CHAPTER – 1

Chemical Reactions and Equations

Chemical Change and Chemical Reaction

A change in which the chemical composition of one or more than one reacting substances changes is called a chemical change or a chemical reaction.
Eg: curding of milk, burning of paper, rusting of iron, etc.
Any one of the following changes indicate that a chemical change has occurred :

1) Change in **STATE**
2) Change in **COLOUR**
3) Evolution of a **GAS**
4) Change in **TEMPERATURE**

Chemical Equations

A chemical equation is the symbolic representation of a chemical reaction in the form of symbols and formulae, wherein the reactant entities are given on the left and the product entities on the right hand side.

Eg: $C + O_2 \rightarrow CO_2$

BALANCING A CHEMICAL EQUATION

A balanced chemical equation is the one in which the total number of atoms of an element on the reactant side are equal to the total number of atoms of the same element on the product side.

We need to balance chemical equations to satisfy the Law of Conservation of Mass, which states that mass can neither be created nor be destroyed in any physical or chemical change. Thus, the total mass of reactants must be equal to the total mass of the products.

Examples of Balancing a Chemical Equation

1) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

Element	Number of atoms in Reactants (LHS)	Number of atoms in Products(RHS)
Zn	1	1
H	2	2
S	1	1
O	4	4

Total number of atoms of each element on LHS = Total number of atoms of each element on RHS
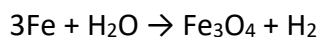Hence the given chemical equation is balanced.

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

Element	Number of Atoms in Reactants (LHS)	Number of Atoms in Products (RHS)
Fe	1	3
H	2	2
O	1	4

Clearly,   Total Number of atoms of Fe and O on the LHS ≠ Total Number of atoms of Fe and O on RHS

Step 1: To Balance Fe atoms

There is 1 Fe atom on LHS and 3 atoms on the RHS, so we need to multiply the Fe on LHS with 3.

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

Step 2: To Balance O atoms

There is 1 O atom on the LHS and 4 O atoms on the RHS, so we need to multiply the H_2O on the LHS by 4 because only H_2O is providing O atoms.
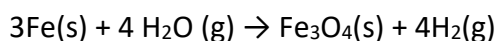
$$3Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$$
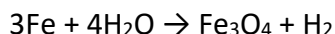
Step 3: To Balance H atoms

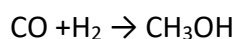There are 8 H atoms on the LHS and 2 H atoms on the RHS, so we need to multiply the H_2 on the RHS by 4.

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$
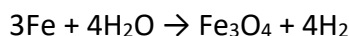
Step 4: To State Physical State

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

The above chemical equation is the required balanced chemical equation.

3) (CLASSROOM EXERCISE) $CO + H_2 \rightarrow CH_3OH$
4) (CLASSROOM EXERCISE) $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2 + H_2O$
5) (CLASSROOM EXERCISE) $PbSO_4 \rightarrow PbO + NO_2 + O_2$
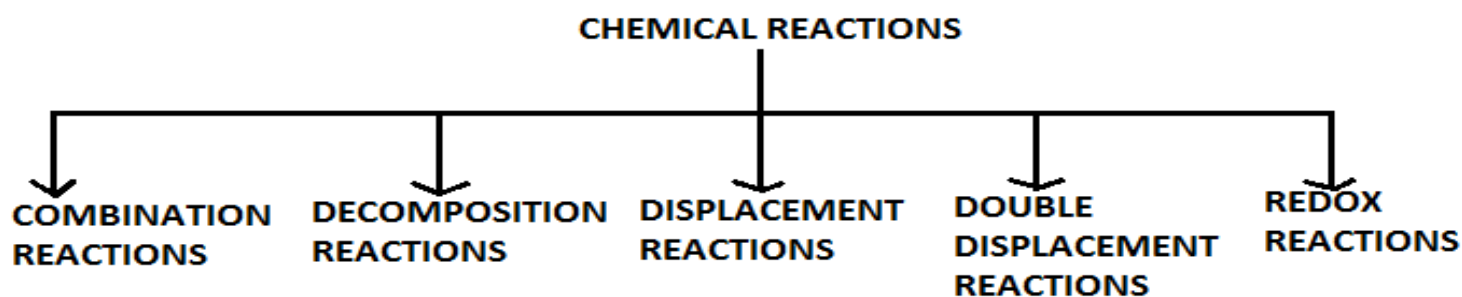6) (CLASSROOM EXERCISE) Solid Lead Nitrate is taken in a test tube and heated to give Lead Oxide, Nitrogen Dioxide and Di oxygen. Write the appropriate chemical equation for the reaction.
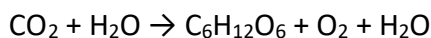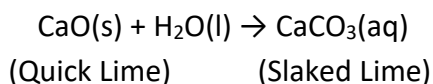
Types of Chemical Reactions

