Chemical Reactions and Equations

Physical Change :

1) No new substances is formed.
2) It is a temporary change.
3) It is easily reversible by simple physical methods.
4) Only physical property of a substance are changed.
5) Generally, there is no overall change in energy.

★ physical properties (size, shape, colour and state)

Examples : falling of leaves, melting of ice to form water, boiling of water to form water vapours, dissolving salt or sugar in water, mixing carbon dioxide gas and soda Etc.

Chemical Change :

1) One or more new substances are formed.
2) It is permanent change.
3) It is generally Irreversible.
4) Both physical and chemical property of a substance are changed.
5) Change in energy take place as very large amount of energy is absorbed or given out.

★ absorbed → endothermic
★ given out → exothermic.

Examples: Germination of seeds, Ripening of foods, cooking of food, digestion, respiration, burning of coal, rusting of iron, souring of milk, etc.

Chemical Reaction are the processes involving a chemical change in which new substance having new properties or formed from original substance.

Chemical reaction involves breaking of old bonds and formation of new bonds.
old bonds → of reactant
formation of new bonds → product

Reactants : substance which take part in chemical reaction.
Products : New substance produce as a result of chemical reaction.

eg : $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$

$2H_2(g) + O_2(g)$: Reactant
$2H_2O(l)$: Product
→ Show the direction of chemical reaction.

(g) → gaseous state
(l) → liquid state
(s) → solid state
(aq) → aqueous state → dissolve in water.

Characteristics of Chemical Reactions

Change in state

$NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s)$

★ gaseous ⟶ solid

Change in colour

$Ag(s) + H_2S(g) \longrightarrow Ag_2S(s) + H_2(g)$

(Silvery white) (Black)

Evolution of a Gas

$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$

★[NCERT page 2 Act. 1.3] evolution of gas

Formation of a Precipitate

$BaCl_2(aq) + H_2SO_4(aq) \longrightarrow BaSO_4(s)\downarrow + 2HCl(aq)$

(white ppt.)

★[NCERT Page No. 11 Act. 1.10 (same)]

★ ppt. → precipitate

$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$

↳ yellow ppt.

[NCERT Act 1.2 page No 2]

Change in temperature

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g) + Heat$

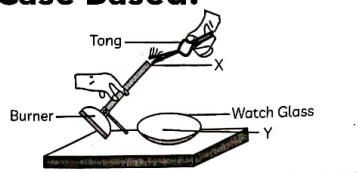
Exothermic Reaction ← Heat evolved — Heat ~~मिल~~ रहा है

$Ba(OH)_2(aq) + 2NH_4Cl(s) + Heat \longrightarrow BaCl_2(aq) + 2NH_3 + 2H_2O(l)$

[NCERT Page No. 10 Blue box]

Heat देना पड़ रहा है. ↳ Heat absorbed → endothermic reaction

Case Based:



[NCERT Activity 1.1]

(A) Which option correctly identifies both X and Y?

Option	X	Y
(a)	Magnesium	Magnesium carbonate
(b)	Aluminium	Aluminium oxide
(c)	Magnesium	Magnesium oxide
(d)	Iron	Iron oxide

(B) The colour of powder or ash formed when a magnesium ribbon is burnt in air is:
(a) grey (b) black
(c) white (d) yellow

(C) Why should a magnesium ribbon be cleaned before burning in air? [NCERT]

(D) Is burning of magnesium ribbon a physical change or a chemical change? Justify your answer.

(E) Assertion(A): Magnesium ribbon burns with a dazzling white flame.
Reason (R): When magnesium ribbon burns in air only heat is evolved.
(a) Both (A) and (R) are true and (R) is correct explanation of the (A).
(b) Both (A) and (R) are true but (R) is not correct explanation of the (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true.

Page No. 1 Activity 1.1

$2Mg + O_2 \longrightarrow 2MgO$

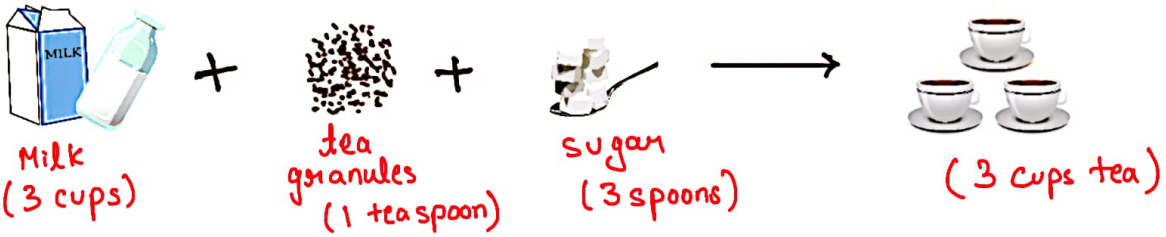
(A) X = Magnesium
Y = Magnesium Oxide

(B) page 2 second line white powder.

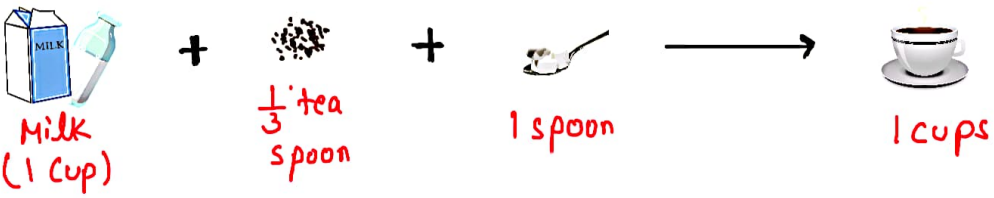
(C) To remove the layer of magnesium oxide that may have formed on the ribbon due to the reaction of magnesium with oxygen.

D) Burning of ribbon is a chemical change as magnesium Burns in air to form a new substance magnesium oxide. Moreover, it also involves change in temperature as a lot of heat and light is produced during this change.

