1: Chemical Reaction and Equations

Introduction:

Physical Change	Chemical Change
A change of matter that occurs without changing the chemical composition of matter	A chemical change is the change of chemical composition of matter
Identity of matter doesn't lose	Identity of matter is changed
New products are not formed	New products are formed
It is usually reversible	It is usually irreversible
It is temporary change	It is permanent change
Physical change affects only physical properties, i.e. shape, size, physical state, etc.	Chemical change affects both physical and chemical properties of the substance, i.e. shape, size, colour, temperature, formation of precipitate, etc.
Examples: boiling of water, melting of an ice-cubes, breaking of glass, crumpling of paper	Examples: burning of paper, digestion of food, rusting of irons, food is cooked.

Chemical reactions are observed in daily life:

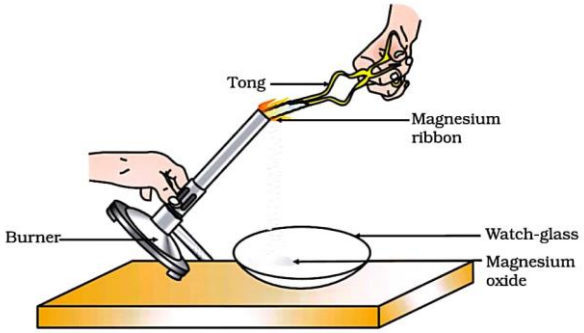
- Milk is left at room temperature during summers.
- An iron tawa/pan/nail is left exposed to humid atmosphere.
- Grapes get fermented.
- Food is cooked.
- Food gets digested in our body.
- We respire.

In all the above situations, the nature and the identity of the initial substance have somewhat changed.

Activity 1.1

(CAUTION: This Activity needs the teacher's assistance. I would be better if students wear eye protection.)

- **Clean a magnesium ribbon about 2 cm long by rubbing it with sandpaper. Hold it with a pair of tongs. burner and collect the ash so formed in a watch-glass as shown in Figure. Burn the magnesium ribbon keeping as far as possible from your eyes. What do you observe?**



Observation:

$2\ Mg_{(s)}$ (magnesium) + $O_{2\ (g)}$ (oxygen) → $2\ MgO_{(s)}$ (magnesium oxide) → White powder

magnesium ribbon burns with a dazzling white flame and changes into a white powder. This powder is magnesium oxide.

Activity 1.2

- **Take lead nitrate solution in a test tube. Add potassium iodide solution to this. What do you observe?**

$Pb(NO_3)_{2\ (aq)}$ (lead nitrate) + $KI_{(aq)}$ (potassium iodide) → $PbI_{2\ (s)}\downarrow$ (lead iodide) + $KNO_{3\ (aq)}$ (potassium nitrate)

Yellow precipitate

Observation:

When lead nitrate react with potassium iodide, we get yellow precipitate of lead iodide and potassium nitrate.

- **What is precipitate?**

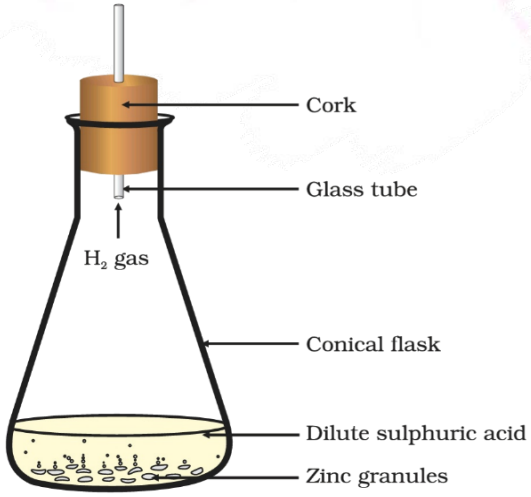
The insoluble substance in the solution is known as precipitate.

- **What is aqueous (aq) solution?**

The aqueous solution is a solution in which the solvent is water.

Activity 1.3

- **Take a few zinc granules in a conical flask or a test tube. Add dilute hydrochloric acid or sulphuric acid to this. (CAUTION: Handle the acid with care). Do you observe anything happening around the zinc granules? Touch the conical flask or test tube. Is there any change in its temperature?**



$Zn_{(s)}$ + $HCl_{(aq)}$ ⟶ $ZnCl_{2\,(aq)}$ + $H_{2\,(g)}$ + heat

(Zinc) (Hydrochloric acid) (Zinc chloride) (Hydrogen)

$Zn_{(s)}$ + $H_2SO_{4\,(aq)}$ ⟶ $ZnSO_{4\,(aq)}$ + $H_{2\,(g)}$ + heat

(Zinc) (Silphuric acid) (Zinc sulphate) (Hydrogen)

Exothermic Reaction

When zinc granules react with dilute HCl / dilute H_2SO_4, zinc displaced Hydrogen atom from H_2SO_4 / HCl and make $ZnSO_4$ and Hydrogen gas is evolved. And flask becomes hot, i.e., some amount of heat also release.
Therefore, this is also known as exothermic reaction.

1.1 Chemical Equations:

- A chemical equation is a symbolic representation of a chemical reaction. It shows the reactants (the starting substances) and the products (the substances formed) along with their respective quantities.
- **Components of a Chemical Equation:**
  1. **Reactants**: Substances that undergo a chemical change.
  2. **Products**: Substances that are produced as a result of the reaction.
  3. **Coefficients**: Numbers placed before the formulas to balance the equation and indicate the number of molecules or moles involved.
  4. **State Symbols**: Indicate the physical state of the substances: solid (s), liquid (l), gas (g), aqueous (aq).