1) COMBINATION REACTIONS:
A Chemical Reaction in which several of the reactants combine to form a single product is called combination reactions.

Eg: 1) $CaO(s) + H_2O(l) \rightarrow CaCO_3(aq)$
                    (Quick Lime)   (Slaked Lime)
    2) $C(s) + O_2(g) \rightarrow CO_2(g)$
    3) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
    4) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
    5) $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
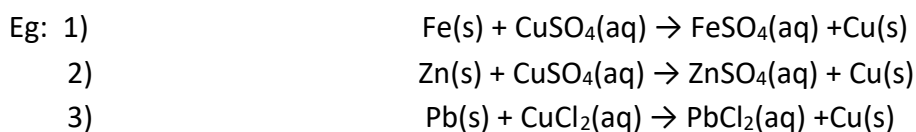
2) DECOMPOSITION REACTIONS:

A Chemical reaction in which a single reactant breaks into two or more than two products is called decomposition reaction.
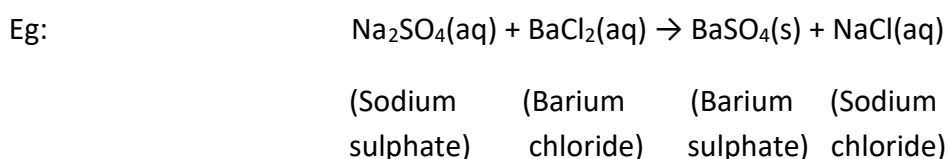
Eg: 1) $2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$

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

    3) $2Pb(NO_3)_2(s) \rightarrow PbO(s) + 4NO_2(g) + O_2(g)$

    4) $2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$

    5) $2AgBr(s) \rightarrow 2Ag(s) + Br_2(g)$

    6) $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$
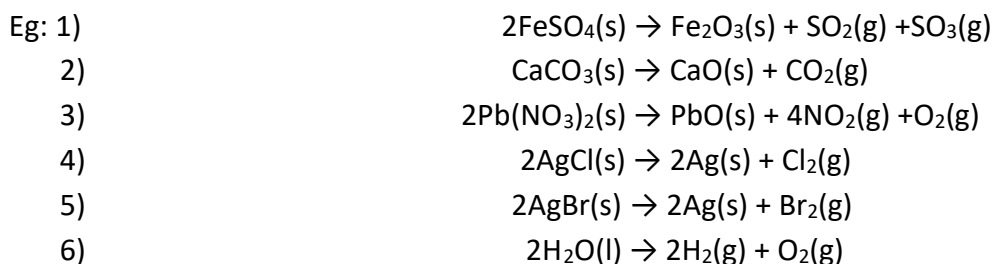
3) DISPLACEMENT REACTIONS:

A displacement reaction is the one in which one atom gets displaced or replaced by another atom in a molecule.

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

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

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

4) DOUBLE DISPLACEMENT REACTIONS:

A Double Displacement reaction is the one in which two atoms interchange their positions in their respective molecules.

Eg: $Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + NaCl(aq)$

           (Sodium   (Barium   (Barium   (Sodium

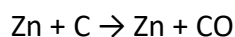   sulphate)   chloride)   sulphate)   chloride)

5) OXIDATION AND REDUCTION REACTIONS:

An oxidation and reduction reactions are the ones in which simultaneously one of the reactants gains oxygen/loses hydrogen and another reactant loses oxygen/gains hydrogen.

Eg:

$Zn + C \rightarrow Zn + CO$

$MnO_4 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$
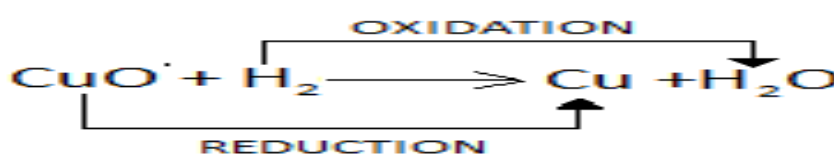
CORROSION: The phenomenon of formation of a layer on a metal surface when kept for a long time is called corrosion.

