

CHEMICAL REACTIONS AND EQUATIONS

Introduction

We observe many chemical reactions in daily life like –

- ♦ Iron exposed to humidity and air gets rusted.
- ♦ Digestion of food in our body.
- ♦ Grapes get fermented, etc.

Chemical reactions and their effects:

Chemical reactions may result in

- ♦ Change in state
- ♦ Change in temperature
- ♦ Change in colour
- ♦ Evolution of gas
- ♦ Change in smell
- ♦ Formation of precipitate

Chemical Equations

Word Equations:

- ♦ When magnesium is burnt in presence of oxygen, it gets converted into magnesium oxide. This reaction can be written in word equation format as follows.

Magnesium + Oxygen
(Reactants)



Magnesium oxide.
(Products)

- ◆ Here magnesium and oxygen are reactants. These are written on the left side of equation separated by '+' sign.
- ◆ Magnesium oxide is product. This is written on right side of equation. If two or more products are formed, they are separated by '+' sign.
- ◆ An arrow is drawn between reactants and products such that arrow head points towards products.
- ◆ Chemical Equation using chemical symbols:

When magnesium is burnt in presence of oxygen, it gets converted into magnesium oxide. This reaction can be written in word equation format as follows.



- ◆ Here magnesium and oxygen are reactants. The chemical symbols of these (Mg and O_2) are written on the left side of equation separated by '+' sign.
- ◆ Magnesium oxide is product. The chemical symbol of it (MgO), is written on right side of equation. If two or more products are formed, they are separated by '+' sign.
- ◆ An arrow is drawn between reactants and products such that arrow head points towards products.
- ◆ This equation is said to be skeletal chemical equation as it is just shows reactants involved but number of atoms of elements are unbalanced on both sides.

Law of conservation of Mass

Mass can neither be created nor be destroyed in a chemical reaction.

Balanced Chemical Reactions

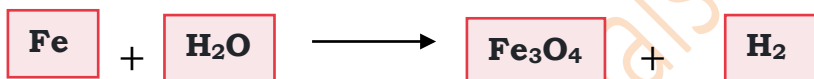
If the number of atoms of each element are balanced both on reactant side and product side, then chemical equation is said to be balanced.

Balancing the Chemical Equations

Consider the reaction $\text{Fe} + \text{H}_2\text{O} \longrightarrow \text{Fe}_3\text{O}_4 + \text{H}_2$

Step I:

Draw the boxes for each formula in the above reaction and do not change anything inside the boxes in the next steps.

**Step II:**

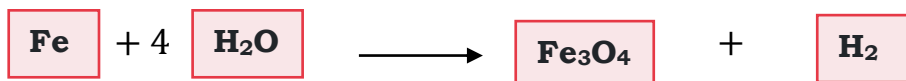
List the number of atoms of different elements in the unbalanced equation.

Element	Number of atoms on reactant side	Number of atoms on product side
Fe	1	3
H	2	2
O	1	4

Step III:

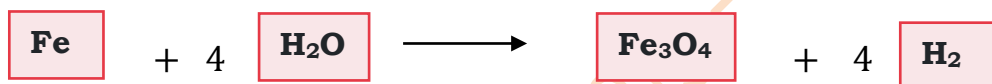
Consider element having highest number of atoms. In this case, it is oxygen.

Number of atoms of oxygen on reactant side is 1 and on product side is 4. To balance it, write the coefficient 4 for H₂O on reactant side. So partly balanced equation becomes,



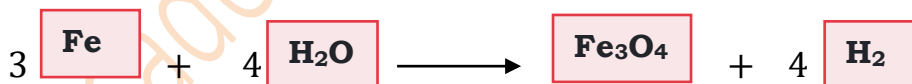
Step IV:

Now the number of hydrogen atoms has becomes 8 on reactant side and 2 on product side. To balance it, write the coefficient of 4 for H₂ on product side. Now the partly balanced equation becomes,



Step V:

The number of Fe atoms on reactant side is 1 and on product side is 3. To balance it, write the coefficient of 3 for Fe on reactant side. Now the complete balanced equation becomes,

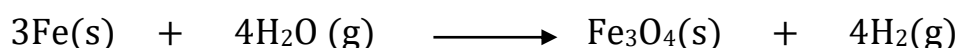


Step VI:

Check the number of atoms of each element to verify whether the equation is completely balanced or not. In this case, it is balanced.

