Physical and Chemical Changes

Physical and Chemical Changes

You must have observed that when ice melts, it changes to water. Similarly, when we burn paper, it changes to ash. Thus, in both cases, a change is taking place. There are many changes taking place all around us. **Can we classify these changes?** All the changes can be broadly classified into two types:

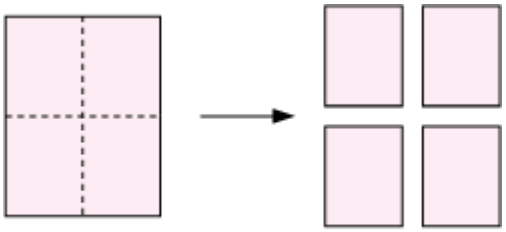
1. Physical changes

2. Chemical changes

Let us differentiate between physical changes and chemical changes.

We know that the shape, size, colour, and state of a substance are its physical properties. Physical changes usually involve changes in these properties of a substance. A change in any one of these physical properties is called a **physical change**.

For example, if you cut a piece of paper into 4 equal squares, then the shape of the paper changes, but there is no change in the properties of the paper. Also, no new substance gets formed in the process. Hence, the cutting of paper is a physical change.



In this case, we cannot join back the pieces to form the original paper. Hence, the cutting of paper is irreversible in nature. Let us now discuss a physical change, which is reversible in nature that is evaporation. **Evaporation is the process in which a liquid gets converted into its vapours**. This process depends on various factors such as,

- **Nature of liquids:** There are some liquids which evaporate quickly, such as petrol and kerosene, while there are other liquids which take some time to evaporate, such as water.

- **Surface area:** Evaporation of a liquid depends on the surface of the liquid. If surface area of the liquid increases, then evaporation increases.
- **Humidity:** It is the amount of water vapour present in the environment. If humidity or water vapour in air is high, evaporation will be slow and if air is free of water vapour then evaporation takes place rapidly.
- **Temperature:** As the temperature rises, the evaporation takes place more quickly.

Let's understand the evaporation process with the help of an illustration:

If we add a spoon of common salt in some water and stir the mixture for sometime, then the salt disappears. Now, if we place the salt solution in a china dish over a hot plate, then it will be observed that the water evaporates after sometime, leaving behind a white solid (as shown in the figure).

Evaporating salt solution

The white solid that is left after all the water is boiled is nothing but salt. This proves that when salt dissolves in water, no new substance is formed. However, this process is reversible. Thus, dissolution of salt in water is a physical change.

Hence, it can be concluded that in a physical change,

- a change in the physical properties of a substance such as state, shape, size, and colour takes place
- no new substances are formed

For example,

Ice → Water → Steam (They are all still water!)

- The original substance can generally be recovered again

Now, you know what physical changes are. **Do you know the characteristics of chemical changes?**

A chemical change is the one in which the formation of one or more new substances takes place. The new substance formed has different chemical properties from that of the substance that formed it.

Now, watch the following animation to see an example of chemical change.

Let us add more to our knowledge by performing the next activity.

When lime is added to water, the temperature of water increases and water almost starts boiling. A substance called slaked lime is produced during this change. Hence, it is a chemical change. The following chemical equation can be used to represent the chemical change.

$CaO + H_2O \rightarrow Ca(OH)_2 + \text{Energy}$

Lime Water Slaked lime

Thus, it can be concluded that in a chemical change,

- one or more new substance(s) are formed
- the chemical properties of the new substance(s) are different from those of the starting material
- the original material cannot be recovered easily

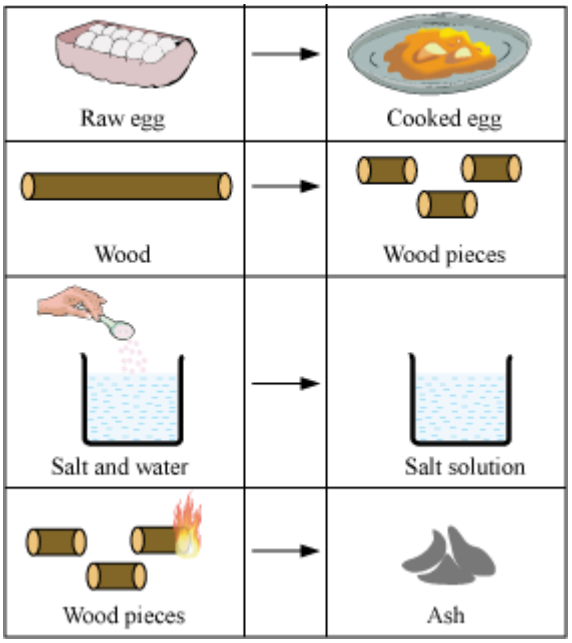
For example, magnesium oxide and calcium hydroxide (formed in the above activities) cannot be converted back into their original substances.

Hence, we can summarize the differences between physical and chemical changes as given in the table below.

Physical Change	**Chemical Change**
1. The chemical composition of a substance does not change.	**1.** The chemical composition of a substance changes.
2. Most changes are reversible.	**2.** Most changes are irreversible.

3. No new substances are formed. For example, Ice → Water → Steam	**3.** New substances are formed.For example, Paper → Ashes

Can you specify the type of changes given in the table?