Let's, take activity 1.1

- The burning of magnesium ribbon in presence of oxygen forms magnesium oxide. This description of a chemical reaction is quite long.
- Word equation would be

Magnesium + Oxygen ⟶ Magnesium Oxide

Reactants **Products**

The arrowhead point towards the products, and shows the direction of the reaction

1.1.1 Writing a chemical equation:

- Chemical equation is written more concisely by using chemical formulae instead of words,
- A chemical equation represents a chemical reaction.
  The chemical equation for magnesium, oxygen and magnesium oxide can be written as-

$Mg_{(s)}$ + $O_{2\,(g)}$ ⟶ $MgO_{(s)}$

(Magnesium) (Oxygen) (Magnesium oxide)

- In the above equation, mass and number of atoms are not same both side. Hence, this is an unbalanced chemical equation. It is also called skeletal chemical equation for the burning of magnesium in air.

1.1.2 Balanced chemical equation:

- A chemical reaction in which atoms of different elements of reactant and product side are equal then the chemical equation is called balanced chemical equation.
- According to the law of conservation of mass, mass can neither be created nor be destroyed.
- So, the mass of reactants should be equal to the mass of products.
- Number of atoms of each element should be equal on both side of the reaction for keeping mass constant.

▪ Consider the following equation :

$$\underset{\text{(Iron)}}{Fe} + \underset{\text{(Water)}}{H_2O} \rightarrow \underset{\text{(Iron (II, III) oxide)}}{Fe_3O_4} + \underset{\text{(Hydrogen)}}{H_2}$$

→ Displacement Reaction

Step for balancing the equation are as follows:

STEP 1: To balance a chemical equation, first draw boxes around each formula. Do not change anything inside the boxes while balancing the equation

$$\boxed{Fe} + \boxed{H_2O} \rightarrow \boxed{Fe_3O_4} + \boxed{H_2}$$

STEP 2: List the number of atoms of given elements present in the unbalanced equation

Element	Number of atoms in reactants	Number of atoms in products
Fe	1	3
H	2	2
O	1	4

STEP 3: Select the compound having maximum number of atoms and balance the element which have higher number of atoms .
Here, first balancing the number of oxygen atoms of Fe_3O_4 .

Atoms of Oxygen	In Reactants	In Product
1. Initial	1 (in H_2O)	4 (In Fe_3O_4)
2. To balance	1 × 4	4

$$\boxed{Fe} + 4\boxed{H_2O} \rightarrow \boxed{Fe_3O_4} + \boxed{H_2}$$

STEP 4: H and Fe atoms are still not balanced . Now balance the H atoms. to equalise the number of H atoms , multiply the number of molecules of H_2 by 4 in right side.

Atoms of hydrogen	In reactants	In products
1. Initial	8 (in H_2O)	2 (in H_2)
2. To balance	8	2 × 4

$$Fe + 4\,H_2O \rightarrow Fe_3O_4 + 4\,H_2$$

STEP 5: Fe atoms are still not balanced. To equalise the number of Fe atoms, Multiply the Fe by 3 on left side.

$$3\,Fe + 4\,H_2O \rightarrow Fe_3O_4 + 4\,H_2$$

STEP 6: Remove the box (☐)

$$\underset{\text{(Iron)}}{3\,Fe_{(s)}} + \underset{\text{(Water)}}{4\,H_2O_{(l)}} \rightarrow \underset{\text{(Iron (II, III) oxide)}}{Fe_3O_{4\,(s)}} + \underset{\text{(Hydrogen)}}{4\,H_{2(g)}}$$

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 –

$$CO_{(g)} + 2\,H_{2\,(g)} \xrightarrow{340\ atm} CH_3OH_{(l)}$$

Photo synthesis process reaction

$$6\,CO_{2\,(aq)} + 12\,H_2O_{(l)} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \underset{\text{(Glucose)}}{C_6H_{12}O_{6\,(aq)}} + 6\,O_{2\,(aq)} + 6\,H_2O_{(l)}$$

In-text Questions Page 6:

1. Why should a magnesium ribbon be cleaned before burning in air?

Ans. Magnesium ribbon is more reactive and when it is exposed to air, A layer of MgO is formed on its surface

$$2\,Mg_{(s)} + O_{2\,(g)} \rightarrow 2\,MgO_{(s)}$$

This layer of MgO is removed by rubbing with sand paper before burning in air. Therefore, magnesium ribbon easily react with oxygen. Thus, magnesium ribbon is cleaned before burning in air.

2. Write the balanced equation for the following chemical reactions.

(i) Hydrogen + Chlorine → Hydrogen chloride

Ans.

$$H_{2\,(g)} + Cl_{2\,(g)} \rightarrow 2\,HCl_{(g)}$$

(ii) Barium chloride + Aluminium sulphate → Barium sulphate + Aluminium chloride

Ans.

$$3\,BaCl_{2\,(aq)} + Al_2(SO_4)_{3\,(aq)} \rightarrow 3\,BaSO_{4\,(s)} + 2\,AlCl_{3\,(aq)}$$

(iii) Sodium + Water → Sodium hydroxide + Hydrogen

Ans.

$$Na_{(s)} + H_2O_{(l)} \rightarrow 2\,NaOH_{(aq)} + H_{2\,(g)}$$

3. Write a balanced chemical equation with state symbols for the following reactions.

(i) Solutions of barium chloride and sodium sulphate in water react to give insoluble barium sulphate and the solution of sodium chloride.

Ans.

$BaCl_{2\,(aq)}$ (barium chloride) + $Na_2SO_{4\,(aq)}$ (sodium sulphate) → $BaSO_{4\,(s)}$ (barium sulphate) + $NaCl_{\,(aq)}$ (sodium chloride)

(ii) Sodium hydroxide solution (in water) reacts with hydrochloric acid solution (in water) to produce sodium chloride solution and water.

Ans.