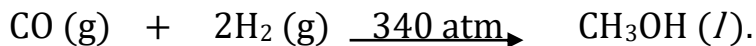
Step VII:

Write the phase of each reactant and product.



Note:

In some reactions, the conditions such as temperature, pressure and catalysts and promoters need to be specified. They can be written on the arrow head.

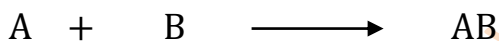
**Types of chemical reactions**

There are mainly four types of chemical reactions.

1. Combination Reaction.
2. Decomposition Reaction.
3. Displacement Reaction.
4. Double Displacement Reaction.

1. Combination Reactions:

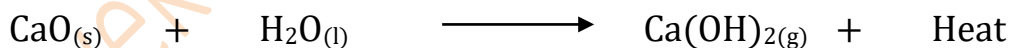
A combination reaction is a chemical reaction, in which two or more reactants combine to form a new single product.



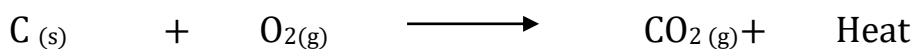
Here A and B are two reactants and AB is a product.

Examples:

- i. When calcium oxide combines with water, a single product calcium hydroxide is formed. Calcium oxide is also called as quick lime and calcium hydroxide is called as slaked lime.



- ii. When coal (carbon) is burnt in presence of oxygen, a single product carbon dioxide is formed.



iii. When hydrogen gas reacts with oxygen gas water is formed.



2. Decomposition Reaction

Decomposition reaction is a chemical reaction in which a single reactant splits up into two or more products is called a decomposition reaction.



There are mainly three types of decomposition reactions.

- i. Thermal Decomposition reaction
- ii. Photolytic Decomposition Reaction
- iii. Electrolytic Decomposition Reaction

i. Thermal decomposition:

If the decomposition reaction is carried out by heat, then such chemical reaction is called thermal decomposition.

Examples:

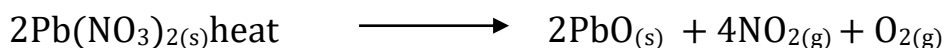
- ◆ When iron sulfate (green colour) is heated, it decomposes to form iron oxide, sulphur dioxide gas and sulphur trioxide gas.



- ◆ When calcium carbonate is heated, it decomposes to form calcium oxide and carbon dioxide. Calcium carbonate is also known as lime stone. Calcium oxide is mainly used in the manufacture of cement.



- ◆ When lead nitrate (colourless) is heated, it decomposes and gives yellow coloured lead monoxide, nitrogen dioxide (brown fumes) and oxygen gas.

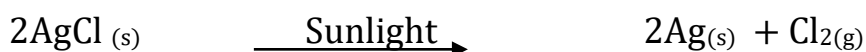


ii. Photolytic decomposition:

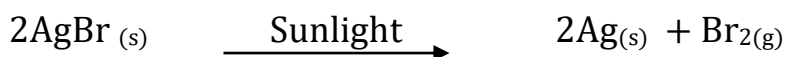
Decomposition reaction which take place using light energy are known as photolytic decomposition.

Examples:

- ◆ Decomposition of silver chloride (white) to give metallic silver (grayish white) and chlorine gas (yellowish green) when exposed to sunlight.



- ◆ Decomposition of silver bromide (pale yellow) to give metallic silver (grayish white) and bromine gas (brown) when exposed to sunlight.