(E) page 2 second line → Magnesium ribbon burns with dazzling white flame.
(c) A is true, but (R) is false.



If you want one cup of tea :



जितना Reactant हैं उतना product फॉर्म हो रहा...

Chemical equations :

The symbolic representation of chemical reactions where the reactants and products are written in the form of symbols and formulae on the left hand side and right hand side of an arrow respectively.

eg: $CaCl_2 + 2AgNO_3 \longrightarrow Ca(NO_3)_2 + 2AgCl\downarrow$ (white ppt.)

Decomposition reaction
Fir miluga Bhulna nahi

Word Equations :

Magnesium + Oxygen — Magnesium oxide
(Reactant) (Product)

Unbalanced Chemical Equations

It has an unequal number of atoms of one or more elements in reactant and product because the mass is not the same on both sides of equation. Such chemical reaction is a skeletal chemical equation for a reaction.

$$Mg + O_2 \longrightarrow MgO$$

Balanced Chemical :

It has an equal number of atoms of different elements in the reactants and products in accordance with the law of conservation of mass.

$$2Mg + O_2 \longrightarrow 2MgO$$

Usually physical states are not included in a chemical equation unless it is necessary to specify them.

Sometimes the reaction conditions, such as temperature, pressure, catalyst, etc., for the reaction are indicated above and/or below the arrow in the equation. For example –

$$CO(g) + 2H_2(g) \xrightarrow{340\,atm} CH_3OH(l) \quad (1.11)$$

$$6CO_2(aq) + 12H_2O(l) \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6(aq) + 6O_2(aq) + 6H_2O(l) \quad (1.12)$$

(Glucose)

Balancing कैसे करे ?

① $Mg + O_2 \longrightarrow MgO$

② $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

③ $Fe + H_2O \longrightarrow Fe_3O_4 + H_2$

④ $AlCl_3(aq) + NH_4OH(aq) \longrightarrow Al(OH)_3(s) + NH_4Cl(aq)$

Types of Chemical Reactions

1.2 TYPES OF CHEMICAL REACTIONS

We have learnt in Class IX that during a chemical reaction atoms of one element do not change into those of another element. Nor do atoms disappear from the mixture or appear from elsewhere. Actually, chemical reactions involve the breaking and making of bonds between atoms to produce new substances. You will study about types of bonds formed between atoms in Chapters 3 and 4.

Combination Reaction

Those reaction in which two or more reactants and combine to form a single product are known as combination reactions.

Examples of Combination Reactions

S. No.	Example of Combination Reaction	Chemical Equation
(1)	Burning of hydrogen in air to form water	$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(l)}$
(2)	Burning of carbon (coal) in air to form carbon dioxide	$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$
(3)	Reaction of hydrogen with chlorine to form hydrogen chloride	$H_{2(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)}$
(4)	Burning of sodium metal in chlorine to form sodium chloride	$2Na_{(s)} + Cl_{2(g)} \longrightarrow 2NaCl_{(s)}$
(5)	Heating of iron with sulphur to form iron sulphide	$Fe_{(s)} + S_{(s)} \longrightarrow FeS_{(s)}$

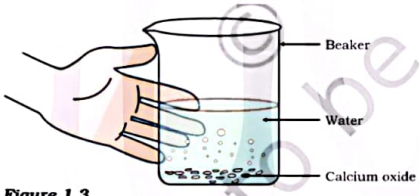


Figure 1.3 *Formation of slaked lime by the reaction of calcium oxide with water*

Activity 1.4

- Take a small amount of calcium oxide or quick lime in a beaker.
- Slowly add water to this.
- Touch the beaker as shown in Fig. 1.3.
- Do you feel any change in temperature?

Calcium oxide reacts vigorously with water to produce slaked lime (calcium hydroxide) releasing a large amount of heat.

$$\underset{\text{(Quick lime)}}{CaO(s)} + H_2O(l) \rightarrow \underset{\text{(Slaked lime)}}{Ca(OH)_2(aq)} + \text{Heat} \qquad (1.13)$$

In this reaction, calcium oxide and water combine to form a single product, calcium hydroxide. Such a reaction in which a single product is formed from two or more reactants is known as a combination reaction.

Do You Know?

A solution of slaked lime produced by the reaction 1.13 is used for whitewashing walls. Calcium hydroxide reacts slowly with the carbon dioxide in air to form a thin layer of calcium carbonate on the walls. Calcium carbonate is formed after two to three days of whitewashing and gives a shiny finish to the walls. It is interesting to note that the chemical formula for marble is also $CaCO_3$.

$$\underset{\text{(Calcium hydroxide)}}{Ca(OH)_2(aq)} + CO_2(g) \rightarrow \underset{\text{(Calcium carbonate)}}{CaCO_3(s)} + H_2O(l) \qquad (1.14)$$

1. A solution of a substance 'X' is used for white washing.
   (i) Name the substance 'X' and write its formula.
   (ii) Write the reaction of the substance 'X' named in (i) above with water.

Exothermic and Endothermic Reactions

Chemical reactions are accompanied with change in temperature of the reaction mixture. There can be either a rise in temperature or a fall in temperature.

Exothermic Reactions:

$$\text{Reactant(s)} \longrightarrow \text{Product(s)} + \text{Heat}$$

Those reactions in which heat is evolved are known as exothermic reactions. Some examples of exothermic reactions are:

(1) Burning of carbon in air to form carbon dioxide:

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)} + \text{Heat}$$

(2) Burning of natural gas:

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)} + \text{Heat}$$

(3) Reaction between calcium oxide with water to form slaked lime:

$$CaO_{(s)} + H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)} + \text{Heat}$$

Important

➥ *The reaction between calcium oxide with water to form slaked lime is used for white washing walls. The reaction taking place is:*

$$Ca(OH)_{2(aq)} + CO_{2(g)} \longrightarrow CaCO_{3(s)} + H_2O_{(l)}$$

(4) Respiration: It is the release of energy by the oxidation of glucose in the cells of our body.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy}$$

(5) Decomposition of vegetable matter into compost.