$NaOH_{\,(aq)}$ (Sodium hydroxide) + $HCl_{\,(aq)}$ (hydrochloric acid) → $NaCl_{\,(aq)}$ (sodium chloride) + $H_2O_{\,(l)}$ (water)

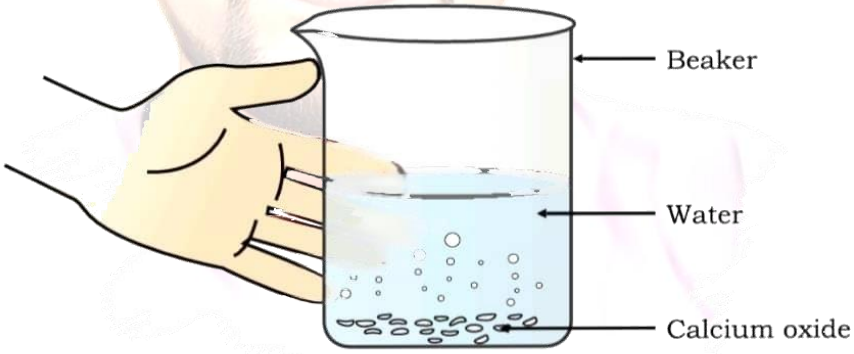
1.2 Types of chemical reaction:

1.2.1 Combination Reaction:

- The reaction in which two or more substance combine to form a new single substance.

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.
- 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.

$CaO_{(s)}$ (Quick lime) + $H_2O_{\,(l)}$ (Water) → $Ca(OH)_{2\,(aq)}$ (Slaked lime) + Heat

Heat: **Exothermic & combination**

$Ca(OH)_2$ (Slaked lime): Use for white washing

- $Ca(OH)_2$ slaked lime is used for white washing walls.
- It reacts with CO_2 to form $CaCO_3$ and gives a shiny finish to the walls.

$Ca(OH)_{2\,(aq)}$ (Calcium hydroxide) + $CO_{2\,(g)}$ (Carbon dioxide) → $CaCO_{3\,(s)}$ (Calcium carbonate) + $H_2O_{\,(l)}$ (Water)

$CaCO_3$ (Calcium carbonate): Reason for shiny walls

- some more examples of combination reactions:

(i) Burning of coal

$C_{(s)} + O_{2\,(g)} \rightarrow CO_{2\,(g)}$

(ii) Formation of water from $H_{2\,(g)}$ and $O_{2\,(g)}$

$2\,H_{2\,(g)} + O_{2\,(g)} \rightarrow 2\,H_2O_{\,(l)}$

Exothermic Reaction:

- Reaction in which heat is released along with the formation of products.

- Example of Exothermic Reaction
  - Burning of natural gas

$CH_{4\,(g)} + 2\,O_{2\,(g)} \rightarrow CO_{2\,(g)} + 2\,H_2O_{\,(g)} + \text{heat}$

(Methane) (Oxygen) (Carbon dioxide) (Water)

  - Respiration is also exothermic reaction.
  - Decomposition of vegetable matter into compost.

Exothermic

❖ What is Respiration?

- We all know that we need energy to stay alive. We get this energy from the food we eat.
- During digestion, food is broken down into simpler substance.
- For example: rice, potato and bread contain carbohydrates.
- These carbohydrates are broken down to form glucose.
- This glucose combines with oxygen in the cells of our body and provide energy. This reaction is known as respiration.

$C_6H_{12}O_{6\,(aq)} + 6\,O_{2\,(aq)} \rightarrow 6\,CO_{2\,(aq)} + 6\,H_2O_{\,(l)} + \text{energy}$

(Glucose) (Oxygen) (Carbon dioxide) (Water)

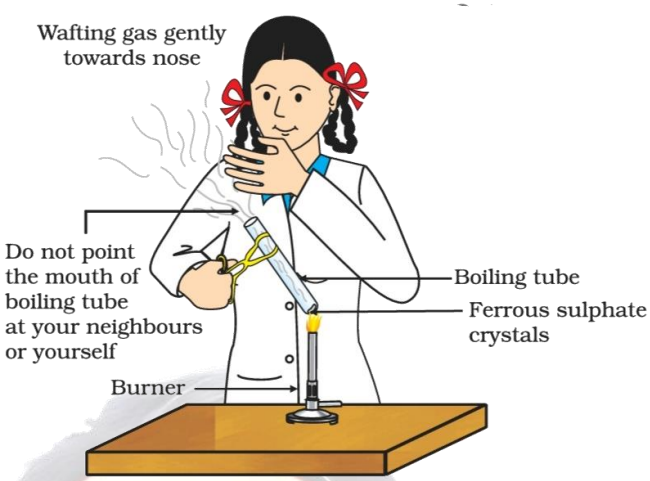
Exo - thermic

1.2.2 Decomposition Reaction:

- The Reaction in which a single substance breakdown and forms two or more substances is called decomposition reaction.

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.
- Observe the colour of the crystals after heating.



- Ferrous sulphate crystals are green in colour and have 7 molecules of crystalline water.

$$FeSo_4 \cdot 7\,H_2O\ (s) \xrightarrow{\text{heat}} FeSO_4\ (s) + 7\,H_2O\ (g)$$

(Ferrous sulphate crystal) → (Ferrous sulphate) + (Water)

Green color

Endo thermic

- When ferrous sulphate further decomposes, it gives a reddish brown residue of ferric oxide and fumes of sulphur dioxide and sulphur trioxide evolve.

Strong irritating smell

Reddish brown residue

$$2\,FeSO_4\ (s) \xrightarrow{\text{heat}} Fe_2O_3\ (s) + SO_2\ (g) + SO_3\ (g)$$

(Ferrous sulphate) → (Ferric oxide) + (Sulphur dioxide) + (Sulphur trioxide)

Endo-thermic

- Calcium carbonate to calcium oxide and carbon dioxide on heating is an important decomposition reaction used in various industries.
- Calcium oxide is called lime or quick lime. It has many uses – one is in the manufacture of cement.
- When decomposition reaction is carried out by heating, it is called thermal decomposition.

