5 Physical and Chemical Changes

0758CH06

Every day you come across many changes in your surroundings. These changes may involve one or more substances. For example, your mother may ask you to dissolve sugar in water to make a cold drink. Making a sugar solution is a change. Similarly, setting curd from milk is a change. Sometimes milk becomes sour. Souring of milk is a change. Stretched rubber band also represents a change.

Make a list of ten changes you have noticed around you.

In this chapter we shall perform some activities and study the nature of these changes. Broadly, these changes are of two kinds, **physical** and **chemical**.

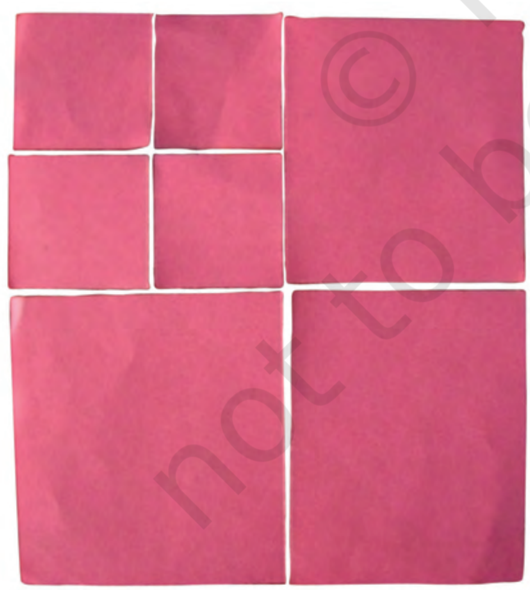

Fig. 5.1 *Paper pieces*

5.1 Physical Changes

Activity 5.1

Cut a piece of paper in four square pieces. Cut each square piece further into four square pieces. Lay these pieces on the floor or a table so that the pieces acquire the shape of the original piece of paper (Fig. 5.1).

Obviously, you cannot join the pieces back to make the original piece, but is there a change in the property of the paper?

Activity 5.2

Collect the chalk dust lying on the floor near the chalkboard in your classroom. Or, crush a small piece of chalk into dust. Add a little water to the dust to make a paste. Roll it into the shape of a piece of chalk. Let it dry.

Did you recover chalk from the dust?

Activity 5.3

Take some ice in a glass or plastic tumbler. Melt a small portion of ice by placing the tumbler in the sun. You have now a mixture of ice and water. Now place the tumbler in a freezing mixture (ice plus common salt).

Does the water become solid ice once again?

Reprint 2024-25

Activity 5.4

Boil some water in a container. Do you see the steam rising from the surface of water? Hold an inverted pan by its handle over the steam at some distance from the boiling water. Observe the inner surface of the pan.

Do you see any droplet of water there?

Activity 5.5

CAUTION
Be careful while handling a flame.

Hold a used hack-saw blade with a pair of tongs. Keep the tip of the free end of the blade on the gas stove. Wait for a few minutes.

Does the colour of the tip of the blade change?

Remove the blade from the flame. Observe the tip once again after some time.

Does it get back its original colour?

In Activities 5.1 and 5.2 above, you saw that paper and a piece of chalk underwent changes in size. In Activities 5.3 and 5.4, water changed its state (from solid to liquid, or from gas to liquid). In Activity 5.5, the hack-saw blade changed colour on heating.

Properties such as shape, size, colour and state of a substance are called its **physical properties**. A change in which a substance undergoes a change in its physical properties is called a **physical change.** A physical change is generally reversible. **In such a change no new substance is formed**.

Let us now consider the other kind of change.

5.2 Chemical Change

A change with which you are quite familiar is the rusting of iron. If you leave a piece of iron in the open for some time, it acquires a film of brownish substance. This substance is called **rust** and the process is called **rusting** (Fig. 5.2). Iron gates of parks or farmlands, iron benches kept in lawns and gardens, almost every article of iron, kept in the open gets rusted. At home you must have seen shovels and spades getting rusted when exposed to the

Fig. 5.2 *Rusting iron*

atmosphere for some time. In the kitchen, a wet iron pan (*tawa*) often gets rusted if left in that state for some time. Rust is not iron. It is different from iron on which it gets deposited.

Let us consider a few more changes where new substances are formed.

