Chemical Reaction

It is the process in which substance react together and form a new substance with new properties.

Reactant

The substance which takes parts in chemical reaction.

Product

The substance which forms in the chemical reaction.

A.K.Q

Why magnesium is rubbed with sand paper before burning?

To remove the oxide layer from the surface and thus it will allow the ribbon to burn effectively to get the desired result.

When magnesium ribbon burn in air it react with oxygen and form a product magnesium oxide.

$2Mg(s)+O_2(g) \longrightarrow 2MgO(s)$

- Magnesium ribbon → Silvery white metal, burn with dazzling white flames
- Magnesium oxide → White powder

Characteristics of chemical reaction

- **Change in state**

  Example: $2H_2(g)+O_2(g) \longrightarrow 2H_2O(l)$

  Before reaction the reactant are in gaseous state and after reaction the product formed is in the liquid state

- **Change in colour**

  Example: $2KI(aq) + Pb(NO_3)_2(aq) \longrightarrow 2KNO_3(aq) + PbI_2(s)$

  Before reaction the solution are colourless and after reaction the yellow colour lead iodide is formed

- **Evolution of gas**

  Example: $Zn(s)+H_2SO_4(aq) \longrightarrow ZnSO_4(aq)+H_2(g)$

  In the reaction the evolution of Hydrogen gas takes place

- **Change in temperature**

  Example: $Zn(s)+2HCl(aq) \longrightarrow ZnCl_2(aq)+H_2(g)+Heat$

  When the Zn react with HCl/H_2SO_4 then a lot of heat released

- **Formation of precipitate**

  Example: $2KI(aq) + Pb(NO_3)_2(aq) \longrightarrow 2KNO_3(aq) + PbI_2(s)$ (Yellow ppt.)

  In the above reaction the yellow colour of precipitate formed (lead iodide)

Chemical Equation

The method of representing a chemical reaction with the symbols and formulae of the substance is known as chemical equation.

Example: Zinc metal react with dilute sulphuric acid to form zinc sulphate and hydrogen gas.

Zinc + Sulphuric acid $\longrightarrow$ Zinc sulphate + Hydrogen

$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$

Balanced chemical equation

A balanced chemical equation has an equal number of atom of each element in the reactant and product side.

★ The chemical equation are balanced to satisfy the law of conservation of mass in chemical reaction.

? **What is balancing of a chemical equation?**

The process of making the number of different types of atoms equal on both the side of an equation.

Example: 1. $Fe + H_2O \longrightarrow Fe_3O_4 + H_2$ (Unbalanced)

$3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$ (Balanced)

? **How to make chemical equation more informative?**

- By indicating the "Physical states" of the reactant and product.
- By indicating the "heat change" taking place in the reaction.
- By indicating the "condition" under which the reaction take place.

★ Solid-S Liquid-L Gas-G Aquas Solution-aq (पानी में)

Example:

1. $3Fe(s) + 4H_2O(g) \longrightarrow Fe_3O_4(s) + 4H_2(g)$
2. $Co(g) + 2H_2(g) \xrightarrow{340\ atm} CH_3OH(l)$
3. $6Co_2(aq) + 12H_2O(l) \xrightarrow[Chlorophyll]{Sunlight} C_6H_{12}O_6(aq) + 6O_2(aq) + 6H_2O(l) + energy$

Types of Chemical reaction

Combination reaction

Those reaction in which two or more than two substance react (combine) to form a single substance.

Example:

1. $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq) + Heat$
   (Quicklime) (Slaked lime)
2. Burning of coal : $C(s) + O_2(g) \longrightarrow Co_2(g) + Heat$
3. Formation of water from $H_2(g)$ and $O_2(g)$:
   $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l) + Heat$

B.K.Q.

