St. john's R.P.School

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Affiliated to C.B.S.C

Introduction to Chemical Reactions and Equations

NOTES

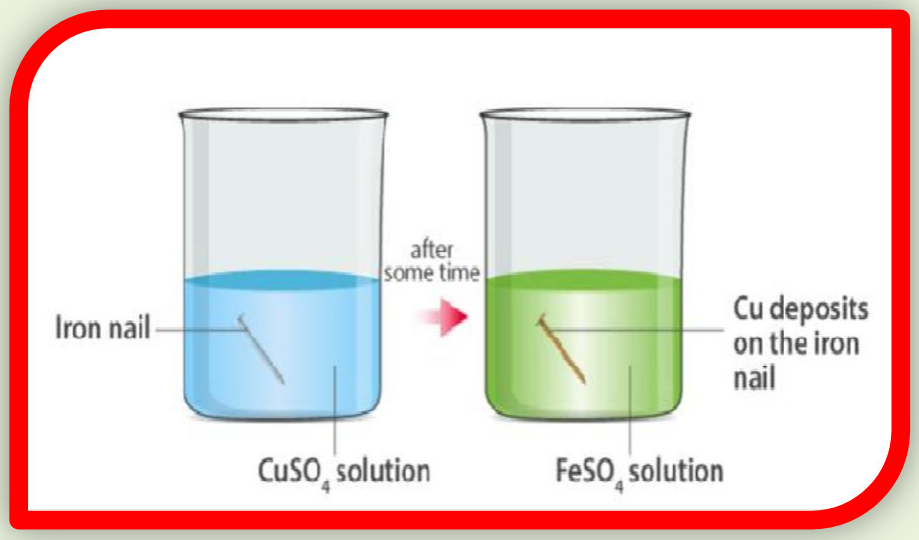
STD...XTH ***PREPARED BY.....DR..S.K.VERMA***

Physical and chemical changes

Chemical change – one or more new substances with new physical and chemical properties are formed.

Example: $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$

(Blue) (Green)



Here, when copper sulphate reacts with iron, two new substances, i.e., ferrous sulphate and copper are formed.

Physical change – change in colour or state occurs but no new substance is formed. Example: Water changes to steam on boiling but no new substance is formed (Even though steam and water look different when they are made to react with a piece of Na, they react the same way and give the exact same products). This involves only a change in state (liquid to vapour)

Observations that help determine a chemical reaction

A chemical reaction can be determined with the help of any of the following observations:

a) Evolution of a gas

b) Change in temperature

c) Formation of a precipitate

d) Change in colour

e) Change of state

Chemical Reaction

Chemical reactions are chemical changes in which reactants transform into products by making or breaking of bonds (or both) between different atoms.

Types of chemical reactions

Chemical reactions are grouped into multiple categories.

Few examples are:

- Combination
- Decomposition
- Single Displacement
- Double displacement
- Redox
- Endothermic

- Exothermic
- Precipitation
- Neutralisation

Word equation

A word equation is a chemical reaction expressed in words rather than chemical formulas. It helps identify the reactants and products in a chemical reaction.
For example,

Sodium + Chlorine → Sodium chloride

The above equation means: "Sodium reacts with chlorine to form sodium chloride."

Symbols of elements and their valencies

A symbol is the chemical code for an element. Each element has one or two-letter atomic symbol, which is the abbreviated form of its name.
Valency is the combining capacity of an element. It can be considered as the number of electrons lost, gain or shared by an atom when it combines with another atom to form a molecule.

Writing chemical equations

Representation of a chemical reaction in terms of symbols and chemical formulae of the reactants and products is known as a chemical equation.

$$\underset{\text{(Reactants)}}{Zn(s) + dil.\,H_2SO_4(aq)} \rightarrow \underset{\text{(Products)}}{ZnSO_4(aq) + H_2(\uparrow)}$$

- For solids, the symbol is "(s)".
- For liquids, it is "(l)".

• For gases, it is “(g)”.

• For aqueous solutions, it is “(aq)”.

• For gas produced in the reaction, it is represented by “(↑)”.

• For precipitate formed in the reaction, it is represented by “(↓)”.

Balancing of a Chemical Reaction

Conservation of mass

According to the law of conservation of mass, no atoms can be created or destroyed in a chemical reaction, so the number of atoms for each element in the reactants side has to balance the number of atoms that are present in the products side.
In other words, the total mass of the products formed in a chemical reaction is equal to the total mass of the reactants participated in a chemical reaction.

Balanced chemical equation

The chemical equation in which the number of atoms of each element in the reactants side is equal to that of the products side is called a balanced chemical equation.

Steps for balancing chemical equations

Hit and trial method: While balancing the equation, change the coefficients (the numbers in front of the compound or molecule) so that the number of atoms of each element is same on each side of the chemical equation.

