that it starts burning. This minimum temperature at which a substance catches fire is called its **ignition temperature**. Since the temperature of the lighted matchstick was already higher than the ignition temperature of the paper, it caught fire almost immediately.

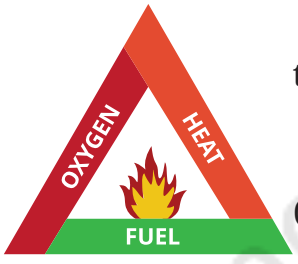


Fig. 5.8: Fire triangle

So, we can **conclude** that for the combustion process to occur, there are three requirements (Fig. 5.8)—

(i) A combustible substance, also called 'fuel'

(ii) Oxygen

(iii) Heat that allows the fuel to reach its ignition temperature.

5.4 Can Physical and Chemical Changes Occur in the Same Process?

What changes take place when a candle is lit? Let us explore!

Activity 5.7: Think, pair, and share

Look at the Fig. 5.9. **Analyse** what students are discussing about the burning candle.

What do you think?

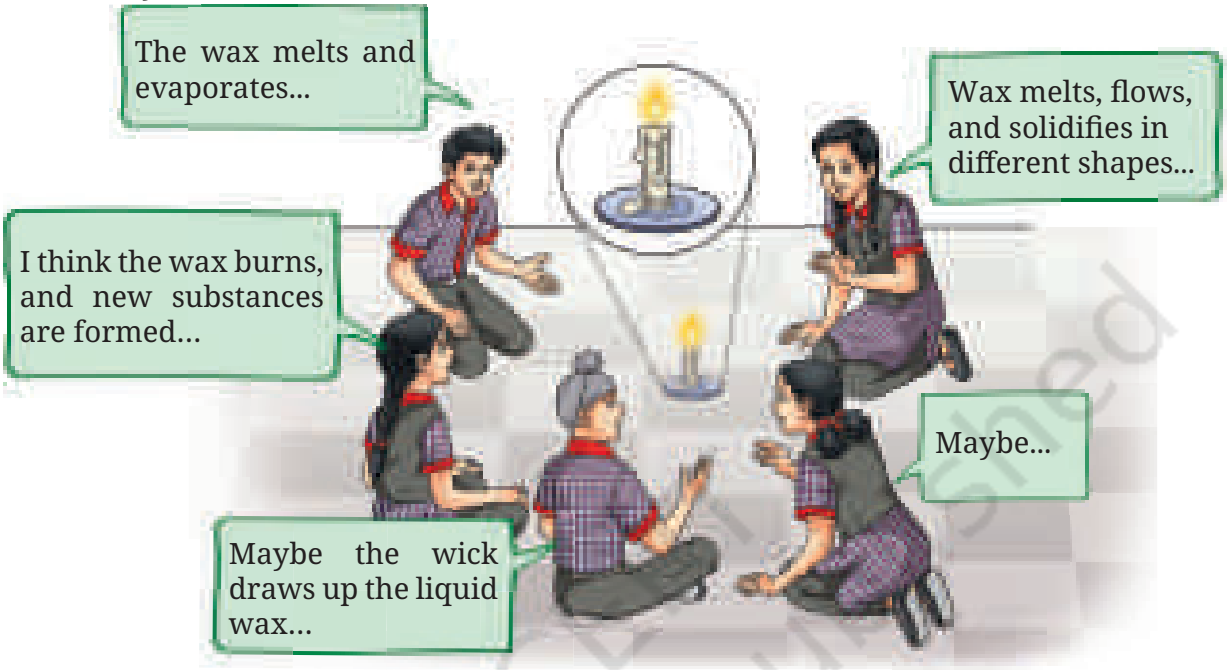
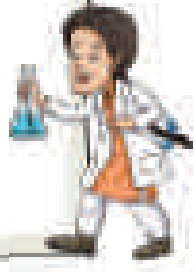


Fig. 5.9: What changes occur when a candle burns?

The wax of the candle melts, is carried up the wick, and evaporates due to the heat of the flame. The vapour of wax burns to produce a flame. The melting of wax, its solidification, and evaporation are physical changes. The burning of vapour on the other hand, is a chemical change. This shows that the burning of a candle involves both physical and chemical changes.

Know a Scientist

The candle you just observed has long been an object of curiosity for several scientists including Michael Faraday, who made significant contributions to several areas of science. In the nineteenth century, Faraday delivered a series of lectures called *Chemical History of a Candle*. Faraday believed that the candle was the perfect object to introduce scientific study. Through it, he discussed differences between various physical and chemical processes like melting, vapourisation, and combustion.



5.5 Are Changes Permanent?

Once something has undergone a change, can we get it back in its original form?