(6) All combustion reactions.

$$\text{Reactant} + O_2 \longrightarrow 6CO_2 + \text{Product} + \text{Heat}$$

Endothermic Reactions:

Reactant(s) + Heat ⟶ Product

Those reactions in which heat is absorbed are known as endothermic reactions. Some examples of endothermic reactions are:

(1) Formation of nitrogen monoxide by heating nitrogen and oxygen to a temperature of about 3000°C.

$$N_{2(g)} + O_{2(g)} + \text{Heat} \longrightarrow 2NO_{(g)}$$

(2) All decomposition reactions are endothermic reactions since the decomposition reactions require energy either in the form of heat, light or electricity for breaking down the reactants.

For example, when calcium carbonate is heated, it decomposes to form calcium oxide and carbon dioxide:

$$CaCO_{3(s)} + \text{Heat} \longrightarrow CaO_{(s)} + CO_{2(g)}$$

(3) Photosynthesis is an endothermic process as sunlight is absorbed by green plants during photosynthesis resulting in the formation of glucose, water and oxygen.

$$6CO_{2(g)} + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

Decomposition Reaction ($AB \longrightarrow A + B$)

Those reactions in which a compound splits up into two or more simpler substances are known as decomposition reactions.

Depending upon the form of energy required for the reaction, there are three types of decomposition reactions:

Thermal Decomposition Reactions

When a decomposition reaction is carried out by heating, it is called thermal decomposition.

For example, decomposition of calcium carbonate to calcium oxide and carbon dioxide on heating is an important decomposition reaction used in various industries.

$$\underset{\text{Calcium carbonate (Limestone)}}{CaCO_{3(s)}} \xrightarrow{\text{Heat}} \underset{\text{Calcium oxide}}{CaO_{(s)}} + \underset{\text{Carbon dioxide}}{CO_{2(g)}}$$

1.2.2 Decomposition Reaction

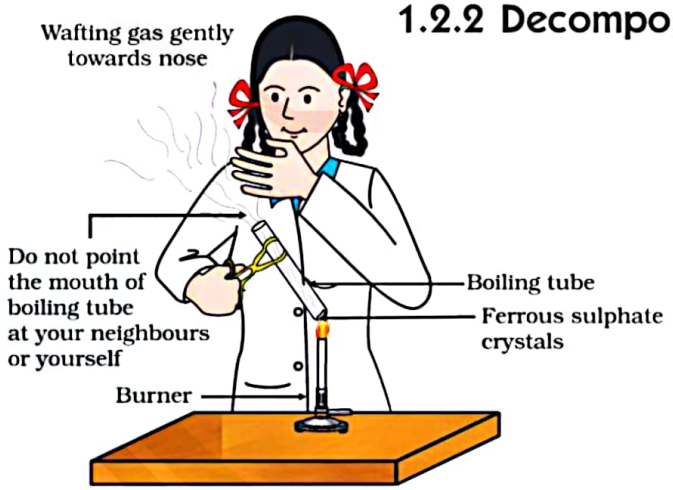


Figure 1.4
Correct way of heating the boiling tube containing crystals of ferrous sulphate and of smelling the odour

Activity 1.5

- Take about 2 g ferrous sulphate crystals in a dry boiling tube.
- Note the colour of the ferrous sulphate crystals.
- Heat the boiling tube over the flame of a burner or spirit lamp as shown in Fig. 1.4.
- Observe the colour of the crystals after heating.

Have you noticed that the green colour of the ferrous sulphate crystals has changed? You can also smell the characteristic odour of burning sulphur.

$$\underset{\text{(Ferrous sulphate)}}{2FeSO_4(s)} \xrightarrow{\text{Heat}} \underset{\text{(Ferric oxide)}}{Fe_2O_3(s)} + SO_2(g) + SO_3(g) \qquad (1.19)$$

In this reaction you can observe that a single reactant breaks down to give simpler products. This is a decomposition reaction. Ferrous sulphate crystals ($FeSO_4$, $7H_2O$) lose water when heated and the colour of the crystals changes. It then decomposes to ferric oxide (Fe_2O_3), sulphur dioxide (SO_2) and sulphur trioxide (SO_3). Ferric oxide is a solid, while SO_2 and SO_3 are gases.

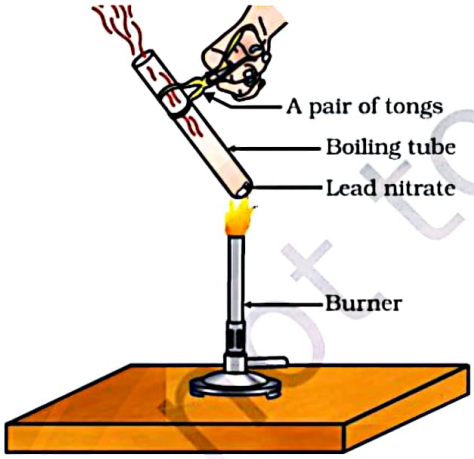


Figure 1.5
Heating of lead nitrate and emission of nitrogen dioxide

Another example of a thermal decomposition reaction is given in Activity 1.6.

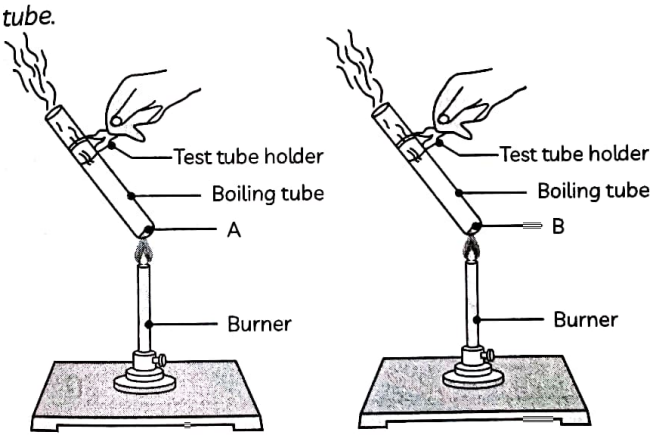
Activity 1.6

- Take about 2 g lead nitrate powder in a boiling tube.
- Hold the boiling tube with a pair of tongs and heat it over a flame, as shown in Fig. 1.5.
- What do you observe? Note down the change, if any.