Short-cut technique for balancing a chemical equation

Example:

$a CaCO_3 + b H_3PO_4 \rightarrow c Ca_3(PO_4)_2 + d H_2CO_3$

Set up a series of simultaneous equations, one for each element.

Ca: a=3c

C: a=d

O: 3a+4b=8c+3d

H: 3b=2d

P: b=2c

Let's set c=1

Then a=3 and

d = a = 3

b = 2c = 2

So a=3; b=2; c=1; d=3

The balanced equation is

$3CaCO_3 + 2H_3PO_4 \rightarrow Ca_3(PO_4)_2 + 3H_2CO_3$

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Combination reaction

In a combination reaction, two elements or one element and one compound or two compounds combine to give one single product.

$H_2 + Cl_2 \rightarrow 2HCl$

element + element → compound

$2CO + O_2 \rightarrow 2CO_2$

compound + element → compound

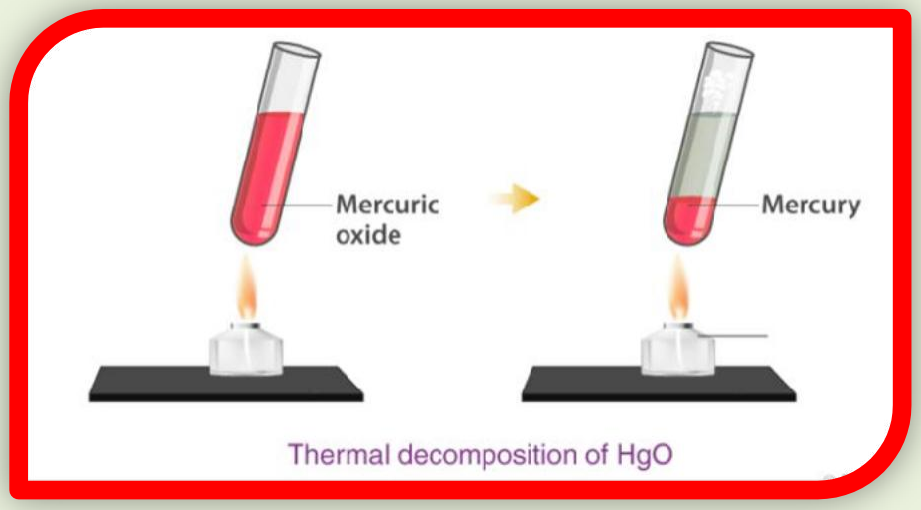
$NH_3 + HCl \rightarrow NH_4Cl$

compound + compound → compound

Decomposition reaction

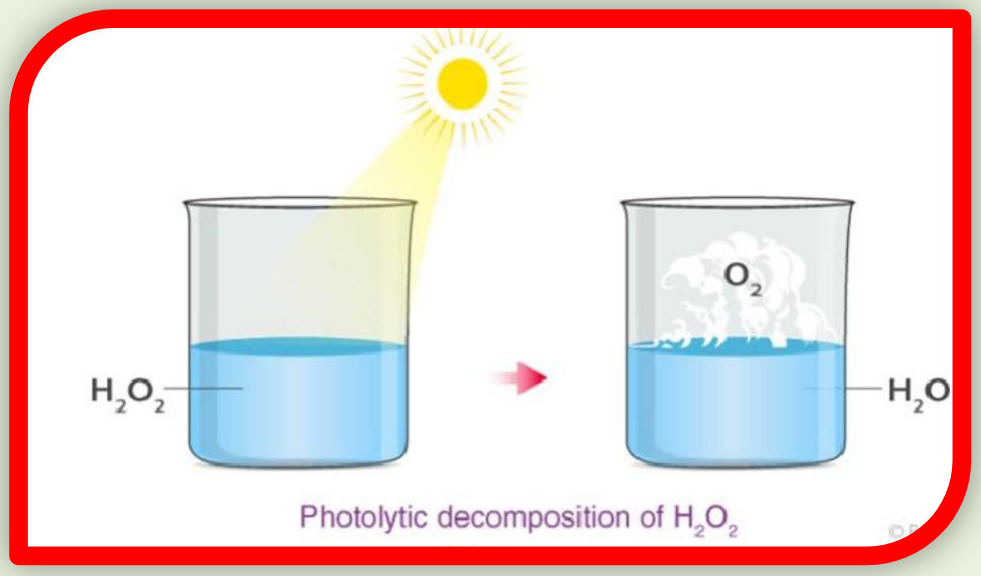
A single reactant decomposes on the application of heat or light or electricity to give two or more products.
Types of decomposition reactions:

a. Decomposition reactions which require heat – thermolytic decomposition or thermolysis.



Thermal decomposition of HgO

b. Decomposition reactions which require light – photolytic decomposition or photolysis.



c. Decomposition reactions which require electricity – electrolytic decomposition or electrolysis.