Activity 5.6

(To be demonstrated by the teacher)

CAUTION

It is dangerous to look for long at the burning magnesium ribbon. The teachers should advise children not to stare at the burning ribbon.

Get a small piece of a thin strip or ribbon of magnesium. Clean its tip with sandpaper. Bring the tip near a candle flame. It burns with a brilliant white light (Fig. 5.3). When it is completely burnt it leaves behind a powdery ash.

Fig. 5.3 *Magnesium ribbon burning*

Does the ash look like the magnesium ribbon?

The change can be represented by the following equation:

Magnesium (Mg) + Oxygen (O_2) $\rightarrow$ Magnesium oxide (MgO)

The equations here are different from those in mathematics. In equations of this kind, the arrow implies 'becomes'. No attempt should be made to balance chemical equations at this stage.

Collect the ash and mix it with a small amount of water. Stir the mixture (aqueous solution) well. Test the mixture with blue and red litmus papers.

Does the mixture turn red litmus blue?

Does the mixture turn blue litmus red?

On the basis of this test, how do you classify the aqueous solution — acidic or basic?

On dissolving the ash in water it forms a new substance. This change can be written in the form of the following equation:

Magnesium oxide (MgO) + Water (H_2O) $\rightarrow$ Magnesium hydroxide [$Mg(OH)_2$]

As you have already learnt in Chapter 4, magnesium hydroxide is a base. So, magnesium oxide is a new substance formed on burning of magnesium. Magnesium hydroxide is another new

Reprint 2024-25

substance formed by mixing magnesium oxide with water.

Activity 5.7

(To be demonstrated by the teacher)

Dissolve about a teaspoonful of copper sulphate (blue vitriol or *neela thotha*) in about half a cup of water in a glass tumbler or a beaker. Add a few drops of dilute sulphuric acid to the solution. You should get a blue coloured solution. Save a small sample of the solution in a test tube or a small glass bottle. Drop a nail or a used shaving blade into the remaining solution. Wait for half an hour or so. Observe the colour of the solution. Compare it with the colour of the sample solution saved separately (Fig. 5.4).

Fig. 5.4 *Change in colour of the copper sulphate solution due to reaction with iron*

Do you see any change in the colour of the solution?

Take out the nail or the blade.

Has it changed in any way?

The changes that you notice are due to a reaction between copper sulphate and iron. The change of colour of the solution from blue to green is due to the formation of iron sulphate, a new substance. The brown deposit on the iron nail is copper, another new substance. We can write the reaction as:

Copper sulphate solution (blue) + Iron
$\rightarrow$ Iron sulphate solution (green)
+ Copper (brown deposit)

Activity 5.8

Take about a teaspoonful of vinegar in a test tube. Add a pinch of baking soda to it. You would hear a hissing sound and see bubbles of a gas coming out. Pass this gas through freshly prepared lime water as shown in Fig. 5.5.

What happens to the lime water?

The change in the test tube is as follows:

Vinegar (Acetic acid) + Baking soda (Sodium hydrogencarbonate) $\rightarrow$

Carbon dioxide + other substances

The reaction between carbon dioxide and lime water is as follows:

Reprint 2024-25

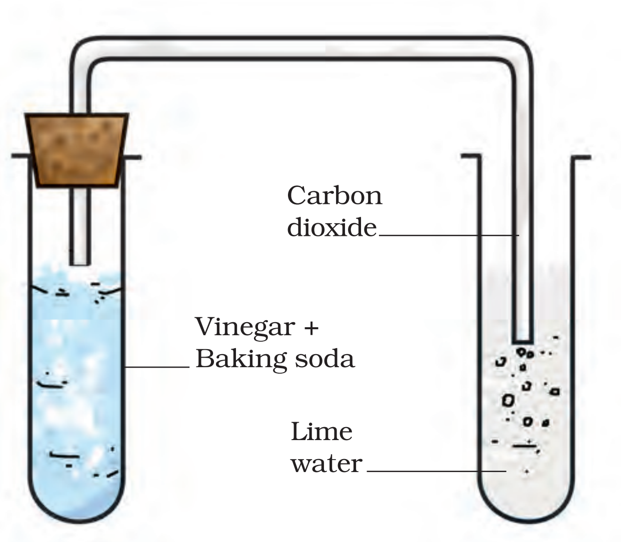

Fig. 5.5 Set up to pass gas through lime water

Carbon dioxide (CO_2) + Lime water [$Ca(OH)_2$] → Calcium Carbonate ($CaCO_3$) + Water (H_2O)

When carbon dioxide is passed through lime water, calcium carbonate is formed, which makes lime water milky. The turning of lime water into milky is a standard test of carbon dioxide. You will use it in Chapter 6 to show that the air we breathe out is rich in carbon dioxide.