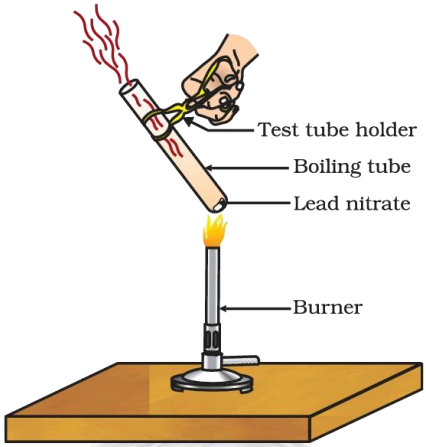
$$CaCO_3\ (s) + Heat \rightarrow CaO\ (s) + CO_2\ (g)$$

(Lime stone) → (Quick lime) + (Carbon dioxide)

endothermic

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.
- What do you observe? Note down the change, if any.



- On heating of lead nitrate, we get lead oxide (PbO) and you will observe the emission of brown fumes of nitrogen dioxide (NO_2) and oxygen gas are evolved.

$2\ Pb(NO_3)_2\ (S)$ + Heat → $2\ PbO\ (S)$ + $4\ NO_2\ (g)$ + $O_2\ (g)$

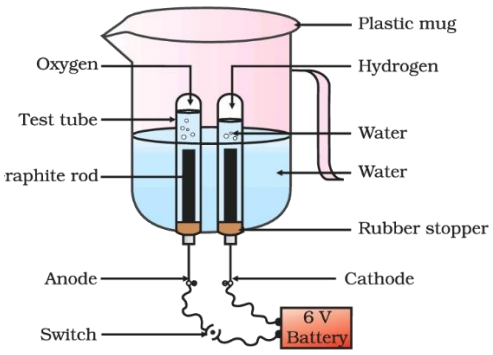
(Lead nitrate) (lead oxide) (Nitrogen dioxide) (Oxygen)

Endo thermic

Brown fumes

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.
- 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?



- The bubbles produced by the passing current, hydrogen gas collected in test tube placed at cathode (-ve electrode) and oxygen gas collected in test tube placed at anode (+ve electrode).

$$2\,H_2O_{(l)} \xrightarrow{\text{electrolysis}} 2\,H_{2(g)} + O_{2(g)}$$

(Water) → (Hydrogen) + (Oxygen)

endothermic

- The volume of hydrogen collected will be twice the volume of oxygen.

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.
- Observe the colour of the silver chloride after some time.

- 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.
- The below two reactions are used in black and white photography.
- Exposure of silver chloride to sunlight:

White silver chloride

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

(Silver chloride) → (Silver) + (Chlorine)

grey

- Silver bromide behaves similarly.

$$2\,AgBr_{(s)} \xrightarrow{\text{Sunlight}} 2\,Ag_{(s)} + Br_{2(g)}$$

(Silver chloride) → (Silver) + (Chlorine)

Endo-thermic

Endothermic Reaction:

The reaction in which energy is required in the form of heat, light or electricity are called endothermic reaction.

- 2g barium hydroxide in a test tube. Add 1g of ammonium chloride and mix with the help of a glass rod.

- Touch the bottom of the test tube with your plam , you can observe that the temperature is decreased .

Carry out activity page 10
2g barium hydroxide in a test tube. Add 1g of ammonium chloride and mix with the help of a glass rod.
$Ba(OH)_{2\,(aq)} + 2\,NH_4Cl_{\,(aq)} \rightarrow BaCl_{2\,(aq)} + 2\,NH_{3\,(g)} + 2\,H_2O_{\,(l)}$ (barium hydroxide) (ammonium chloride) (barium chloride) (ammonia) (Water) Touch the bottom of the test tube with your plam , you can observe that the temperature is decreased.

Endo-thermic

In-text Questions Page 10

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.

Ans. (i) Substance X is calcium oxide. Its formula is CaO.

(ii) Calcium oxide reacts vigorously with water and formed slaked lime $Ca(OH)_2$ and release large amount heat. It is an exothermic reaction.

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

(Quick lime) (Water) (Slaked lime)

exothermic

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.

Ans.

- Hydrogen and oxygen obtained separately during the electrolysis of water
- Water is made up of two parts of hydrogen and one part of oxygen.
- Hence, two parts of hydrogen gas in one test tube and one part of oxygen gas in another test tube.
- Hence, hydrogen and oxygen gases are obtained in the ratio 2:1 by volume

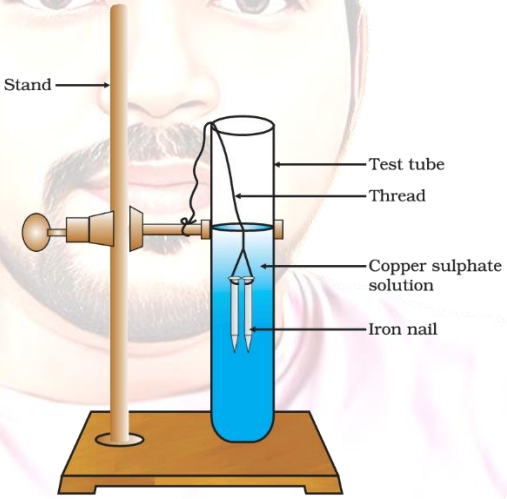
- **Thermal Decomposition**: Decomposition caused by heat.
- **Electrolytic Decomposition**: Decomposition caused by an electric current.
- **Photolytic Decomposition**: Decomposition caused by light.

1.2.3 Displacement Reaction:

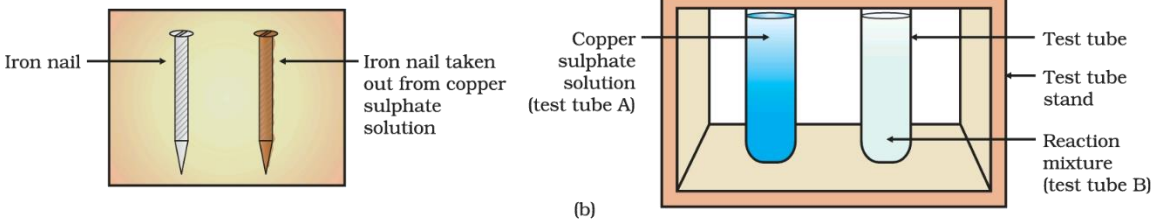
- The chemical reaction in which high reactive element displaces another low reactive element from its solution is called displacement reaction.