You will observe the emission of brown fumes. These fumes are of nitrogen dioxide (NO_2). The reaction that takes place is –

$$\underset{\text{(Lead nitrate)}}{2Pb(NO_3)_2(s)} \xrightarrow{\text{Heat}} \underset{\text{(Lead oxide)}}{2PbO(s)} + \underset{\text{(Nitrogen dioxide)}}{4NO_2(g)} + \underset{\text{(Oxygen)}}{O_2(g)} \qquad (1.21)$$

Two boiling tubes were taken, about 2 grams of a green coloured metal salt 'A' was taken in the first tube and 2 grams of a white coloured metal salt 'B' was taken in the second tube. Both the tubes were heated by holding them with a pair of tongs. Smell of burning sulphur was observed in first test tube whereas brown gas was emitted in the second test tube.



[NCERT Activity 1.5, 1.6]

(A) The salts 'A' and 'B' are:

(a) ferrous nitrate and lead sulphate respectively

(b) ferric oxide and lead nitrate respectively

(c) ferrous sulphate and lead nitrate respectively

(d) ferric oxide and lead sulphate respectively

(B) During the experiment of heating of green coloured metal salt 'A', four students recorded their observation as:

(I) green colour changes to brown black colour.

(II) brownish yellow gas is evolved.

(III) blue colour changes to green colour.

(IV) smell of burning sulphur is observed.

Which of the above observations are incorrect?

(a) Both (I) and (II) (b) Both (I) and (IV)

(c) Both (II) and (III) (d) Both (III) and (IV)

(C) What are the products formed when green coloured metal salt 'A' is heated?

(D) On heating white coloured metal salt 'B', two gases are evolved, one is colourless and the other is brown in colour. Which gases are they?

(E) In which of the following category will you put the reaction of heating of ferrous sulphate and lead nitrate?

(I) Decomposition reaction

(II) Combination reaction

(III) Endothermic reaction

(IV) Exothermic reaction

(a) Only (I) (b) Only (II)

(c) Both (I) and (III) (d) Both (II) and (IV)

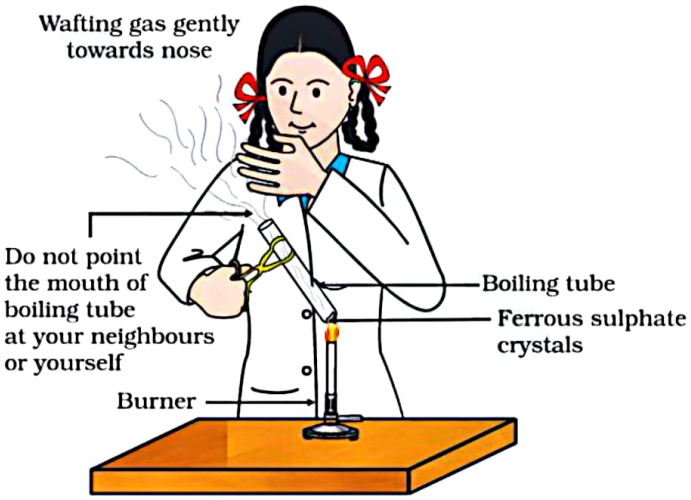


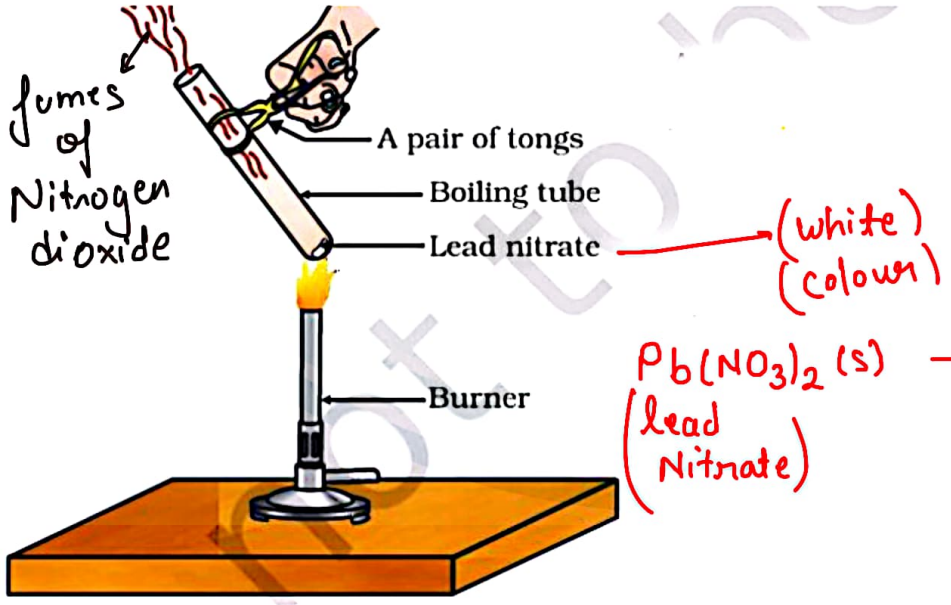
Figure 1.4
Correct way of heating the boiling tube containing crystals of ferrous sulphate and of smelling the odour

evolution of Sulphur gas.