Activity 5.8: Let us think

Think again about all the changes that we have discussed or talked about so far. In which of these can we get back the object or substance in the form we started with? Record your observations in Table 5.2.

Table 5.2: Can changes be reversed?

S.No.	Change	The original state can be brought back (Yes/No)
1.	Melting ice cubes	Yes
2.	Chopping vegetables	No
3.	Boiling water	Yes
4.	Making popcorn from corn	No
5.		
...		
12.		

Returning to the original object or substance with which we started shows that the changes we brought can be **reversed**. For example, when ice melts, it can be refrozen into ice. Similarly, when water evaporates, it can be condensed back into liquid water. However, some changes cannot be reversed since we cannot get the original object or substance back after the change. For example, chopped vegetables cannot return to their original size and shape, and making popcorn cannot go back to its original form. Thus, changes around us could be grouped into those that can be reversed and those that cannot be reversed.

5.6 Are All Changes Desirable?

Many useful changes happen in our daily life. For example, the changing of milk into curd, ripening of fruits, cutting of fruits, and cooking of food. All these are **desirable** changes. Can you think of some other desirable changes happening around you?

On the other hand, some changes may be **undesirable**, such as the rusting of iron or the decay of food during its storage. A change that is undesirable in some situations may be desirable in other situations. For example, decomposition of food can be very useful in converting food waste into compost.

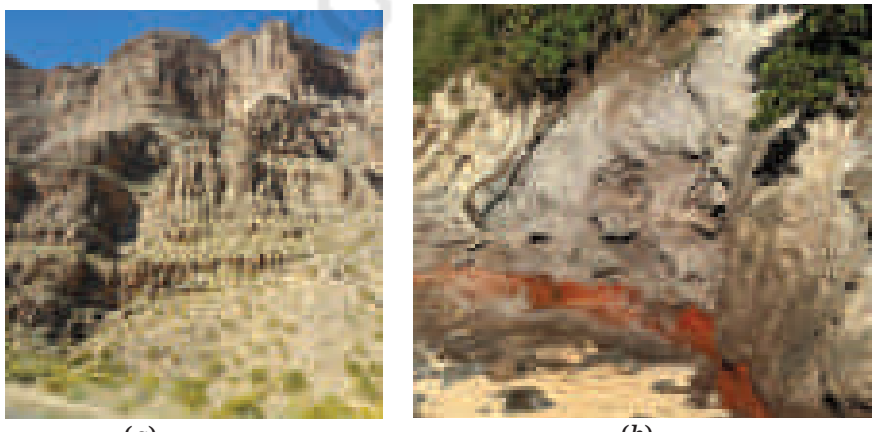
Some changes occurring over the years due to human activity can have a long-term environmental impact. For example, the increased consumption of fuels in cars, trains, aeroplanes, etc., is increasing the amount of carbon dioxide in the atmosphere. Drying of paint on walls, doors, furniture, etc., releases many substances through evaporation, causing atmospheric pollution.

5.7 Some Slow Natural Changes

5.7.1 Weathering of rocks

Have you seen heaps of sand, soil, and stones lying at the base of mountains as shown in Fig. 5.10a? These are called sediments. How have these formed? These are formed by physical changes that break up large rocks into smaller pieces. Temperature changes due to climatic conditions, growing roots of trees, and even freezing of water within cracks in the rocks can cause them to break.

Water or chemicals present in water, can also react with the rocks and cause chemical changes in their composition. An example of such a chemical change is shown in Fig. 5.10b. Here, an originally black-coloured rock called basalt, which contains iron, has chemically changed to produce a red-coloured layer. The red colour is a result of the iron oxide produced when the rock surface was exposed for a long time to water or air containing water vapour. These physical and chemical changes in rocks are collectively called **weathering**, which eventually leads to the formation of soil.



(*a*) (*b*)

Fig. 5.10: (a) Sediments at the base of a cliff (b) red sediment layer

5.7.2 Erosion

Have you noticed fine sand collecting on riverbeds or in lakes? This sand is formed when rock pebbles, soil, and sediments are broken down and moved from one location to another by natural forces like wind and flowing water. This process is called **erosion**.

Erosion during a landslide is an example of a physical change. River rocks and pebbles often appear smoother due to the constant erosion caused by the flowing water. When the speed of the water or wind decreases, such as in an ocean or a lake, the material transported during erosion settles down at the bottom. These sediments harden over time and become new rocks. Most of these changes take place over thousands of years and cannot be reversed.

In a Nutshell

- A physical change is one in which a substance or object undergoes a change in its physical properties and no new substance is formed.
- A chemical change is one in which one or more new substances are formed. It involves a chemical reaction and can be represented by a chemical equation.
- Combustion, cooking, and rusting are examples of chemical changes.
- Substances that undergo combustion are combustible substances. Heat and/or light are given out during combustion.
- The lowest temperature at which a substance can catch fire is called its ignition temperature.
- Some changes can be reversed and some cannot.
- Some changes are desirable and some are not.
- Rocks undergo physical and chemical changes due to weathering to form soil.
- Erosion caused by flowing water and wind is a physical change.