$CaO + H_2O$
(Calcium oxide/Quick lime)
↓
$Ca(OH)_2$ ⟶ Use for white washing
(Calcium hydroxide/slaked lime/lime water)
↓
$Ca(OH)_2 + CO_2$
↓
$Ca(CO_3) + H_2O$ ⟶ Give shiny finish to wall after 2-3 days
(Calcium carbonate/lime stone/ marble)

Decomposition reaction

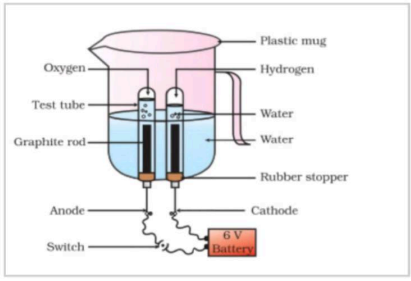
Those reaction in which a compound splits up into two or more than two simpler substance are known as decomposition reaction.

Heat (Δ) Electricity (⊣⊢) Sunlight (☀)

Example:

- $2FeSO_4(s) \xrightarrow{Heat} Fe_2O_3(s) + SO_2(g) + SO_3(g)$
- $CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$ [use for manufacture of cement]
- $2Pb(NO_3)_2(s) \xrightarrow{Heat} 2PbO(s) + 4NO_2(g) + O_2(g)$
  (Brown fume)

- $2H_2O(l) \xrightarrow{electricity} 2H_2(g) + O_2(g)$
- $2AgCl(s) \xrightarrow{Sunlight} 2Ag(s) + Cl_2(g)$
- $2AgBr(s) \xrightarrow{Sunlight} 2Ag(s) + Br_2(g)$
  (Black and white photography)
- Ferrous sulphate ($FeSO_4$) - Green colour
- Ferric Oxide (Fe_2O_3) - Brown colour
- Ferrous sulphate crystal ($FeSO_4.7H_2O$)



A.K.Q.

? **Is the volume of the gas collected the same in both the test tubes?**

No, because water is composed of 2 parts of Hydrogen(H_2) and 1 part of oxygen O_2.

? **Test these gases one by one by bringing a burning candle close to the mouth of the test tubes.**
-what happen in each case?
-which gases is present in each taste tube?

Case 1
Less gas volume test tube
Burn rapidly with yellow flame due to presence of oxygen gas
Reason:O=O means O_2 is unsaturated compounds burn with yellow flame.

Case 2
More gas volume test tube
Burn with a blue flame and makes a pop sound due to presence of hydrogen gas.
Reason:H-H means H_2 is saturated compounds burn with clean flame.

$2H_2O(l) \xrightarrow{electricity} 2H_2(g) + O_2(g)$

Displacement reaction

Those reaction in which one element takes the place of another element in a compound.
Example:

- $Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$
- $Zn(s) + CuSO_4(aq) \longrightarrow ZnSO_4(aq) + Cu(s)$
- $Pb(s) + CuCl_2(aq) \longrightarrow PbCl_2(aq) + Cu(s)$
  -$CuSO_4$ (Blue)
  -$FeSO_4$ (Brownish green)

displacement reaction reactivity series ke hisab se hota hai jo reactivity series me upar hai vo niche wale ko displace kar deta hai

K	(Potassium)
Na	(Sodium)
Ca	(Calcium)
Mg	(Magnesium)
Al	(Aluminium)
Zn	(Zinc)
Fe	(Iron)
Pb	(Lead)
H	(Hydrogen)
Cu	(Copper)
Hg	(Mercury)
Ag	(Silver)
Au	(Gold)

Double Displacement reaction

Those reaction in which two compounds react by an exchange of ions to form two new compound.
Example:

- $Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$
- $Pb(NO_3)_2(aq) + 2KI(aq) \longrightarrow PbI_2(s) + 2KNO_3(aq)$
- $AgNO3(aq) + NaCl(aq) \longrightarrow AgCl2(s) + NaNO3(aq)$
  (White ppt.)

ions exchange ho jate hai

On the basis of heat released or absorbed

Exothermic reaction (Heat ya energy feel ho)

The reaction in which heat is evolved is known as exothermic reaction.
Example:

- Burning of Natural Gas :
  $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$
- $C_6H_{12}O_6(aq) + 6O_2(aq) \longrightarrow 6CO_2(aq) + 6H_2O(l) + energy$
- Decomposition of vegetable matter into compost is also an example of an exothermic reaction.