Some other examples of physical changes

- Melting of butter
- Boiling of water
- Condensation of water vapours
- Making of fruit salad with raw fruits
- Expansion or contraction of metals on heating or cooling
- Freezing of water
- Beating of metals into sheets
- Mixing of sugar and sand
- Crystallisation of salts from their solutions

Some other examples of chemical changes

- Digestion of food

- Cooking of food
- Rusting of iron
- Decaying of wood
- Burning of paper
- Souring of milk
- Ripening of mangoes
- Burning of candle

Burning a candle: We now understand the difference between physical change and chemical change. But there are a few changes in which simultaneous physical and chemical changes occur. Let us study about those changes.

When we burn a candle, heat and light is produced, which melts the candle. This process is a physical change. But at the same time, two new products, which are carbon dioxide and water vapours, are formed, making it a chemical change.

Thus, burning a candle is a combination of physical and chemical change.

- **Sublimation of ammonium chloride**

Sublimation of an element is a change from the solid directly to gas phase with no intermediate liquid stage. For example, when ammonium chloride is heated, it goes directly into the vapour state. When these vapours are cooled, ammonium chloride is obtained back.

Since we obtain the original substance back at the end, it is a physical change. **But do you know why does it sublime?**

Ammonium chloride sublimes because of dissociation of ammonium chloride into ammonia and hydrogen chloride in the vapour state. On cooling, ammonia and hydrogen chloride recombine to form ammonium chloride again.

Thus, the physical change taking place is the result of chemical dissociation and combination.

- **Cooking rice**

  Do you know what happens when we cook rice?

  While cooking rice, water molecules pierce the walls of the cells of the starch present in rice. Thus, some of the starch is decomposed. Therefore, this change is physical to a major extent since the composition of rice remains the same.

Evaporating salt solution

Allotropic Changes

Allotropy is exhibited by certain chemical elements, which can exist in two or more different forms, known as allotropes of that element. For example, carbon has graphite and diamond as its allotropes. Oxygen has ozone as its allotrope.

In each allotrope, the element's atoms are bonded together in a different manner. Also, they may differ in number of atoms forming the unit.

In oxygen gas, there are two atoms in a molecule. On the other hand, in ozone, three atoms are present in a molecule. Also, oxygen and ozone are different in some of their chemical properties.

Hence, we conclude that allotropic changes are chemical changes.

Rusting Of Iron And Crystallization

Whether it is a change taking place within our body or in our surroundings, we know that changes can be broadly categorized as **physical** and **chemical** changes.

Physical change

In a physical change, a substance undergoes a change in its physical properties. During this change, the formation of new substances does not take place and most of the physical changes are reversible. Evaporation, melting of butter, and cutting of paper are some examples of physical changes.

Chemical change

In a chemical change, the formation of one or more new substances takes place. The new substance formed has different chemical properties from that of the substance that formed it. Burning of fuels, cooking of food, fermentation, and souring of milk are some examples of chemical changes.

We will now discuss two important changes:

Rusting (a chemical change) and **crystallization** (a physical change)

You must have observed that when articles of iron are kept out in the open for some time, they get covered by a brownish substance. This brownish substance is called **rust**. Rust is the new substance obtained from the combination of iron and atmospheric oxygen. The characteristic properties of rust are different from that of iron as well as oxygen. Hence, rusting of iron is a chemical change, which affects articles of iron and slowly destroys them.

The two main factors that cause rusting are oxygen and water. As soon as the article comes in contact with air (oxygen) and moisture (water), it starts rusting. The chemical process that occurs during rusting can be represented as follows:

$$\text{Iron (Fe)} + \text{Oxygen } (O_2) + \text{Water } (H_2O) \rightarrow \text{Rust } (Fe_2O_3)$$

Rusting becomes faster with an increase in the content of moisture in air. That is why water pipes made of iron tend to get rusted easily.

Salt makes the process of rusting faster. Rusting is a complex process involving many steps. The presence of salt speeds up the first step, which in turn speeds up the whole process.

Did you know?

Ships are made of iron and a part of them remain under water. Seawater contains many salts dissolved in it and salt water makes the process of rusting faster. Therefore, ships suffer a lot of damage. As a result, a fraction of the ship's iron has to be replaced every year. Hence, a large amount of money is spent to replace the damaged iron and steel.

Every year, our world suffers huge monetary losses owing to the process of rusting, which causes harm to the articles made of iron. Therefore, attempts are being made to prevent rusting. Here are some ways that can prevent rusting.

1. Painting or coating iron articles with grease: This does not allow iron to come in contact with oxygen and water. Hence, it prevents rusting. In fact, paints and grease should be applied regularly to prevent rusting.

2. Rusting can also be prevented by depositing a layer of metal such as chromium or zinc on the surface of the iron article. **The process of depositing zinc on iron is called galvanization.**

Alloying is another method used for the prevention of rusting. Stainless steel is an alloy. It is a homogeneous mixture of iron, carbon, chromium and nickel. It does not rust.

Now, let us discuss crystallization in detail, which is a physical change.

We know that evaporation is a physical process in which a substance changes from liquid to gaseous state. By evaporation, salt is obtained from seawater and all water changes to water vapour. As a result, only the non-volatile salt remains. The salt obtained by this method is not pure and has to be purified. Hence, purified crystals of salt can be obtained by the method of crystallization.

In the crystallization method, a saturated solution of a substance (to be purified) is made. Then, this solution is boiled to make it a supersaturated solution. When this supersaturated solution is cooled, crystals of pure substances are obtained. Thus, large crystals of pure substances can be formed from their solutions by the process of crystallization.

Since no new product has been formed, this is an example of physical change. Let us watch the following animation to understand the process of crystallization.