1 Chemical Reactions and Equations

Introduction

Changes are like Permanent changes, Temporary changes, Natural changes, Artificial changes

Again changes are classified into types.

1. Physical Changes 2. Chemical Changes

1.1 Chemical Reaction

A chemical reaction is a process in which one or more substances (reactants) are transformed into one or more new substances (products) with different properties. During a chemical reaction, chemical bonds are broken and new bonds are formed, leading to the creation of new compounds.

1.2 Characteristics of Chemical Reactions:

a. Change in Color: A color change indicates the formation of new substances.

Example: When iron rusts, it changes color from metallic gray to reddish-brown.

b. Change in Temperature: Some reactions release heat (exothermic reactions), while others absorb heat (endothermic reactions).

Example: Burning of wood releases heat (exothermic), and photosynthesis absorbs heat (endothermic).

c. Formation of Precipitate: A solid (precipitate) is formed when two solutions are mixed.

Example: Mixing barium chloride ($BaCl_2$) with sodium sulphate (Na_2SO_4) forms a white precipitate of barium sulphate ($BaSO_4$).

d. Evolution of Gas: Gases are produced in many reactions.

Example: In the reaction between sodium bicarbonate ($NaHCO_3$) and hydrochloric acid (HCl), carbon dioxide (CO_2) gas is produced.

e. Conservation of Mass: The law of conservation of mass must be followed.

1.3 Word-equation: The simplest way to do a chemical reaction is to write it in the form of a word-equation

Example: When a magnesium ribbon is burnt in oxygen, it gets converted to magnesium oxide.

Magnesium + Oxygen → Magnesium oxide

(Reactants) (Product)

1.4 Writing Chemical Equations: Chemical equations are symbolic representations of chemical reactions. They show the reactants and products involved, using chemical formulas.

General Form of a Chemical Equation: Reactants → Products

For example: The reaction between hydrogen and oxygen to form water can be written as:

$$2H_2 + O_2 \rightarrow 2H_2O$$

1.5 Balancing Chemical Equations: To satisfy the law of conservation of mass, the number of atoms of each element must be the same on both sides of the equation. This is achieved by adjusting the coefficients (the numbers in front of the chemical formulas).

Steps for Balancing Chemical Equations:

Every chemical equatio must be obey the law of conservation of mass.

Example:

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

Step-1: First draw boxes around each formula in chemical equations

$$\boxed{Fe} + \boxed{H_2O} \rightarrow \boxed{Fe_2O_4} + \boxed{H_2}$$

Step-2: List the no.of atoms of different elements present in the unbalanced chemical equation.

Element	No.of atoms in LHS	No.of atoms in RHS
Fe	1	3
H	2	2
O	1	4

Step-3: To start balancing with the compounds that contains the maximum number of atoms.

Atoms of Oxygen	In LHS	In RHS
(i) Initial	1 (in H_2O)	4 (in Fe_3O_4)
(ii) To balance	1 x 4	4

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

Step-4: Next balance H atoms.

Atoms of hydrogen	In LHS	In RHS
(i) Initial	8 (in $4H_2O$)	4 (in H_2)
(ii) To balance	8	2 x 4

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

Step-5: Next balance Fe atoms.

Atoms of Iron	In LHS	In RHS
(i) Initial	1 (in Fe)	3 (in Fe_3O_4)
(ii) To balance	1 x 3	3

$$3\boxed{Fe} + 4\boxed{H_2O} \rightarrow \boxed{Fe_3O_4} + 4\boxed{H_2}$$

Step-6: Finally, we count atoms of each element on both sides of the equations.

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

Step-7: Writing symbols of physical states carefully

$$3\ Fe(s) + 4\ H_2O(g) \rightarrow Fe_3O_4(s) + 4\ H_2(g)$$

1.6 Types of Chemical Reactions: Chemical reactions can be classified into various types based on the nature of the chemical change occurring.

a. Combination Reaction: A reaction in which a single product is formed from two or more reactants is known as a combination reaction.

General Equation: A + B → AB

Example: Calcium oxide reacts vigorously with water to produce slaked lime.

$$CaO + H_2O \rightarrow Ca(OH)_2$$

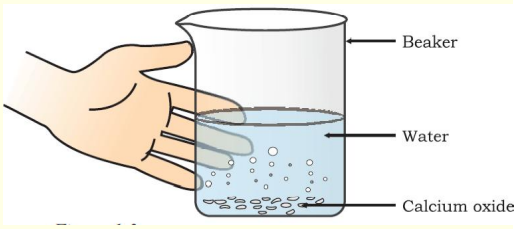
Activity of Combination Reaction:

Combination Reaction

Aim: Observe the combination reaction between quick lime and water

Apparatus: Calcium oxide/ quick lime, water, beaker.

Procedure: Take a small amount of calcium oxide/ quick lime in a beaker slowly add water to quick lime.



$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + Heat$$

Observation: Calcium oxide reacts vigorously with water to produce Calcium hydroxide/ slaked lime releasing a large amount of heat.

b. Decomposition Reaction: A reaction in which a single substance decomposes to give two or more substances is known as decomposition reaction.

General Equation: AB → A + B

Example: Decomposition of calcium carbonate to calcium oxide and carbon dioxide on heating.