$FeSO_4(s) \xrightarrow{\Delta} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

Ferrous Sulphate (green)

Ferric Oxide (black brown)



(white colour)

$Pb(NO_3)_2(s) \xrightarrow{\Delta} 2PbO(s) + 4NO_2(g) + O_2(g)$

(Lead Nitrate) (Lead oxide) (Nitrogen dioxide) ↓ (brown fumes)

Figure 1.5
Heating of lead nitrate and emission of nitrogen dioxide

Decomposition Reaction by Electric Energy (Electrolytic Decomposition)

The decomposition reactions that are carried out by using electricity are known as electrolytic decomposition reactions.

For example, the electrolysis of water to form hydrogen and oxygen gas.

$$2H_2O \xrightarrow{\text{electricity}} 2H_{2(g)} + O_2$$

Activity 1.7

- Take a plastic mug. Drill two holes at its base and fit rubber stoppers in these holes. Insert carbon electrodes in these rubber stoppers as shown in Fig. 1.6.
- Connect these electrodes to a 6 volt battery.
- Fill the mug with water such that the electrodes are immersed. Add a few drops of dilute sulphuric acid to the water.
- Take two test tubes filled with water and invert them over the two carbon electrodes.
- Switch on the current and leave the apparatus undisturbed for some time.
- You will observe the formation of bubbles at both the electrodes. These bubbles displace water in the test tubes.
- Is the volume of the gas collected the same in both the test tubes?
- Once the test tubes are filled with the respective gases, remove them carefully.
- Test these gases one by one by bringing a burning candle close to the mouth of the test tubes.
  CAUTION: This step must be performed carefully by the teacher.
- What happens in each case?
- Which gas is present in each test tube?

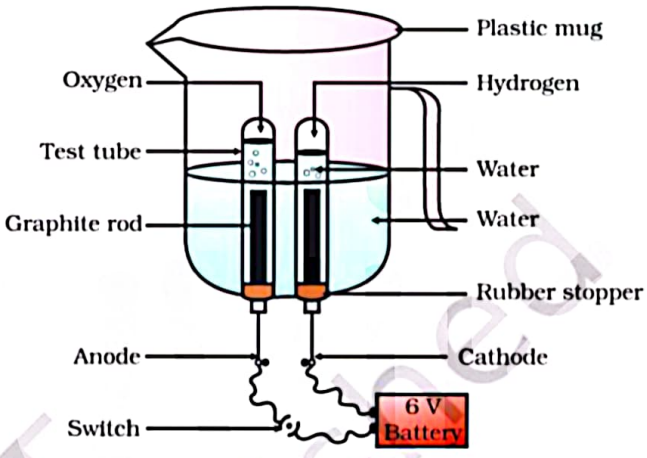


Figure 1.6
Electrolysis of water

2. Why is the amount of gas collected in one of the test tubes in Activity 1.7 double of the amount collected in the other? Name this gas.

Page No. 10 (Intex Question)

$2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$

As the electrolysis of water produces 2 volumes of hydrogen gas and 1 volume of oxygen gas, it can therefore be concluded that the ratio of hydrogen and oxygen element in water is 2 : 1 by volume. Water contains 2 atoms of hydrogen for each atom of oxygen.

Decomposition Reaction by Light Energy (Photolytic Decomposition)

The decomposition reactions that occur in the presence of sunlight are known as photo decomposition reactions or photolysis.

For example, silver chloride (white) decomposes into silver (grey) and chlorine in the presence of sunlight.

$$2AgCl_{(s)} \xrightarrow{\text{Sunlight}} 2Ag_{(s)} + Cl_{2(g)}$$

Activity 1.8

- Take about 2 g silver chloride in a china dish.
- What is its colour?
- Place this china dish in sunlight for some time (Fig. 1.7).
- Observe the colour of the silver chloride after some time.

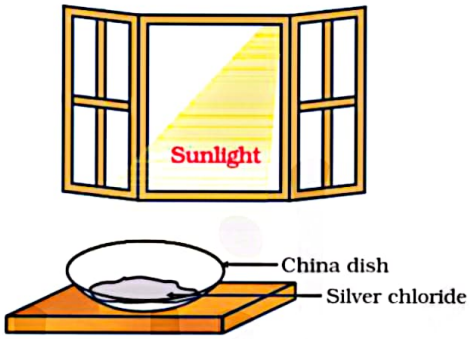


Figure 1.7
Silver chloride turns grey in sunlight to form silver metal

You will see that white silver chloride turns grey in sunlight. This is due to the decomposition of silver chloride into silver and chlorine by light.

$$2AgCl(s) \xrightarrow{\text{Sunlight}} 2Ag(s) + Cl_2(g) \qquad (1.22)$$

Silver bromide also behaves in the same way.

$$2AgBr(s) \xrightarrow{\text{Sunlight}} 2Ag(s) + Br_2(g) \qquad (1.23)$$

The above reactions are used in black and white photography.
What form of energy is causing these decomposition reactions?

We have seen that the decomposition reactions require energy either in the form of heat, light or electricity for breaking down the reactants. Reactions in which energy is absorbed are known as endothermic reactions.

11. Why are decomposition reactions called the opposite of combination reactions? Write equations for these reactions.

The decomposition reaction, a single substance reactant split into two or more products whereas in combination reaction, two or more reactants combine to form a single product. Thus, decomposition reaction is the opposite of combination reaction.

eg: $ZnCO_3 \rightarrow ZnO + CO_2$ (decomposition)
$2H_2 + O_2 \rightarrow 2H_2O$ (combination)

Displacement Reaction
(A + BC ⟶ AC + B)

Those reactions in which one element takes the place of another element in a compound, are known as displacement reactions. In general, a more reactive element displaces a less reactive element from its compound.

$$Fe_{(s)} + \underset{\text{(Copper sulphate)}}{CuSO_{4(aq)}} \longrightarrow \underset{\text{(Iron sulphate)}}{FeSO_{4(aq)}} + Cu_{(s)}$$

In this reaction, iron has displaced or removed another element, copper, from copper sulphate solution. This reaction is known as displacement reaction.