In Activities 5.6–5.8, you saw that in each change one or more new substances were formed. In Activity 5.6, the ash was the new substance formed when magnesium was burnt in air. In Activity 5.7, the reaction of copper sulphate with iron produced iron sulphate and copper. Both of these are new substances. Copper was deposited on the shaving blade of iron. In Activity 5.8, vinegar and baking soda together produced carbon dioxide, which turned lime water milky. Can you name the new substance formed in this reaction?

A change in which one or more new substances are formed is called a chemical change. A chemical change is also called a **chemical reaction**.

Chemical changes are very important in our lives. All new substances are formed as a result of chemical changes. For example, digestion of food in our body, ripening of fruits, fermentation of grapes, etc., happen due to series of chemical changes. A medicine is the end product of a chain of chemical reactions. Useful new materials, such as plastics and detergents, are produced by chemical reactions. Indeed, every new material is discovered by studying chemical changes.

We have seen that one or more new substances are produced in a chemical change. In addition to new products, the following may accompany a chemical change:

- Heat, light or any other radiation (ultraviolet, for example) may be given off or absorbed.
- Sound may be produced.
- A change in smell may take place or a new smell may be given off.
- A colour change may take place .
- A gas may be formed.

Let us look at some examples.

You saw that burning of magnesium ribbon is a chemical change. Burning of coal, wood or leaves is also a chemical change. In fact, burning of any substance is a chemical change. Burning is always accompanied by production of heat.

Reprint 2024-25

Explosion of a firework is a chemical change. You know that such an explosion produces heat, light, sound and unpleasant gases that pollute the atmosphere. That is why you are advised not to play with fireworks.

When food gets spoiled, it produces a foul smell. Shall we call this change a chemical change?

You must have noticed that a slice of an apple acquires a brown colour if it is not consumed immediately. If you have not seen this change in colour, cut a fresh slice of apple and keep it away for some time. Repeat the same activity with a slice of potato or brinjal. The change of colour in these cases is due to the formation of new substances. Are not these changes chemical changes?

In Chapter 4, you neutralised an acid with a base. Is neutralisation a chemical change?

A protective shield

You must have heard of the ozone layer in our atmosphere. It protects us from the harmful ultraviolet radiation which come from the sun. Ozone absorbs this radiation and breaks down to oxygen. Oxygen is different from ozone. Can we call the breaking down of ozone a chemical change?

If ultraviolet radiation were not absorbed by ozone, it would reach the earth's surface and cause harm to us and other life forms. Ozone acts as a natural shield against this radiation.

We learnt in Chapter 1 that plants produce their food by a process called photosynthesis. Can we call photosynthesis a chemical change?

Paheli said that even digestion is a chemical change.

5.3 Rusting of Iron

Let us get back to rusting. This is one change that affects iron articles and slowly destroys them. Since iron is used in making bridges, ships, cars, truck bodies and many other articles, the monetary loss due to rusting is huge.

The process of rusting can be represented by the following equation:

Iron (Fe) + Oxygen (O_2, from the air) + water (H_2O) $\rightarrow$ rust (iron oxide Fe_2O_3)

For rusting, the presence of both oxygen and water (or water vapour) is essential.

In fact, if the content of moisture in air is high, which means if it is more humid, rusting becomes faster.

So, how do we prevent rusting? Prevent iron articles from coming in contact with oxygen, or water, or both. One simple way is to apply a coat of paint or grease. In fact, these coats should be applied regularly to prevent rusting. Another way is to deposit a layer of a metal like chromium or zinc on iron.

Reprint 2024-25

This process of depositing a layer of zinc on iron is called **galvanisation**. The iron pipes we use in our homes to carry water are galvanised to prevent rusting.