Let Us Enhance Our Learning

1. Which of the following statements are the characteristics of a physical change?
   (i) The state of the substance may or may not change.
   (ii) A substance with different properties is formed.
   (iii) No new substance is formed.
   (iv) The substance undergoes a chemical reaction.
   (a) (i) and (ii) (b) (ii) and (iii)
   (c) (i) and (iii) (d) (iii) and (iv)

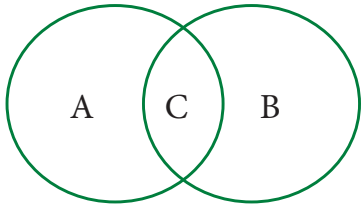
2. Predict which of the following changes can be reversed and which cannot be reversed. If you are not sure, you may write that down. Why are you not sure about these?
   (i) Stitching cloth to a shirt
   (ii) Twisting of straight string
   (iii) Making idlis from a batter
   (iv) Dissolving sugar in water
   (v) Drawing water from a well
   (vi) Ripening of fruits
   (vii) Boiling water in an open pan
   (viii) Rolling up a mat
   (ix) Grinding wheat grains to flour
   (x) Forming of soil from rocks

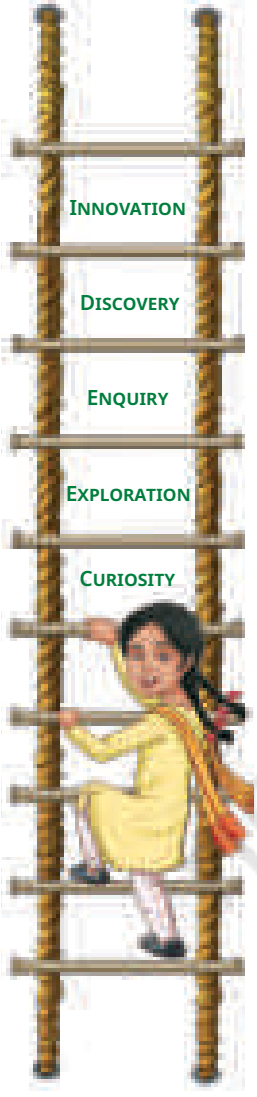
3. State whether the following statements are True or False. In case a statement is False, write the correct statement.
   (i) Melting of wax is necessary for burning a candle. (True/False)
   (ii) Collecting water vapour by condensing involves a chemical change. (True/False)
   (iii) The process of converting leaves into compost is a chemical change. (True/False)
   (iv) Mixing baking soda with lemon juice is a chemical change. (True/False)

4. Fill in the blanks in the following statements:
   (i) Nalini observed that the handle of her cycle has got brown deposits. The brown deposits are due to _____, and this is a_____ change.
   (ii) Folding a handkerchief is a _____ change and can be_____.
   (iii) A chemical process in which a substance reacts with oxygen with evolution of heat is called _____, and this is a _____ change.
   (iv) Magnesium, when burnt in air, produces a substance called _____. The substance formed is _____ in nature. Burning of magnesium is a _____ change.
5. Are the changes of water to ice and water to steam, physical or chemical? Explain.
6. Is curdling of milk a physical or chemical change? Justify your statement.
7. Natural factors, such as wind, rain, etc., help in the formation of soil from rocks. Is this change physical or chemical and why?
8. Read the following story titled 'Eco-friendly Prithvi', and tick the most appropriate option(s) given in the brackets. Provide a suitable title of your choice for the story.

   Prithvi is preparing a meal in the kitchen. He chops vegetables, peels potatoes, and cuts fruits (physical changes/chemical changes). He collects the seeds, fruits, and vegetable peels into a clay pot (physical change/chemical change). The fruits, vegetable peels, and other materials begin to decompose due to the action of bacteria and fungi, forming compost (physical change/chemical change). He decides to plant seeds in the compost and water them regularly. After a few days, he notices that the seeds begin to germinate and small plants start to grow, eventually blooming into colourful flowers (physical change/chemical change). His efforts are appreciated by all his family members.

9. Some changes are given here. Write physical changes in the area marked 'A' and chemical changes in the area marked 'B'. Enter the changes which are both physical and chemical in the area marked 'C'.





Process of burning a candle; Tearing of paper; Rusting; Curdling of milk; Ripening of fruits; Melting of ice; Folding of clothes; Burning of magnesium and Mixing baking soda with vinegar.

10. The experiments shown in Fig. 5.11a, b, c, and d were performed. Find out in which case(s) did lime water turn milky and why?