RANCIDITY: The taste of food, when kept for a long time changes as it gets oxidised. This phenomenon is called rancidity

SOME IMPORTANT QUESTIONS (SHORT ANSWER TYPE):

Q1: Why should a magnesium ribbon be cleaned before burning in air?

Ans: A magnesium ribbon when kept for a long time in open air develops a protective oxide layer. This oxide layer alters in the ignition of the magnesium ribbon. For the magnesium ribbon to burn effectively with a dazzling white flame, we need to clean it with sandpaper to remove any oxide layer formed.

Q2. Why should we balance chemical equations?

Ans: According to the Law of Conservation Of Mass ,which states that, mass can neither be created nor be destroyed in any physical or chemical reaction. Thus, the mass of reactants must be equal to the mass of products. Therefore,

Total number of atoms of each element on LHS = Total number of atoms of each element on RHS

Hence, to validate the Law of conservation of Mass we need to balance chemical reactions.

Q3. During electrolysis of water experiment, where does the following form

a) H_2
b) O_2

Ans: a) H_2 is formed at the cathode.

b) O_2 is formed at the anode.

Q4. A solution of a substance 'X' is used for white washing.

a) Name the substance 'X' and write its formula.
b) Write the reaction of the substance 'X' named in (a) above with water.

Ans: a) An aqueous solution of CaO is used for whitewashing.

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

Q5. Why does the colour of copper sulphate solution change when an iron nail is dipped in it?

Ans: The colour of copper sulphate solution changes from blue to brown when an iron nail is dipped in it. It is because Fe displaces Cu from its salt solution i.e., $CuSO_4$. Thus the solution now becomes $FeSO_4$, which is brown in colour.

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

Q6. Define: a) Exothermic reactions   b) Endothermic reactions

Ans: a) <u>Exothermic Reactions:</u> A reaction which produces heat energy is called an exothermic reaction.

Eg: $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + \textbf{HEAT}$

b) <u>Endothermic Reactions:</u> A reaction which absorbs heat energy is called an endothermic reaction.

Eg: $Pb(NO_3)_2(s) + \textbf{HEAT} \rightarrow PbO(s) + 4NO_2(g) + O_2(g)$

Q7. Why is respiration an exothermic reaction?

Ans: During respiration, glucose ($C_6H_{12}O_6$) gets oxidised to form CO_2 and H_2O along with release of heat energy.

$$C_6H_{12}O_6(aq) + 6O_2(aq) \rightarrow 6CO_2(g) + 6H_2O(l) + \textbf{HEAT}$$

Due to the release of heat energy, the reaction is termed as exothermic reaction.

Q8. Why do we apply paint on iron articles?

Ans: When iron gets in contact with moisture it corrodes. When we apply paint on iron articles, it prevents a contact of iron with moisture. Thus, preventing the rusting of iron.

Q9. Oil and fat containing food items are flushed with nitrogen. Why?

Ans: When food, containing oil and fat is left in open air for a very long time its taste changes. It becomes rancid i.e., it gets oxidised. To prevent this change of taste in food items bags are flushed with nitrogen gas, which is inert in nature.

Q10. 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: The element 'X' is Copper (Cu). The compound formed by heating it in air is CuO (Copper Oxide).

$$2Cu(s) + O_2(g) \rightarrow 2CuO(s)$$
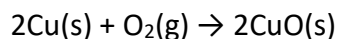
Q11. How does a photographic plate function?

Ans: Photographic plate contains AgBr in it. AgBr is photosensitive and when sunlight falls on it, it decomposes and thereby preserving the photographic plate.

$$2AgBr(s) \rightarrow 2Ag(s) + Br_2(g)$$
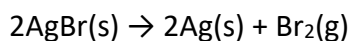
Q12. Mention the methods of prevention of rusting of metal items.

Ans: The methods of prevention of rusting are listed below:

1) Paint:
2) Oiling and Greasing:
3) Galvanizing:
4) Electroplating:
5) Alloying

Note: Galvanizing is done through dipping a metal strip in hot zinc bath. Whereas, electroplating is done using electric current.