Endothermic reaction (Jaha heat/energy supply karna pade)

Those reaction in which heat is absorbed are known as endothermic reactions.

Example:

- $N_2(g) + O_2(g) + Heat \longrightarrow 2NO(g)$
- All the decomposition reaction are endothermic reaction.

Oxidation and Reduction (Redox)

Oxidation

Oxidation is a process which involves the addition of oxygen or any electronegative element or the removal of hydrogen or any electro positive element.

Reduction

Reaction is the process which involves the addition of hydrogen or any electropositive element or the removal of oxygen or any electronegative element.

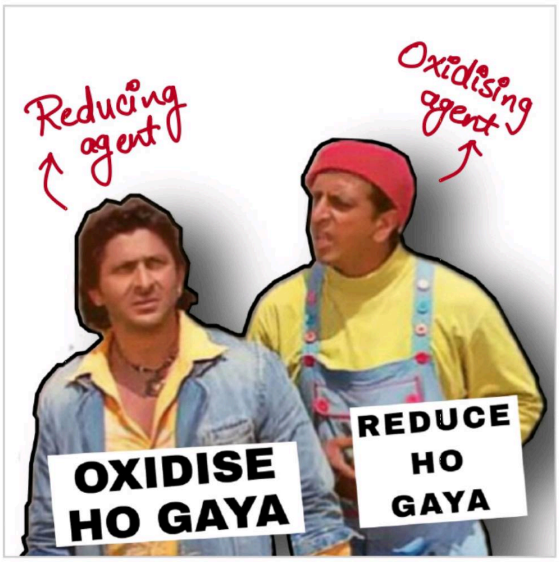
Example

$$\overset{\text{Oxidation}}{\overset{\text{Reduction}}{CuO + H_2 \rightarrow Cu + H_2O}}$$

jo reduce ho jaye vo oxidising agent
jo oxidise ho jaye vo reducing agent

- Substance Oxidised - H_2
- Substance Reduced - CuO
- Oxidising agent - CuO
- Reducing agent - H_2

$$\overset{\text{Oxidation}}{\overset{\text{Reduction}}{ZnO + C \rightarrow Zn + CO}}$$



- Substance oxidised - C
- Substance reduce - ZnO
- Oxidising agent - ZnO
- Reducing agent - C

$$\overset{\text{Oxidation}}{\overset{\text{Reduction}}{MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2}}$$

- Substance Oxidised - HCl
- Substance reduced - MnO_2
- Oxidising Agent - MnO_2
- Reducing agent - HCl

$$\overset{\text{Oxidation}}{Cu + O_2 \longrightarrow CuO}$$

- Substance Oxidised - Cu

★ All displacement reactions are redox reactions but reverse is not true.

A.K.Q.

When copper powder is heated in a china dish the surface of the copper powder becomes coated with a black colour substance. Why has this black coloured substance formed? What is that black substance? Write the chemical equation of the reaction.

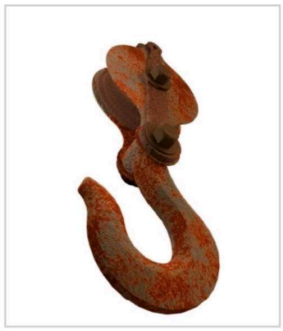
When the copper powder is heated in a china dish the copper powder surface becomes coated with black colour substance due to the formation of copper oxide by surface oxidation.

The black colour is due to the formation of this copper (II) oxide as the copper comes in contact with the air.