Important

- *The reaction between most metals and acids is also a displacement reaction as the metal displaces hydrogen from the acid. For example,*

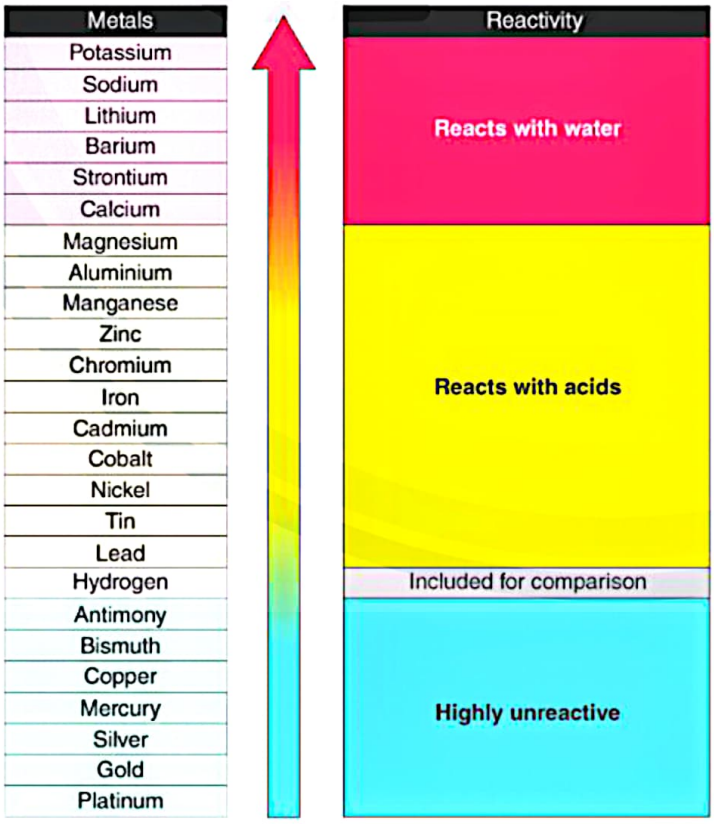
$$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$$

- *The hydrogen gas is collected by the downward displacement of water as it is lighter than water. Moreover, it is also insoluble in water.*

More Reactive ↑

Potassium	(K)	काशी
Sodium	(Na)	नाथ
Calcium	(Ca)	का
Magnesium	(Mg)	माली
Aluminium	(Al)	आलू
Zinc	(Zn)	ज़रा
Iron	(Fe)	फीके
Lead	(Pb)	पकाना
Hydrogen	(H)	है
Copper	(Cu)	कौन
Mercury	(Hg)	है
Silver	(Ag)	आगे
Gold	(Au)	आओ

↓ Least Reactive



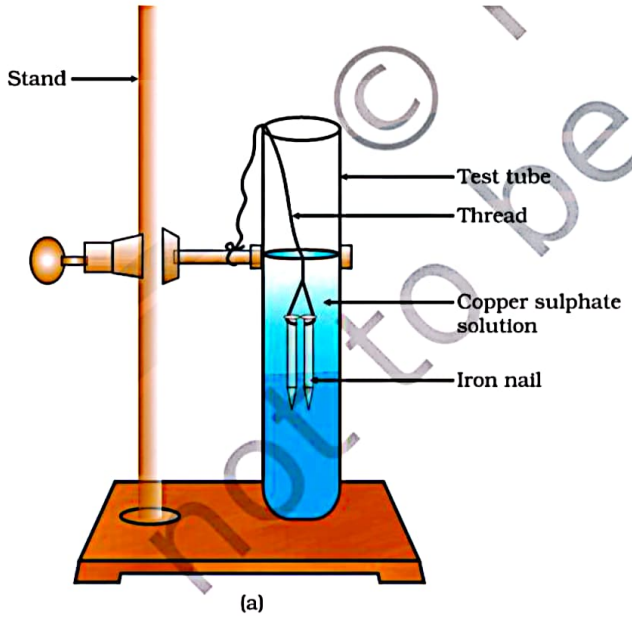


Figure 1.8
(a) Iron nails dipped in copper sulphate solution

Activity 1.9

- Take three iron nails and clean them by rubbing with sand paper.
- Take two test tubes marked as (A) and (B). In each test tube, take about 10 mL copper sulphate solution.
- Tie two iron nails with a thread and immerse them carefully in the copper sulphate solution in test tube B for about 20 minutes [Fig. 1.8 (a)]. Keep one iron nail aside for comparison.
- After 20 minutes, take out the iron nails from the copper sulphate solution.
- Compare the intensity of the blue colour of copper sulphate solutions in test tubes (A) and (B) [Fig. 1.8 (b)].
- Also, compare the colour of the iron nails dipped in the copper sulphate solution with the one kept aside [Fig. 1.8 (b)].

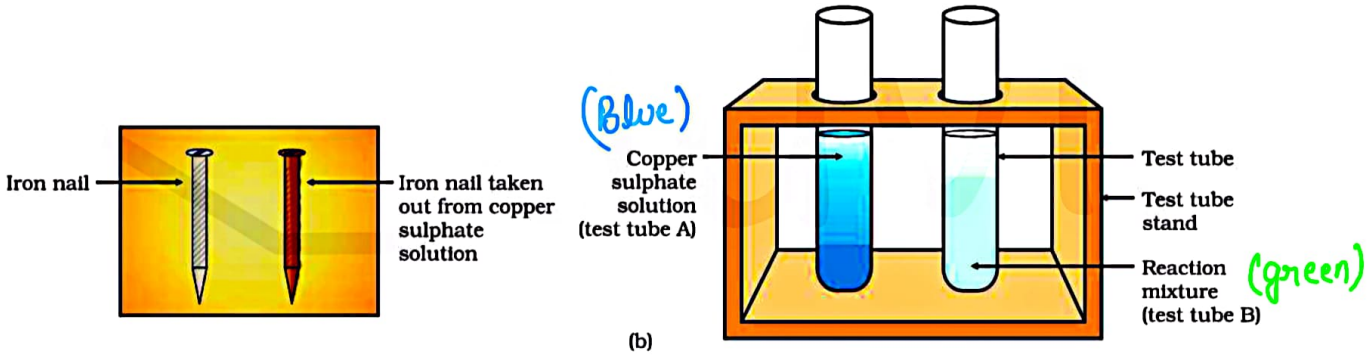


Figure 1.8 *(b) Iron nails and copper sulphate solutions compared before and after the experiment*

Q: Why does the iron nail become brownish in colour and the blue colour of copper sulphate solution fades?