You know that ships are made of iron and a part of them remains under water. On the part above water also, water drops keep clinging to the ship's outer surface. Moreover, the water of the sea contains many salts. The salt water makes the process of rust formation faster. Therefore, ships suffer a lot of damage from rusting in spite of being painted. So much so, that a fraction of ship's iron has to be replaced every year. Can you imagine the monetary loss to the world?

Stainless steel is made by mixing iron with carbon and metals like chromium, nickel and manganese. It does not rust.

5.4 Crystallisation

In Class VI you have learnt that salt can be obtained by the evaporation of sea water. The salt obtained in this manner is not pure and the shape of its crystals cannot be seen clearly. However, large crystals of pure substances can be formed from their solutions. The process is called **crystallisation**. It is an example of a physical change.

Activity 5.9

(To be performed in the presence of the teacher)

CAUTION

Use only dilute sulphuric acid. Be careful while boiling water.

Take a cupful of water in a beaker and add a few drops of dilute sulphuric acid. Heat the water. When it starts boiling add copper sulphate powder slowly while stirring continuously (Fig. 5.6). Continue adding copper sulphate powder till no more powder can be dissolved. Filter the solution. Allow it to cool. Do not disturb the solution when it is cooling. Look at the solution after some time. Can you see the crystals of copper sulphate? If not, wait for some more time.

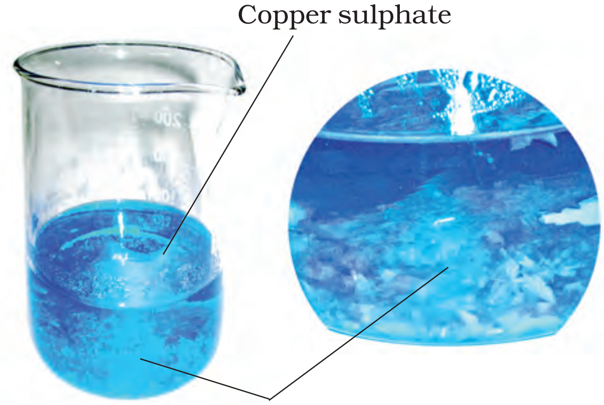

Fig. 5.6 *Crystals of copper sulphate*

Reprint 2024-25

(iii) Both processes A and B are chemical changes.

(iv) None of these processes is a chemical change.

Extended Learning — Activities and Projects

1. Describe two changes that are harmful. Explain why you consider them harmful. How can you prevent them?
2. Take three glass bottles with wide mouths. Label them A, B and C. Fill about half of bottle A with ordinary tap water. Fill bottle B with water which has been boiled for several minutes, to the same level as in A. In bottle C, take the same boiled water and of the same amount as in other bottles. In each bottle put a few similar iron nails so that they are completely under water. Add a teaspoonful of cooking oil to the water in bottle C so that it forms a film on its surface. Put the bottles away for a few days. Take out nails from each bottle and observe them. Explain your observations.
3. Prepare crystals of alum.
4. Collect information about the types of fuels used for cooking in your area. Discuss with your teachers/parents/others which fuels are less polluting and why.

Did you know?

Near the Qutub Minar in Delhi stands an iron pillar (Fig. 5.7) which is more than 7 metres high. It weighs more than 6000 kg. It was built more than 1600 years ago. After such a long period it has not rusted. For its quality of rust resistance it has been examined by scientists from all parts of the world. It tells something about the advances India had made in metal technology as back as 1600 years ago.

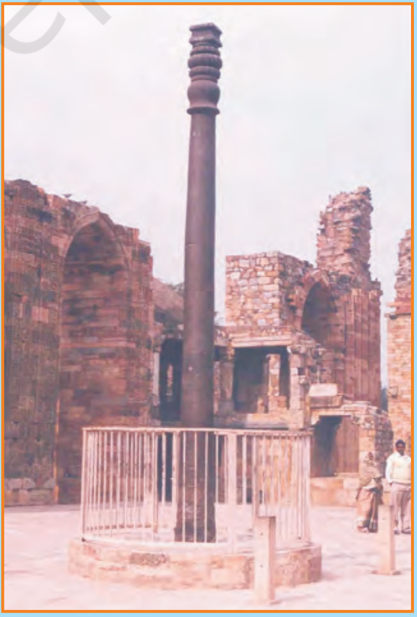

Fig. 5.7 *Iron pillar*

Reprint 2024-25