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. (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. (b)].
- Also, compare the colour of the iron nails dipped in the copper sulphate solution with the one kept aside [Fig. (b)].



(a)



(b)

- When iron nails dipped into the copper sulphate solution, iron displaced copper from copper sulphate solution and make iron sulphate solution.
- The nail becomes brownish in colour and the blue colour of copper sulphate solution fade and it becomes green colour of iron sulphate solution.

$$Fe_{(s)} + CuSO_{4\,(aq)} \rightarrow FeSO_{4\,(aq)} + Cu_{(s)}$$
(Iron) (Copper Sulphate) (Iron sulphate) (Copper)

$FeSO_4$ – Green colour

$CuSO_4$ – Blue colour

Other Examples,

$$Zn_{(s)} + CuSO_{4\,(aq)} \rightarrow ZnSO_{4\,(aq)} + Cu_{(s)}$$
(Zinc) (copper sulphate) (Zinc sulphate) (Copper)

$$Pb_{(s)} + CuCl_{2\,(aq)} \rightarrow PbCl_{2\,(aq)} + Cu_{(s)}$$
(Lead) (copper chloride) (Lead chloride) (Copper)

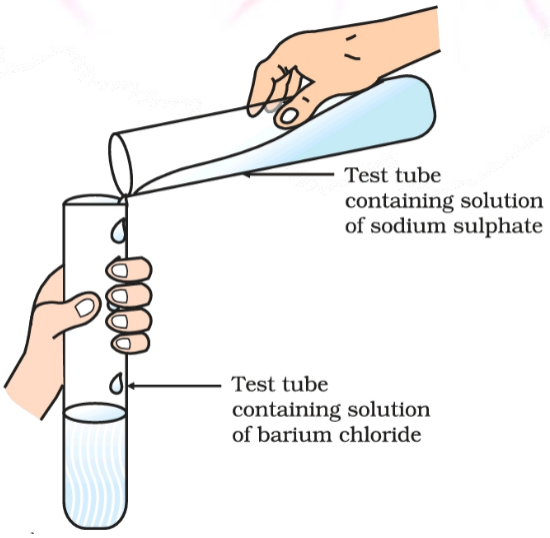
Zinc and lead are more reactive elements than copper.
They displaced copper from its compounds.

1.2.4 Double Displacement Reaction:

- Reaction in which there is an exchange of ions between the reactants are called 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.)
- What do you observe?



Na_2SO_4 (aq) + $BaCl_2$ (aq) → $BaSO_4$ (s) + 2 NaCl (aq)

(Sodium sulphate) (Barium chloride) (Barium sulphate) (Sodium Chloride)

White precipitate

- In this activity, we can see that exchange of ions between two compounds sodium sulphate and barium chloride.
- A white substance of Barium sulphate is formed due to above reaction.
- The insoluble substance is called precipitate.
- Any reaction that produces a precipitate can be called a precipitation reaction.

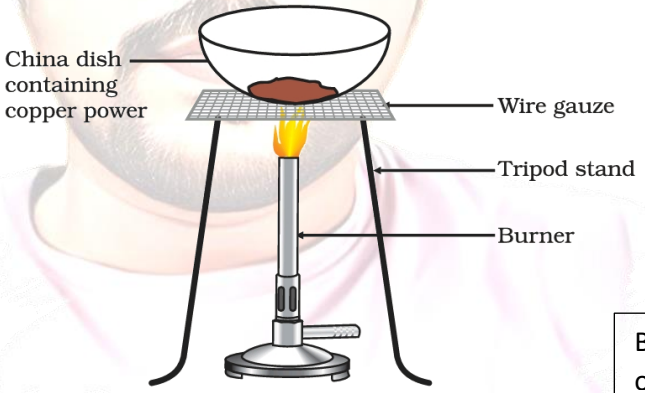
1.2.5 Oxidation and Reduction:

(1) Oxidation: Oxidation is the gain of oxygen or loss of hydrogen.

(2) Reduction: Reduction is the loss of oxygen or gain of hydrogen.

Activity 1.11:

- Heat a china dish containing about 1 g copper powder (Fig).
- What do you observe?



Black copper oxide

$2Cu_{(S)}$ + $O_{2(g)}$ —heat→ $2CuO_{(S)}$

(Copper) (Oxygen) (copper oxide)

Endo-thermic

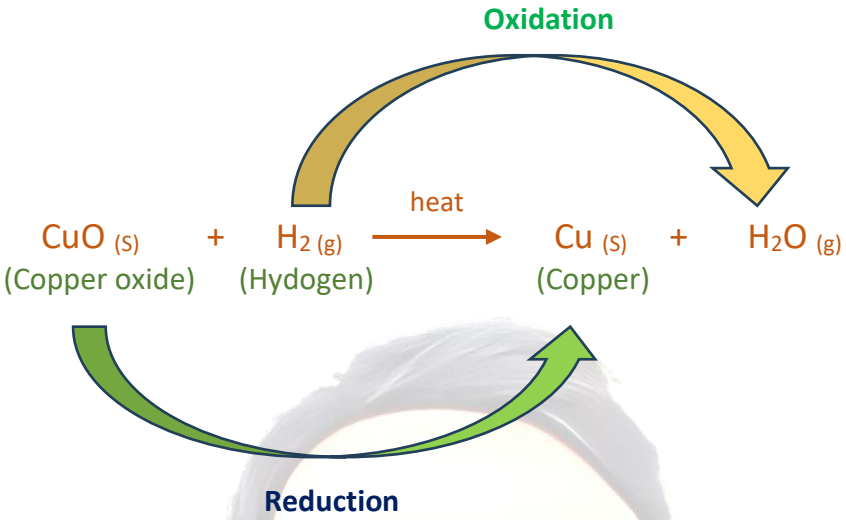
- When copper is heated , a black colour of copper (II) oxide appears.
- If this CuO is reacted with hydrogen gas then again Cu becomes brown as reserve reactions take places.