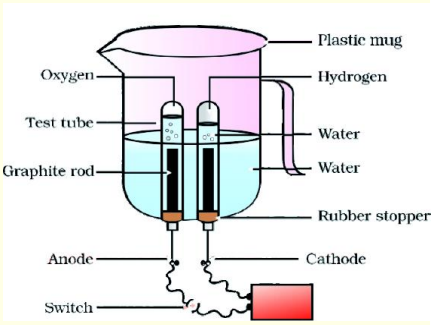
$$CaCO_3 \xrightarrow{heat} CaO + CO_2$$

Types of Decomposition Reactions

- Thermal Decomposition *(Heat absorbed by reactant)*
- Electrolytic decomposition *(Electricityabsorbed by reactant)*
- Photodecomposition reaction *(Light absorbed by reactant)*

Activity of Decomposition Reaction:

Electrolytic Decomposition



Aim: Electrolysis of water.

Apparatus: Plastic mug, Water, Test tubes, Graphite rods, Rubber stoppers, 6V Battery, Switch, Sulphuric acid.

Procedure:

1. Take a plastic mug. Drill two holes at it base and fit rubber stoppers in these holes. Insert carbon electrodes in these rubber stoppers.
2. Connect these electrodes to 6 volt battery. Fill the mug with water such that the electrodes are immersed.
3. Add a few drops of dilute sulphate acid to the water. Take two test tubes filled with water and invert them over the two carbon electrodes.
4. Switch on the current and leave the apparatus undistrubed for some time.

c. Displacement Reaction: The reaction in which an element has displaced or removed another element from the molecule is called displacement reaction.

General Equation: $A + BC \rightarrow AC + B$

Example: Iron has displaced another element copper from copper sulphate solution.

$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

Activity of Displacement Reaction:

Displacement Decomposition

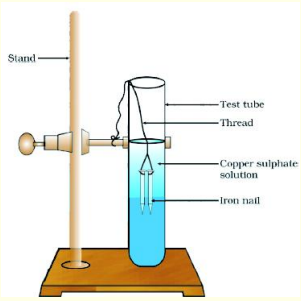
Aim: To Demonstrate the iron has displaced copper from copper sulphate solution.

Apparatus: Test tubes, Iron nails, Copper sulphate solution, Sand paper.

Procedure:

1. Take 3 iron nails and clean them by rubbing with sand paper.

2. Take 2 test tubes marked as A and B.



3. In each test tube, take about 10 ml copper sulphate solution.

4. Tie 2 iron nail with a thread and immerse them carefully in the copper sulphate solution in the tube B for about 20 minutes.

5. Keep on iron nail aside for comparsion.

6. After 20 minutes, take out the iron nails from the copper sulphate solutions.

7. Compare the intensity of the blue colour of copper sulphate solutions in test tube A and B.

8. Compare the colour of the iron nails dipped in the copper sulphate solution with the one kept aside.

d. Double displacement reaction: The reaction in which there is an exchange of ions between the reactants are called double displacement reactions.

General Equation: $AB + CD \rightarrow AD + CB$

Example: Sodium sulphate and Barium chloride are reacting and exchange their ions.

$$Na_2SO_4 + BaCl \rightarrow BaSO_4 + 2NaCl$$

Activity of Displacement Reaction:

Double Displacement Reaction

Aim: To Demonstrate double displacement reaction.

Apparatus: Sodium sulphate solution, Barium chloride solution, Test tubes.

Procedure:

1. Take about 3 ml of Sodium sulphate solution in test tube.

2. In another test tube, take about 3ml of Barium chloride solution.

3. Mix the solution properly.

$$Na2\ SO4\ (aq) + Ba\ Cl2\ (aq) \rightarrow BaSO4 + 2NaCl\ (aq)$$

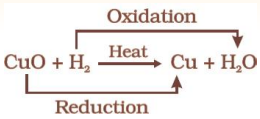
(Sodium sulphate) (Barium chloride) (Barium sulphate) (Sodium chloride)

observation: 1. Insoluble white precipitate Barium sulphate is formed by the reaction of SO_4 and Ba^{2+}.

2. Exchange of ions between th reactants.

e. Oxidation and Reduction: A chemical reaction in which one substance is oxidized (loses electrons) and other is reduced (gains electrons) is called a redox reaction.

Example: $CuO + H_2 \rightarrow Cu + H_2O$ (C is Oxidized to CO and ZnO is reduced to Zn)



f. Precipitation reaction: Any reaction that produces a precipitate can be called a precipitation reaction.

g. Exothermic reaction: Reaction in which energy is given out along with the products is called exothermic reaction.

Ex: Formation of carbon dioxide is an exothermic reaction.

$$C\,(s) + O_2\,(g) \rightarrow CO_2\,(g) + 393.7\ kJ$$

h. Endothermic reaction: Reaction in which energy is absorbed is known as endothermic reaction.

Ex: Formation of nitric oxide is an endothermic reaction.

$$N_2\,(g) + O2\,(g) \rightarrow 2NO\,(g) - 180.5\ kJ$$

1.7 Effects of Oxidation and Reductions in everyday life:

(a) Corrosion: When a metal is attacked by substances around it such as moisture, acids etc. it is said to corrode and this process is called corrosion.

The black coating on silver and the green coating on copper are examples of corrosion. Corrosion causes damage to car bodies, bridges, iron railings, ships and all objects made of metals.

(b) Rancidity: When fats/oils containing food materials for long time, they become rancid and their smell and taste change. This is called rancidity.

Keeping food in air tight containers helps to slow down oxidation. The chips manufacturers usually flush bags of chips with gas such as nitrogen to prevent the chips from getting oxidized.