$2Cu(s) + O_2(g) \rightarrow 2CuO(g)$

Corrosion

It is the process in which metals are eaten up by the action of air, moisture, or a chemical on their surface.
Example: Rusting of iron (reddish brown){$Fe_2O_3.XH_2O$} black coating on silver{Ag_2S}, green coating on copper. {$CuCo_3.Cu(OH)_2$}



Prevention

- Use non-corrosion metals, such as stainless steel or aluminium
- Make sure the metal surface stay clean and Dry
- Use drying agent
- Use a coating or barrier product such as grease, oil, paint or carbon fibre coating
- Use a sacrificial anode to provide a catholic protection system

Rancidity

The condition produced by aerial oxidation of fats and oils in food marked by unpleasant smell and taste.

Prevention

- Adding anti-oxidants to foods containing fats and oils
  Butylated hydroxyanisole (BHA)
  Butylated hydroxytoluene (BHT)
- Packing fat and oil containing foods in nitrogen gas
- Keeping food in refrigerator
- Storing food in air tight container

(Nitrogen gas filled) →

E.K.Q.

? **On heating blue coloured powder of copper (II) nitrate in a boiling tube, copper oxide (black), oxygen gas and a brown gas X is formed**
(a) Write a balanced chemical equation of the reaction.
(b) Identify the brown gas X evolved.
(c) Identity the type of reaction.
(d) What could be the pH range of aqueous solution of the gas X?

Ans-(a) Balanced chemical equation:

$2Cu(NO_3)_2(S) \xrightarrow{heat} 2CuO(s) + O_2(g) + 4NO_2(g)$

(b) The brown gas X evolved is nitrogen dioxide (NO).
(c) This is a decomposition reaction.
(d) Nitrogen dioxide is an oxide of non-metal so it dissolves in water to form acidic solution. Thus, pH of this solution is less than 7.

? **Give the characteristic tests of the following gases**
(a) CO **(b) O_2**
(b) SO_2 **(d) H_2**

Ans- The characteristic tests:
(a) Carbon dioxide (CO) gas turns lime water milky when passed through it due to the formation of insoluble calcium carbonate.

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

(b) Sulphur dioxide (SO) gas when passed through acidic potassium permanganate solution (purple in colour) turns it colourless because SO is a strong reducing agent.

$2KMnO_4 + 2H_2O + 5SO_2 \rightarrow K_2SO_4 + 2MnSO_4 + 2H_2SO_4$

(c) The evolution of oxygen (O_2) gas during a reaction can be confirmed by bringing a burning candle near the mouth of the test tube containing the reaction mixture. The intensity of the flame increases because oxygen supports burning.
(d) Hydrogen (H_2) gas burns with a pop sound when a burning candle is taking near it.

? **Write the balanced chemical equations for the following reactions and identify the type of reaction in each case.**
(a) Nitrogen gas is treated with hydrogen gas in the presence of a catalyst at 773 K to form ammonia gas.
(b) Sodium hydroxide solution is treated with acetic acid to form sodium acetate and water.
(c) Ethanol is warmed with ethanoic acid to form ethyl acetate in the presence of concentrated H_2SO.
(d) Ethene is burnt in the presence of oxygen to form carbon dioxide, water and releases heat and light.

Ans- (a) $N_2(g) + 3H_2(g) \xrightarrow{773K} 2NH_3$ (Combination reaction)
(b) $NaOH(aq) + CH_3COOH(aq) \longrightarrow CH_3COONa(aq) + H_2O(l)$
Double displacement reaction/Neutralisation reaction
(c) $C_2H_5OH + CH_3COOH + \text{conc. } H_2SO_4 \longrightarrow CH_3COOCH + H_2O$
Double Displacement reaction/Esterification reaction
(d) $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g) + \text{Heat} + \text{Light}$ (Exothermic reaction)

? **Grapes hanging on the plant do not ferment but after being plucked from the plant can be fermented. Under what conditions do these grapes ferment? Is it a chemical or a physical change?**

Ans. Grapes when attached to the plants are living and therefore their own immune system prevents fermentation. The microbes can grow in the plucked grapes and under anaerobic conditions these can be fermented. This is a chemical change.