The following chemical reaction takes place in this Activity–

$$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s) \quad (1.24)$$

(Copper sulphate) (Iron sulphate)

A: In this reaction, iron has displaced or removed another element, copper, from copper sulphate solution. This reaction is known as displacement reaction.

Other examples of displacement reactions are

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s) \quad (1.25)$$

(Copper sulphate) (Zinc sulphate)

$$Pb(s) + CuCl_2(aq) \rightarrow PbCl_2(aq) + Cu(s) \quad (1.26)$$

(Copper chloride) (Lead chloride)

Zinc and lead are more reactive elements than copper. They displace copper from its compounds.

Double Displacement Reaction (AB + CD ⟶ AD + CB)

Those reactions in which there is exchange of ions between two compounds to form two new compounds are called double displacement reactions. For example, when silver nitrate solution is added to sodium chloride solution, a white precipitate of silver chloride is formed alongwith sodium nitrate solution.

$$AgNO_{3(aq)} + NaCl_{(aq)} \longrightarrow AgCl_{(s)} + NaNO_{3(aq)}$$

white ppt.

Precipitation Reaction

Any reaction in which an insoluble solid (called precipitate) is formed that separates from the solution is called a precipitation reaction.

For example, when ammonium hydroxide solution is added to aluminium chloride solution, a white precipitate of aluminium hydroxide is formed alongwith ammonium chloride solution.

$$AlCl_{3(aq)} + 3NH_4OH_{(aq)} \longrightarrow Al(OH)_{3(s)} + 3NH_4Cl_{(aq)}$$

White ppt

Other Examples of Double Displacement Reactions:

S. No.	Example of Double Displacement Reaction	Chemical Equation
(1)	Lead (II) nitrate reacts with sodium chloride to produce sodium nitrate and a white precipitate of lead (II) chloride	$Pb(NO_3)_{2(aq)} + 2NaCl_{(aq)} \longrightarrow 2NaNO_{3(aq)} + PbCl_{2(s)}$ → white ppt. (insoluble in cold water but soluble in hot water)
(2)	Aluminium sulphate reacts with calcium hydroxide solution to produce a white precipitate of aluminium hydroxide and calcium sulphate solution.	$Al_2(SO_4)_{3(aq)} + 3Ca(OH)_{2(aq)} \longrightarrow 2Al(OH)_{3(s)} + 3CaSO_{4(aq)}$ → white ppt.

1.2.4 Double Displacement Reaction

Activity 1.10

- Take about 3 mL of sodium sulphate solution in a test tube.
- In another test tube, take about 3 mL of barium chloride solution.
- Mix the two solutions (Fig. 1.9).
- What do you observe?

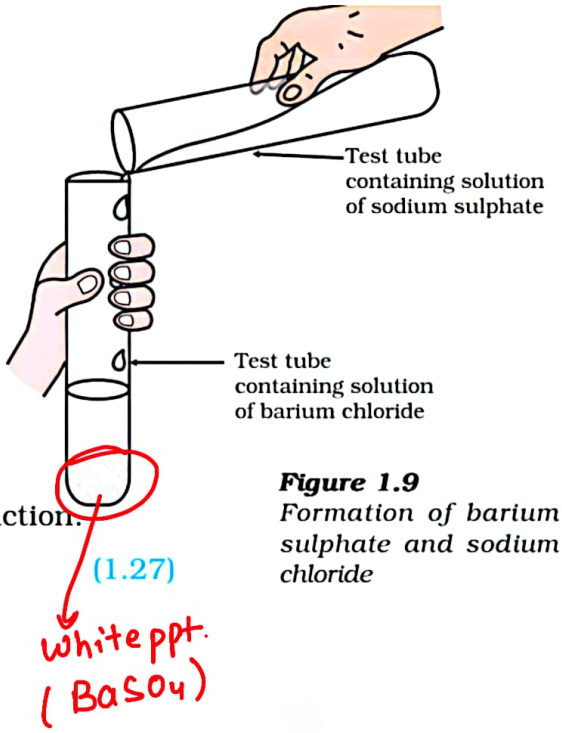


Figure 1.9 *Formation of barium sulphate and sodium chloride*

You will observe that a white substance, which is insoluble in water, is formed. This insoluble substance formed is known as a precipitate. Any reaction that produces a precipitate can be called a precipitation reaction.

$$\underset{\text{(Sodium sulphate)}}{Na_2SO_4(aq)} + \underset{\text{(Barium chloride)}}{BaCl_2(aq)} \rightarrow \underset{\text{(Barium sulphate)}}{BaSO_4(s)} + \underset{\text{(Sodium chloride)}}{2NaCl(aq)} \quad (1.27)$$

Recall Activity 1.2, where you have mixed the solutions of lead(II) nitrate and potassium iodide.

(i) What was the colour of the precipitate formed? Can you name the compound precipitated?

(ii) Write the balanced chemical equation for this reaction.

(iii) Is this also a double displacement reaction?

$$Pb(NO_3)_2(aq) + 2KI(aq) \longrightarrow 2KNO_3(aq) + PbI_2(s)$$

Yellow ppt

What is the difference between displacement and double displacement reactions?