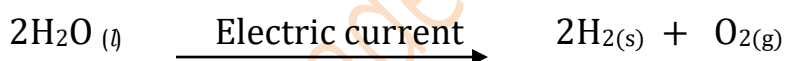


iii. Electrolytic decomposition:

Decomposition reaction which take place using electrical energy are known as electrolytic decomposition.

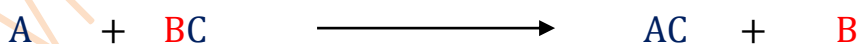
Examples:

- ◆ Water decomposes to give hydrogen and oxygen gases when electric current is passed through it.



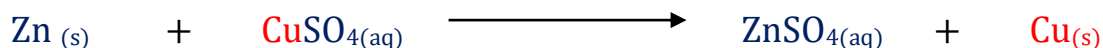
3. Displacement Reaction

A more reactive element displaces less reactive element in a compound when it reacts with the compound. This type of reaction is known as displacement reaction.

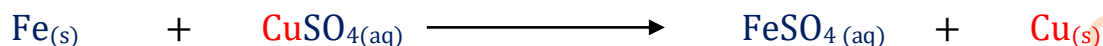


Examples:

- ◆ Zinc is more reactive than copper. So when zinc (grey colour) reacts with copper sulphate (blue colour), it displaces copper (brown colour) and forms zinc sulphate (colourless).



- ◆ Iron is more reactive than copper. So when iron reacts with copper sulphate (blue colour), it displaces copper (brown colour) and forms iron sulphate (green colour).



4. Double Displacement Reaction

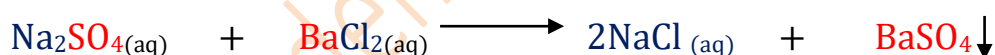
A reaction in which two ions of reactant molecules which displace each other when their compounds react with each other is known as double displacement reaction.



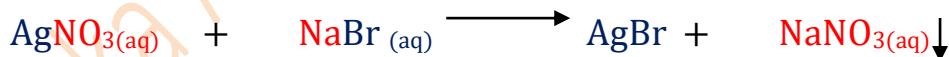
A compound insoluble in water is known as precipitate. Any reaction which produces precipitate is known as precipitate reaction.

Examples:

- ◆ When sodium sulphate reacts with barium chloride, white precipitate of barium sulphate and sodium chloride solution are formed.



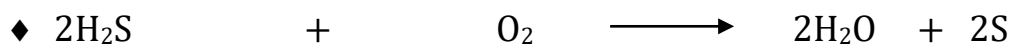
- ◆ When silver nitrate solution is added to sodium bromide, a yellow precipitate of silver bromide and sodium nitrate are formed.



5. Oxidation and reduction reactions

i) Oxidation reactions:

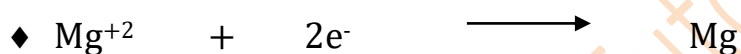
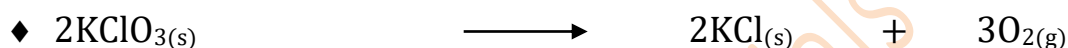
A chemical reaction in which addition of oxygen or removal of hydrogen or loss of an electron takes place is called oxidation reaction.

Examples:

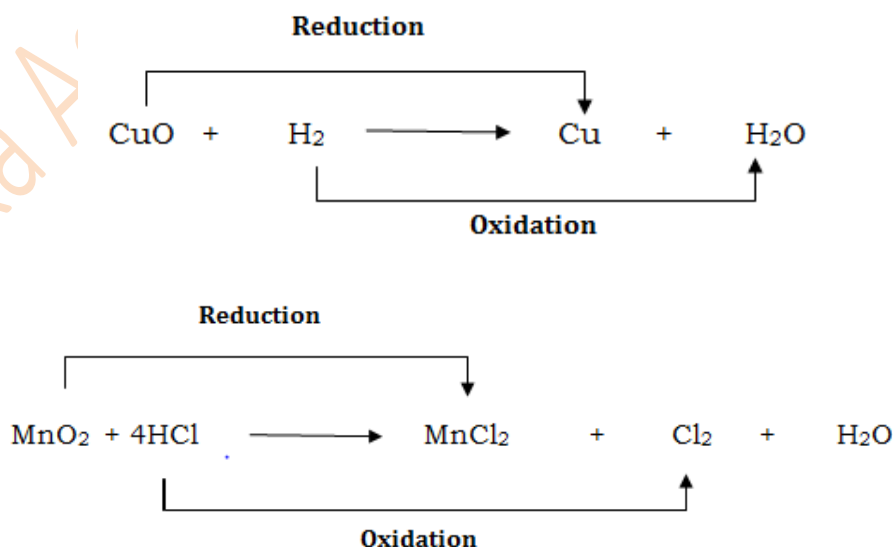
(Hydrogen sulphide)

**ii) Reduction reactions**

A chemical reaction in which removal of oxygen or addition of hydrogen or gaining of an electron takes place is called oxidation reaction.

Examples:**iii) Redox reactions**

A chemical reaction in which both oxidation and reduction take place is called oxidation reaction.

Examples:

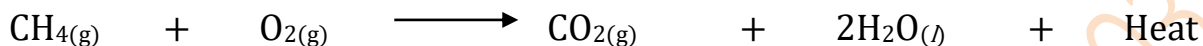
6. Exothermic and Endothermic reactions

i) Exothermic reactions

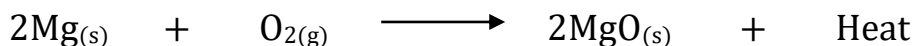
The reaction in which heat is released is known as exothermic reaction.

Examples:

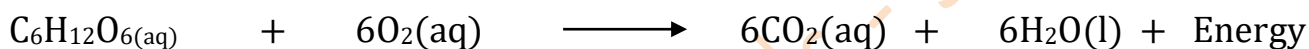
◆ Burning of natural gas



◆ Burning of magnesium ribbon



◆ Respiration



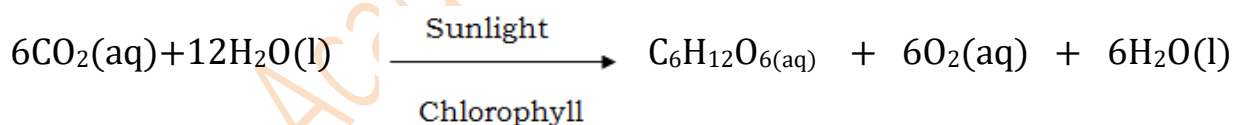
ii) Endothermic reactions

The reaction in which heat is absorbed is known as endothermic reaction.

Examples:



◆ Photosynthesis:



Corrosion

The phenomenon in which metal reacts with surrounding air, water and chemicals present in atmosphere and forms the its compounds like oxides, hydroxides or sulphides etc. is called corrosion.

Examples:

Rusting of iron, black coating on silver, green coating on copper etc.

Effects of corrosion:

1. Corrosion causes damages to materials made of metals like, car bodies, ships, railings, etc.
2. Every year huge amount of iron is wasted due to rusting. Hence it is necessary to prevent corrosion.

Rancidity

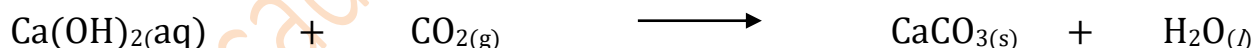
Rancidity is a process in which oils and fats of food are oxidized and results in change of smell and taste.

Methods of prevention of rancidity:

1. Storing food materials in closed and air tight containers.
2. Keeping cooked food in refrigerators.
3. Adding food preservatives or antioxidants etc.