$CuO_{(S)}$ + $H_{2(g)}$ —heat→ $Cu_{(S)}$ + $H_2O_{(g)}$

(Copper oxide) (Hydogen) (Copper)

Redox reaction

- The reaction in which one reactant gets oxidised while other gets reduced.



Here,in above redox reaction, hydrogen gets oxidised and Copper becomes reduced.

- Other examples of Redox reaction:

$ZnO_{(aq)} + C_{(S)} \rightarrow Zn_{(S)} + CO_{(g)}$
(Zinc oxide) (Carbon) (Zinc) (carbon monoxide)

$MnO_{2\,(s)} + 4\,HCl_{(aq)} \rightarrow MnCl_{2\,(aq)} + 2\,H_2O_{(l)} + Cl_{2\,(g)}$
(Manganese oxide) (Hydrochloric acid) (Manganese chloride) (Water) (Chlorine)

1.3 Effects of oxidation reaction in daily life:

Corrosion

- When a metal is attacked by substance around it such as moisture, acids etc.
- Corrosion cause damage to car bodies, bridges, iron, railings, ships, and to all objects made of metals, specially those of iron.
- iron articles are shiny when new, but get coated with a reddish brown powder when left for some time. This process is commonly known as rusting of iron. Some other metals also get tarnished in this manner.

e.g.,
(1) Reddish brown coating on iron
(2) Black coating on silver.
(3) Green coating on copper.

Rancidity

- When fats and oils are oxidised they becomes rancid and their smell and taste changed.
- Antioxidants are added to foods containing fats and oils.
- Keeping food in air tight containers helps to slow down oxidation.
- chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting oxidised

In-text questions page 13:

1. **Why does the colour of copper sulphate solution change when an iron nail is dipped in it?**

Ans.

- When an iron nail dipped in copper sulphate solution, iron being more reactive than copper.
- So it displaced copper from solution and iron sulphate is formed, which is green in colour.
- Thus, colour of copper sulphate solution changes.

$Fe_{(s)}$ + $CuSO_{4\,(aq)}$ → $FeSO_{4\,(aq)}$ + $Cu_{(s)}$

(Iron) (Copper Sulphate) (Blue colour) (Iron sulphate) (Green colour) (Copper)

2. **Give an example of a double displacement reaction other than the one given in Activity 1.10.**

Ans.

- When lead nitrate react with potassium iodide, we get yellow precipitate of lead iodide and potassium nitrate.

$Pb(NO_3)_{2\,(aq)}$ + $KI_{(aq)}$ → $PbI_{2\,(s)}\downarrow$ + $KNO_{3\,(aq)}$

(lead nitrate) (potassium iodide) (lead iodide) (potassium nitrate)

- Here, we can see that the exchange of ions between two compounds lead nitrate and potassium and make lead iodide and potassium nitrate.

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

(i) $4\,Na_{(s)} + O_{2\,(g)} \rightarrow 2\,Na_2O_{(s)}$

- Sodium (Na) metal gets oxidised.
- Oxygen (O) gets reduced.

(ii) $CuO_{(s)} + H_{2\,(g)} \rightarrow Cu_{(s)} + H_2O_{(l)}$

- Hydrogen (H) gets oxidised
- Copper (Cu) gets reduced.

Textual Exercise

1. Which of the statements about the reaction below are incorrect?

$2\ PbO_{(s)} + C_{(s)} \rightarrow 2\ Pb_{(s)} + CO_{2\,(g)}$

(a) Lead is getting reduced.
(b) Carbon dioxide is getting oxidised.
(c) Carbon is getting oxidised.
(d) Lead oxide is getting reduced.

(i) (a) and (b) ✓
(ii) (a) and (c)
(iii) (a), (b) and (c)
(iv) all

2. $Fe_2O_3 + 2\ Al \rightarrow Al_2O_3 + 2\ Fe$
The above reaction is an example of a
(a) combination reaction.
(b) double displacement reaction.
(c) decomposition reaction.
(d) displacement reaction. ✓

3. What happens when dilute hydrochloric acid is added to iron fillings? Tick the correct answer.
(a) Hydrogen gas and iron chloride aare produced. ✓
(b) Chlorine gas and iron hydroxide are produced.
(c) No reaction takes place.
(d) Iron salt and water are produced.

4. What is a balanced chemical equation? Why should chemical equations be balanced?
Ans.

- A chemical reaction in which atoms of different elements of reactant and product side are equal then the chemical equation is called balanced chemical equation.
- According to the law of conservation of mass, mass can neither be created nor be destroyed.
- So, the mass of reactants should be equal to the mass of products.
- Number of atoms of each element should be equal on both side of the reaction for keeping mass constant.
- Hence, it is necessary to balance the chemical equation.

5. Translate the following statements into chemical equations and then balance them.

(a) Hydrogen gas combines with nitrogen to form ammonia.

$N_{2\,(g)}$ + $3\ H_{2\,(g)}$ → $2\ NH_{3\,(g)}$

(Nitrogen) (Hydrogen) (Ammonia)

(b) Hydrogen sulphide gas burns in air to give water and sulphur dioxide.

$2\ H_2S_{\,(g)}$ + $3\ O_{2\,(g)}$ → $2\ SO_{2\,(g)}$ + $2\ H_2O_{\,(l)}$

(Hydrogen sulphide) (Oxygen) (sulphur dioxide) (Water)

(c) Barium chloride reacts with aluminium sulphate to give aluminium chloride and a precipitate of barium sulphate.