Electrolytic decomposition of H2O

Single displacement reaction

More reactive element displaces a less reactive element from its compound or solution.

i) $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$
ii) $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

Double displacement reaction

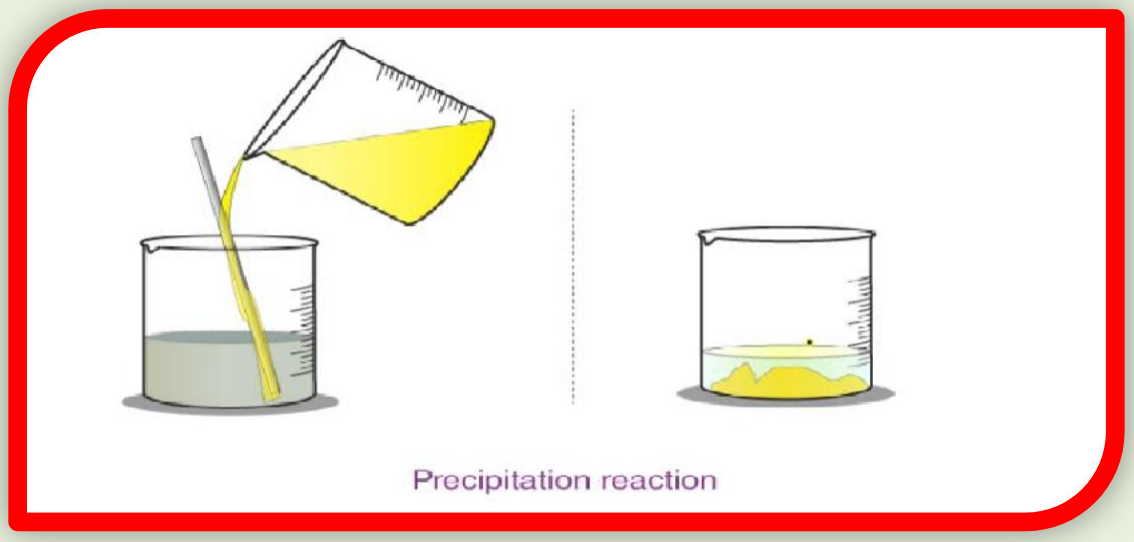
An exchange of ions between the reactants takes place to give new products.
For example,

$$Al_2(SO_4)_3(aq) + 3Ca(OH)_2(aq) \rightarrow 2Al(OH)_3(aq) + 3CaSO_4(s)$$

Precipitation reaction

An insoluble compound called precipitate forms when two solutions containing soluble salts are combined.

For example, $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow 2KNO_3(aq) + PbI_2(\downarrow)(s)(yellow)$



Precipitation reaction

Redox reaction

Oxidation and reduction take place simultaneously.

Oxidation: Substance loses electrons or gains oxygen or loses hydrogen.

Reduction: Substance gains electrons or loses oxygen or gains hydrogen.

Oxidising agent – a substance that oxidises another substance and self-gets reduced.

Reducing agent – a substance that reduces another substance and self-gets oxidised.

Examples:

1. $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$

(Blue) (Green)

$Fe \rightarrow Fe^{+2} + 2e-$ $(oxidation)$; Fe - reducing agent.

$Cu^{+2} + 2e- \rightarrow Cu(s)$ $(reduction)$; Cu - oxidising agent.

2. $ZnO + C \rightarrow Zn + CO$

ZnO reduces to Zn → reduction

C oxidises to CO → oxidation

ZnO - Oxidising agent

C - Reducing agent

Endothermic and exothermic reaction

Exothermic reaction – heat is evolved during a reaction. Most of the combination reactions are exothermic.

$Al + Fe_2O_3 \rightarrow Al_2O_3 + Fe + heat$

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + heat$

Endothermic – Heat is required to carry out the reaction.

$6CO_2 + 6H_2O + Sunlight \rightarrow C_6H_{12}O_6 + 6O_2$

Glucose

Most of the decomposition reactions are endothermic.

Corrosion

Gradual deterioration of a material, usually a metal, by the action of moisture, air or chemicals in the surrounding environment.

Rusting:

$4Fe(s) + 3O_2(from\ air) + xH_2O(moisture) \rightarrow 2Fe_2O_3.xH_2O(rust)$

Corrosion of copper:

$Cu(s) + H_2O(moisture) + CO_2(from\ air) \rightarrow CuCO_3.Cu(OH)_2(green)$

Corrosion of silver:

$Ag(s) + H_2S$ (from air) $\rightarrow Ag_2S$(black) + $H_2(g)$

Rancidity

It refers to the oxidation of fats and oils in food that is kept for a long time. It gives foul smell and bad taste to food. Rancid food causes stomach infection on consumption.
Prevention:

(i) Use of air-tight container

(ii) Packaging with nitrogen

(iii) Refrigeration

(iv) Addition of antioxidants or preservatives