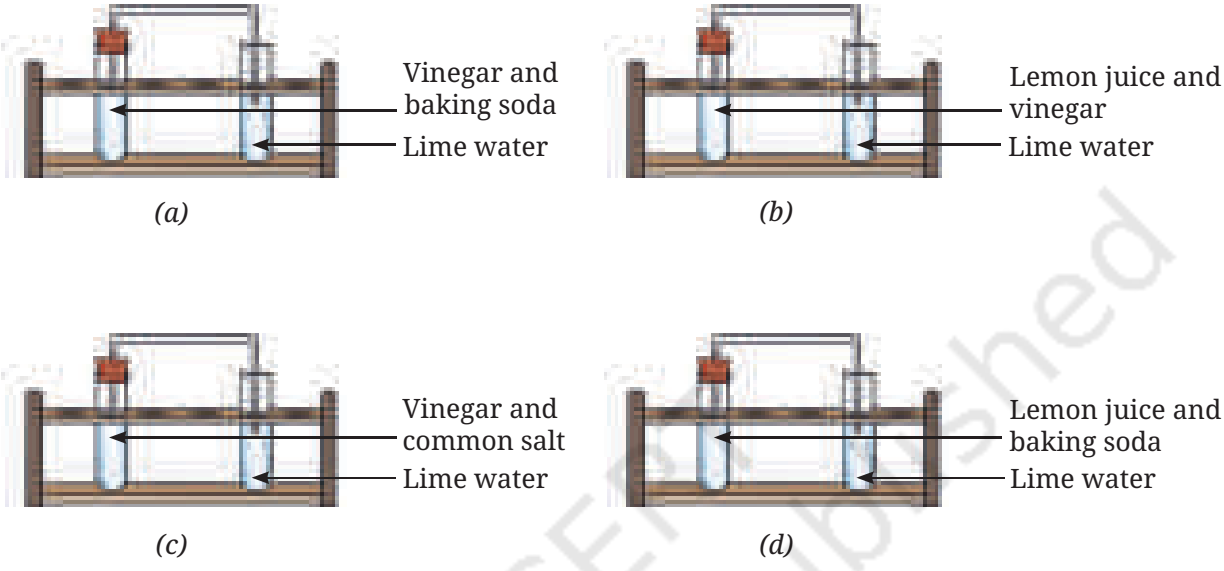


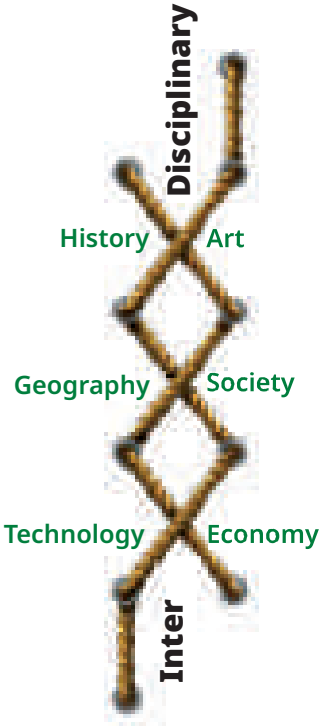
Fig. 5.11

Exploratory Projects

- Write a message on a piece of paper using lemon juice as ink and let it dry. The message will become invisible. Now use a warm iron over the paper (or hold the paper over the flame of a candle, taking care that it does not catch fire). The invisible letters turn dark brown as the paper gets warm. Can any of these changes be reversed?

Caution—Perform this activity under the supervision of an adult.

- We hear a lot of news about landslides and breaking of rocks in hilly regions these days, causing a lot of damage to life and property. Discuss what steps we can take to reduce landslides and rock erosion.
- Observe the activities going on in the kitchen and note any changes that can be reversed. Are these physical or chemical changes?



- Yeast is added while baking bread to make it fluffy and soft. How does yeast work? Try and find out!
  - Take a small bottle, some sugar, fresh yeast, water, and a balloon. Make a sugar solution in the bottle by mixing two teaspoons of sugar and a small amount of water. Now add a spoonful of yeast and cover the mouth of the bottle with a balloon. Leave it undisturbed for about an hour.
  - What do you observe?
  - Carefully take off the balloon, holding its mouth tightly closed and attach it to another small bottle containing freshly prepared lime water. Shake the bottle so that the contents of the balloon get mixed with lime water.
  - What do you observe?
  - What can you conclude from this experiment?
  - Identify all the changes occurring in the experiment and state which of them are physical and chemical changes.
- Chameleons (*Girgits*) change colour to blend in with their surroundings and also when they are angry or sense danger (Fig. 5.12). Is this a change that can be reversed? Explore from the internet or from your school library.

Fig. 5.12: A chameleon