Applications of some compounds and reactions

- ◆ Slaked lime (Calcium hydroxide) is used for white washing walls. It reacts with carbon dioxide in air slowly to form thin layer of calcium carbonate on the walls. Calcium carbonate is formed after two to three days of white washing and gives shiny finish to the walls.



- ◆ Decomposition reactions of AgCl, AgBr are used in black and white photography.

+1 Charge	Formula	+2Charge	Formula	+3 Charge	Formula
Name of ion		Name of ion		Name of ion	
Copper (I) ion (Cuprous ion)	Cu ⁺	Manganese (II) ion	Mn ²⁺	Aluminium ion Auric ion	Al ³⁺ Au ³⁺
Aurous	Au ⁺	*Mercury (I) ion	Hg ₂ ²⁺	Chromium (III) ion	Cr ³⁺
Silver ion	Ag ⁺	Zinc ion	Zn ²⁺	Iron (III) ion (Ferric ion)	Fe ³⁺
Lithium ion	Li ⁺	*Copper (II) ion	Cu ²⁺	Scandium ion	Sc ³⁺
Potassium ion	K ⁺	*Lead (II) ion	Pb ²⁺	Arsenic ion	As ³⁺
Sodium ion	Na ⁺	Cadmium ion	Cd ²⁺	Bismuth ion	Bi ³⁺
		Magnesium ion	Mg ²⁺	Antimony ion	Sb ³⁺
		Barium ion	Ba ²⁺		
		Cobalt ion	Co ²⁺		
		Strontium ion	Sr ²⁺		
		Iron (II) ion (Ferrous ion)	Fe ²⁺		

- 1 Charge	Formula	- 2 Charge	Formula	- 3 Charge	Formula
Name of ion		Name of ion		Name of ion	
Bromide ion	Br ⁻	Oxide ion	O ²⁻	Nitride ion	N ³⁻
Chloride ion	Cl ⁻	Sulphide ion	S ²⁻	Phosphide ion	P ³⁻
Fluoride ion	F ⁻			Boride ion	B ³⁻
Iodide ion	I ⁻				
- 1 Charge	Formula	- 2 Charge	Formula	- 3 Charge	Formula
Name of ion		Name of ion		Name of ion	
Hydrogen carbonate or bicarbonate ion	HCO ₃ ⁻	Carbonate ion Manganate ion	CO ₃ ²⁻ MnO ₄ ²⁻	Phosphate ion Arsenate ion	PO ₄ ³⁻ AsO ₄ ³⁻
Hydrogen sulphate or (bisulphate ion)	HSO ₄ ⁻	Thiosulphate ion Silicate ion	S ₂ O ₃ ²⁻ SiO ₃ ²⁻	Arsenite ion	AsO ₃ ³⁻
Hydroxide ion	OH ⁻	Sulphate ion	SO ₄ ²⁻	Phosphite ion	PO ₃ ³⁻
Nitrate ion	NO ₃ ⁻	Sulphite ion	SO ₃ ²⁻		
Chlorate ion	ClO ₃ ⁻	Chromate ion	CrO ₄ ²⁻	Borate ion	BO ₃ ³⁻
Nitrite ion	NO ₂ ⁻	Dichromate ion	Cr ₂ O ₇ ²⁻	Ferricyanide ion	[Fe(CN) ₆] ³⁻
Permanganate ion	MnO ₄ ⁻	Hydrogen phosphate ion	HPO ₄ ²⁻		
Acetate ion	CH ₃ COO ⁻	Oxalate ion	C ₂ O ₄ ²⁻		
Cyanide ion	CN ⁻				
Hypophosphite ion	H ₂ PO ₂ ⁻			- 4 Charge (Name of compound)	formula
Meta aluminate ion	AlO ₂ ⁻			Carbide ion	C ⁴⁻
+1 Charge	Formula			Ferrocyanide ion	[Fe(CN) ₆] ⁴⁻
Ammonium ion	NH ₄ ⁺				

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