$3\ BaCl_{2\,(aq)}$ + $Al_2(SO_4)_{3\,(aq)}$ → $3\ BaSO_{4\,(s)}$ + $2\ AlCl_{3\,(aq)}$

(Barium chloride) (Aluminium sulphate) (Barium sulphate) (Aluminium chloride)

(d) Potassium metal reacts with water to give potassium hydroxide and hydrogen gas.

$2\ K_{\,(S)}$ + $2\ H2O_{\,(l)}$ → $2\ KOH_{\,(aq)}$ + $H_{2\,(g)}$

(Potassium) (Water) (potassium hydroxide) (hydrogen gas)

6. Balance the following chemical equations.

(a) $HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + H_2O$

(b) $NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$

(c) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

(d) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + HCl$

Ans.

(a) **2** HNO_3 + $Ca(OH)_2$ → $Ca(NO_3)_2$ + **2** H_2O

(b) **2** $NaOH$ + H_2SO_4 → Na_2SO_4 + **2** H_2O

(c) $NaCl$ + $AgNO_3$ → $AgCl$ + $NaNO_3$

(d) $BaCl_2$ + H_2SO_4 → $BaSO_4$ + **2** HCl

7. Write the balanced chemical equations for the following reactions.

(a) Calcium hydroxide + Carbon dioxide → Calcium carbonate + Water

Ans.

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

(b) Zinc + Silver nitrate → Zinc nitrate + Silver

Ans.

$Zn_{(s)}$ + $2\ AgNO_{3\,(aq)}$ → $Zn(NO_3)_{2\,(aq)}$ + $2\ Ag_{(s)}$

(c) Aluminium + Copper chloride → Aluminium chloride + Copper

Ans.

$2\ Al_{(s)}$ + $3\ CuCl_{2\,(aq)}$ → $2\ AlCl_{3\,(aq)}$ + $3\ Cu_{\,(s)}$

(d) Barium chloride + Potassium sulphate → Barium sulphate + Potassium chloride

Ans.

$BaCl_{2\,(aq)}$ + $K_2SO_{4\,(aq)}$ → $BaSO_{4\,(s)}$ + $2\ KCl_{\,(aq)}$

8. Write the balanced chemical equation for the following and identify the type of reaction in each case.

(a) Potassium bromide(aq) + Barium iodide(aq) → Potassium iodide(aq) + Barium bromide(s)

$2\ KBr_{(aq)} + BaI_{2(aq)} \rightarrow 2\ KI_{(aq)} + BaBr_{2(s)}$

Given reaction is a double displacement reaction.

(b) Zinc carbonate(s) → Zinc oxide(s) + Carbon dioxide(g)

$$ZnCO_{3(s)} \xrightarrow{\text{heat}} ZnO_{(s)} + CO_{2(g)}$$

Given reaction is a thermal decomposition reaction.

(c) Hydrogen(g) + Chlorine(g) → Hydrogen chloride(g)

$$H_{2(g)} + Cl_{2(g)} \rightarrow 2\ HCl_{(g)}$$

Given reaction is a combination reaction.

(d) Magnesium(s) + Hydrochloric acid(aq) → Magnesium chloride(aq) + Hydrogen(g)

$$Mg_{(s)} + 2\ HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$

Given reaction is a displacement reaction.

9. What does one mean by exothermic and endothermic reactions? Give examples.
Ans.

Exothermic reaction: A chemical reaction in which heat energy is evolved during the formation of product is called an exothermic reaction.

For example, Combustion of natural gas (methane) is an exothermic reaction.

$$\underset{\text{(Methane)}}{CH_{4(g)}} + \underset{\text{(Oxygen)}}{2\ O_{2(g)}} \rightarrow \underset{\text{(Carbon dioxide)}}{CO_{2(g)}} + \underset{\text{(Water)}}{2\ H_2O_{(g)}} + \text{heat}$$

Endothermic reaction: A chemical reaction in which heat is absorbed during the formation of products is called an endothermic reaction.

For example, Decomposition of silver chloride in presence of sunlight is called an endothermic reaction.

$$\underset{\text{(silver chloride)}}{2\ AgCl_{(s)}} \xrightarrow{\text{sunlight}} \underset{\text{(Silver)}}{2\ Ag_{(s)}} + \underset{\text{(Chlorine)}}{Cl_{2(g)}}$$

10. Why respiration is considered an exothermic reaction? Explain.
Ans.

- We all know that we need energy to stay alive. We get this energy from the food we eat.
- During digestion, food is broken down into simpler substance.
- For example: rice, potato and bread contain carbohydrates.
- These carbohydrates are broken down to form glucose.
- This glucose combines with oxygen in the cells of our body and provide energy. This reaction is known as respiration.
- Here we get the energy after breakdown. So respiration is exothermic reaction.

$$\underset{\text{(Glucose)}}{C_6H_{12}O_{6(aq)}} + \underset{\text{(Oxygen)}}{6\ O_{2(aq)}} \rightarrow \underset{\text{(Carbon dioxide)}}{6\ CO_{2(aq)}} + \underset{\text{(Water)}}{6\ H_2O_{(l)}} + \text{energy}$$

Exo - thermic

11. Why decomposition reactions are called the opposite of combination reactions?

Write equations for these reactions.
Ans.

In decomposition reaction, a single molecule of reactant by absorbing heat is broken down into two or more products (atoms), while in combination reaction, opposite phenomenon to decomposition reaction is observed. In combination reaction, to or more substance (elements or compounds) combine to from a single product with heat change.

Decomposition reactions:

AB + Energy → A + B

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

(silver chloride) (Silver) (Chlorine)

Combination reactions:

A + B → AB + Energy

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + \text{Energy}$

(Carbon) (Oxygen) (Carbon dioxide)

12. Write one equation each for decomposition reactions where energy is supplied in the form of heat, light or electricity.
Ans.