In a displacement reaction a more reactive substance displaces a less reactive substance from its compound and salt solution whereas in a double displacement reaction Exchange of ions take place between the two reactant compounds.
In a displacement reaction, only a single displacement take place whereas in double displacement reaction two displacement take place between the molecules.

for ex:- $Mg + 2HCl \longrightarrow MgCl_2 + H_2$

$BaCl_2(aq) + K_2SO_4(aq) \rightarrow 2BaSO_4(s) + 2KCl(aq)$

Mg displace

Ba and K → displace

Oxidation Reaction

1) Addition of oxygen to a substance
2) Removal of hydrogen from a substance
3) Loss of electron

① $2Cu + O_2 \xrightarrow{Heat} 2CuO$

(Brown) (Black)

Addition of oxygen

(Activity 1.11)

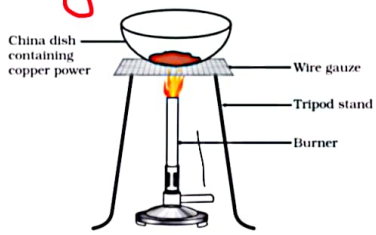


Figure 1.10
Oxidation of copper to copper oxide

Reduction Reaction

1) Addition of hydrogen to substance
2) Removal of oxygen from a substance
3) Gain of electron

Oxidising Agent

The substance which provides oxygen for oxidation or the substance which removes hydrogen. (i.e. Substance which gets reduced is the oxidising agent)

Reducing Agent

The substance which gives hydrogen for reduction or the substance which removes oxygen. (i.e. Substance which gets oxidised is the reducing agent)

Reduction (−O)

$MnO_2 + 4HCl \longrightarrow MnCl_2 + Cl_2 + 2H_2O$

(−H) Oxidation

Hydrochloric acid is oxidised to chlorine (as hydrogen is removed from HCl) and manganese dioxide is reduced to manganese dichloride (as oxygen is removed from MnO_2).

HCl is the reducing agent and MnO_2 is the oxidising agent.

In Reaction, one reactant get oxidised while the other gets reduced during a reaction. Such reactions are called oxidation-reduction reactions or redox reactions.

Chemical Equation	Substance Oxidized	Substance Reduced
$H_2S + Cl_2 \longrightarrow S + 2HCl$	Hydrogen sulphide to Sulphur	Chlorine to HCl
$ZnO + C \longrightarrow Zn + CO$	Carbon to carbon monoxide	Zinc oxide to zinc
$PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$	Lead sulphide is oxidized to lead sulphate	Hydrogen peroxide is reduced to water
$2PbO + C \longrightarrow 2Pb + CO_2$	Carbon to carbon dioxide	Lead oxide to lead

Identify the substances that are oxidised and the substances that are reduced in the following reactions.

(i) $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$

(ii) $CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(l)$

* Page 13

Ans: (i) $4Na(s) + O_2(g) \longrightarrow 2Na_2O(s)$

Na is oxidised to Na_2O as there is addition of oxygen and O_2 gets reduced.

(ii) $CuO(s) + H_2(g) \longrightarrow Cu(s) + H_2O(l)$

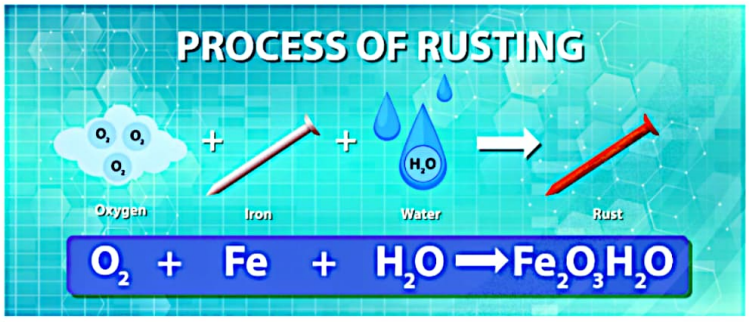
CuO gets reduced to Cu by losing oxygen and H_2 gets oxidised to H_2O by gaining oxygen.

EFFECTS OF OXIDATION REACTIONS IN EVERYDAY LIFE

Corrosion

The process in which metals are eaten up gradually by the action of air, moisture or a chemical such as acids on their surface is called corrosion.

eg: Rusting of iron metal is the most common form of corrosion. $4Fe + 3O_2 + 2x\,H_2O \longrightarrow 2Fe_2O_3 \cdot x\,H_2O$



Effect of corrosion:

Damage to bridges, iron railing, bodies of vehicles, ships and all objects made of metals like iron.

- **Black coating – silver**
- **Green coating – copper**

Why do we apply paint on iron articles?

If iron articles are left exposed, their surface comes in contact with the atmospheric oxygen and in the presence of moisture it forms Iron(III) oxide or rust. They are therefore painted to prevent them from rusting as the point does not allow the surface to come in contact with oxygen and moisture and thus prevents rusting.

Rancidity

The slow oxidation of fats and oils in foods marked by unpleasant smell and taste is called rancidity.

Prevention of Rancidity

(1) By adding anti-oxidants to foods containing fats and oils: Usually substances which prevent oxidation (antioxidants) are added to foods containing fats and oil. The two common anti-oxidants are BHA (Butylated Hydroxy-Anisole) and BHT (Butylated Hydroxy-Toluene).

(2) Keeping food in air tight containers helps to slow down oxidation.

(3) By packaging fat and oil containing foods in nitrogen gas : Chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting oxidized.

(4) By keeping food in a refrigerator.

(5) By storing foods away from light.

* NCERT

Oil and fat containing food items are flushed with nitrogen. Why?

Fried food items containing oil and fat get oxidised and become rancid in the presence of air or oxygen. As nitrogen is a comparatively unreactive gas as compared to oxygen, it prevents the oxidation of food items and hence prevents food from becoming rancid. That is why oil and fat containing food items are flushed with nitrogen gas.

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