Decomposition by heat:

$CaCO_{3(s)} \xrightarrow{\text{heat}} CaO_{(s)} + CO_{2(g)}$

(Calcium carbonate) (Calcium oxide) (Carbon dioxide)

Decomposition by light:

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

(silver chloride) (Silver) (Chlorine)

Decomposition by electricity:

$2\,H_2O_{(l)} \xrightarrow{\text{electrolysis}} 2\,H_{2(g)} + O_{2(g)}$

(Water) (Hydrogen) (oxygen)

13. What is the difference between displacement and double displacement reactions? Write equations for these reactions.
Ans.

In displacement reaction, more reactive element displaces less reactive element from its solution. For example, In case of Zn and Ag, Zn being more reactive than Ag, it displaces Ag from its solution of $AgNO_3$.

(i) $Zn_{(s)} + 2\,AgNO_{3(aq)} \rightarrow Zn(NO_3)_{2(aq)} + 2\,Ag_{(s)}$

(zinc) (silver nitrate) (zinc nitrate) (silver)

Similarly, Fe being more reactive displaces Cu from $CuSO_4$ solution.

(ii) $Fe_{(s)} + CuSO_{4(aq)} \rightarrow FeSO4_{(aq)} + Cu_{(s)}$

(iron) (copper sulphate) (iron sulphate) (copper)

In double displacement reaction, two compounds exchange their ions to form two new compounds.

For example,

(i) $Na_2SO_{4\,(aq)}$ + $BaCl_{2\,(aq)}$ → $BaSO_{4\,(s)}$ + $2\,NaCl_{\,(aq)}$

(sodium sulphate) (barium chloride) (barium sulphate) (sodium chloride)

(ii) $2\,KBr_{\,(aq)}$ + $BaI_{2\,(aq)}$ → $2\,KI_{\,(aq)}$ + $BaBr_{2\,(s)}$

(potassium bromide) (barium iodide) (potassium iodide) (barium bromide)

14. In the refining of silver, the recovery of silver from silver nitrate solution involved displacement by copper metal. Write down the reaction involved.

Ans.

$Cu_{\,(s)}$ + $2\,AgNO_{3\,(aq)}$ → $Cu(NO_3)_{2\,(aq)}$ + $2\,Ag_{\,(aq)}$

(copper) (silver nitrate) (copper nitrate) (silver)

15. What do you mean by a precipitation reaction? Explain by giving examples.

Ans.

Chemical reaction, in which rectants react to form insoluble precipitate is called precipitation reaction.

For example,

(i) $AgNO_{\,3(aq)}$ + $NaCl_{\,(aq)}$ → $AgCl_{\,(s)}$ + $NaNO_{3\,(aq)}$

(silver nitrate) (sodium chloride) (silver chloride) (sodium nitrate)

White precipitate

(ii) $BaCl_{2\,(aq)}$ + $K_2SO_{4\,(aq)}$ → $BaSO_{4\,(s)}$ + $2\,KCl_{(aq)}$

(barium chloride) (potassium sulphate) (barium sulphate) (potassium chloride)

White precipitate

16. Explain the following in terms of gain or loss of oxygen with two examples each.

(a) Oxidation: Oxidation is the gain of oxygen or loss of hydrogen.

Examples:

(i) $2\,Cu_{\,(S)}$ + $O_{2\,(g)}$ $\xrightarrow{\text{heat}}$ $2\,CuO_{(S)}$

(Copper) (Oxygen) (copper oxide)

(ii) $C_{\,(s)}$ + $O_{2\,(g)}$ ⟶ $CO_{2\,(g)}$ + Energy

(Carbon) (Oxygen) (Carbon dioxide)

(b) Reduction: Reduction is the loss of oxygen or gain of hydrogen.

Examples:

(i) $CuO_{\,(S)}$ + $H_{2\,(g)}$ $\xrightarrow{\text{heat}}$ $Cu_{\,(S)}$ + $H_2O_{\,(g)}$

(Copper oxide) (Hydogen) (Copper)

(ii) $CO_{2\,(g)}$ + $H_{2\,(g)}$ ⟶ $CO_{\,(g)}$ + $H_2O_{\,(l)}$

(carbon dioxide) (hydrogen) (carbon monpoxide) (water)

17. A shiny brown coloured element 'X' on heating in air becomes black in colour. Name the element 'X' and the black coloured compound formed.

Ans.

- Here, element 'X' is copper (Cu). When it is heated in air, it forms black coloured copper oxide (CuO).

- For example,

$$2\,Cu_{(S)} + O_{2\,(g)} \xrightarrow{\text{heat}} 2\,CuO_{(S)}$$

(Copper) (Oxygen) (copper oxide)

18. Why do we apply paint on iron articles?

Ans.

- Iron objects undergo rusting due to the metal corrosion; hence, surface of iron is coated with paint to prevent it from rusting.
- As a result, iron does not come in contact with air.
- Thus, iron objects remain safe for longer period and rusting does not occur.

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

Ans.

- When fats and oils are **oxidised** and they becomes rancid and their smell and taste changed.
- **Antioxidants** are added to foods containing fats and oils.
- So, oil and food containing food items are flushed bags of chips with gas such as nitrogen to prevent the chips from getting oxidised.

20. Explain the following terms with one example each.

(a) Corrosion:

- When a metal is attacked by substance around it such as moisture, acids etc.
- Corrosion cause damage to car bodies, bridges, iron, railings, ships, and to all objects made of metals, specially those of iron.
- iron articles are shiny when new, but get coated with a reddish brown powder when left for some time. This process is commonly known as rusting of iron. Some other metals also get tarnished in this manner.

  e.g.,
  (1) Reddish brown coating on iron
  (2) Black coating on silver.
  (3) Green coating on copper.

(b) Rancidity:

- When fats and oils are oxidised they becomes rancid and their smell and taste changed.
- Antioxidants are added to foods containing fats and oils.
- Keeping food in air tight containers helps to slow down oxidation.
- Chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting oxidised.