Chapter-6

Chemical Reaction and Catalyst

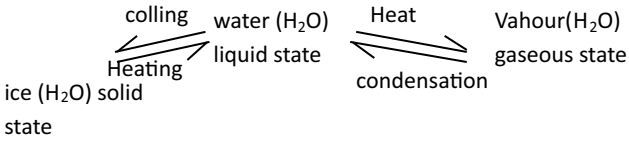
In our life, many chemical incidents happen everyday, in which substances changes their forms. These changes are called physical or chemical changes.

6.1 Physical and chemical change

In some substances, on removing the cause of change, again initial substance is obtained. Whereas on the other side some changes are such in which composition of substances gets changed and new substances are formed, these changes are called chemical changes.

6.1.1 Physical change

These are the changes in which physical properties and state of substance changes but their chemical properties do not change on removing the cause of change, again initial state is obtained like water (H_2O) is in liquid state, on heating gaseous state vapour (H_2O) is formed and on cooling solid state ice (H_2O) is formed.



Magnet formation by iron, sugar dissolving in water etc are other examples.

6.1.2 Properties of physical change :

(1) Only physical properties of substances like state, colour, smell etc changes.

(2) On removing the cause of change, again initial substance is obtained.

(3) This change is temporary.

(4) New substance in not formed.

6.1.3 Chemical Change

These are changes in which chemical properties and composition of substance changes and new substance is formed. When chemical change occurs, it is not necessary that on removing the cause of change again initial substance is obtained Eg- on burning coal, carbon dioxide gas is formed.

C	+	O_2	$\longrightarrow$	CO_2
Coal		Oxygen		Carbon dioxide
(Solid)		(Gas)		(Gas)

Here when carbon and oxygen react then substance with new chemical composition carbone dioxide (CO_2) is formed and in this reaction coal can not be obtained again from (CO_2). Other examples are formation of curd by milk, spoiling of cooked vegetable, rusting of iron etc.

Properties of chemical change :

(1) The substance formed as a result of the chemical change is completely different in chemical proerties and composition from the initial substance.

(2) Generally, initial substances can not be obtained again.

(3) This change is permanent.

(4) New substance is formed.

6.2 Chemical equation

In any chemical reaction, substances are represented by molecular formulas & symbols, then it is called chemical equation. Eg. on heating carbon in presence of oxygen, carbon dioxide is formed.

Carbon + oxygen $\longrightarrow$ Carbon dioxide

$C + O_2 \longrightarrow CO_2$

In this way, chemical reaction can be written in short by chemical equation. In chemical reaction, the

substance that takes part are written on the left hand side of arrow, these are called reactants. Arrow shows the direction of reaction. On the right hand side of arrow are products which are the substances formed during the reaction.

6.2.1 Steps of writing chemical equation -

(1) For writing equation of a chemical reaction, firstly reactants are written, then an arrow is made, then products are written.

(2) When the number of reactants and products are more than one, then plus sign (+) is written between them Eg-

$$C + O_2 \longrightarrow CO_2$$

(3) In a chemical reaction, mass is neither formed nor destroyed. Thus, number of atoms of reactants and products would be same on both sides of arrow.

According to the fundamental law of chemical combination, in a chemical reaction whatever be the mass of reactant, same product of same mass is formed that means mass is conserved in complete reaction. It can also be understood as the total number of atoms of any elements is same on the reactant and on product side So, it is necessary to balance the written equation.

(4) Equation is balanced by increasing and decreasing number of molecules on both sides. Chemical equation is solved by hit and trial method.

(5)To balance chemical equation, firstly the atoms other than oxygen (O) and hydrogen (H) are balanced.

Eg.

$$C_3H_8 + O_2 \longrightarrow CO_2 + H_2O$$

Propane	oxygen	carbon dioxide	water

$$C_3H_8 + O_2 \longrightarrow 3CO_2 + H_2O$$

Number of C is balanced, now balance number of H.

$$C_3H_8 + O_2 \longrightarrow 3CO_2 + 4H_2O$$

Now balance the number of O on both side

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

(6) After balancing the equation, we represent physical state of reactants and products, (s) for solid, (l) for liquid and (g) for gas.

$$C_{(S)} + O_{2\ (g)} \rightarrow CO_{2\ (g)}$$

(7) When reactant and product are in aqueous solution form, then (aq) is written.

$$CaO_{(s)} + H_2O_{(l)} \longrightarrow Ca(OH)_{2\ (aq)}$$

(8) When reaction is reversible that is occur in both directions then arrow sign $\rightleftharpoons$ is used.

(9) Temperature and pressure required for completion of reaction are written above the arrow.

$$N_{2\ (g)} + 3H_{2\ (g)} \overset{773k/200atm}{\rightleftharpoons} 2NH_{3\ (g)}$$

(10) For exothermic and endothermic reaction, (+) and (-) sign are applied with amount of heat on the product side. Heat is also written by Δ sign.

$$N_2 + 3H_2 \longrightarrow 2NH_3 + 10.5 \text{ Kcal/mole}$$

$$N_2 + 2O_2 \longrightarrow 2NO_2 - 21.6 \text{ Kcal/mole}$$

(11) Catalyst used in reaction is written above the arrow

$$\begin{array}{l} CH_2 \\ \| \\ CH_2(g) + H_2(g) \end{array} \xrightarrow{Ni} \begin{array}{l} CH_3 \\ | \\ CH_3 \end{array}$$

ethene → ethane

6.2.2 Properties of chemical equation-

A brief information of reaction is obtained through chemical equation. Its properties are :-

(1) Complete information about the reactants and products i.e. number of molecules, mass etc are obtained.

(2) Physical state of substance can be known.

(3) Required conditions for reaction i.e. temperature, pressure, catalyst etc are known by it.

(4) By equation, it is clear whether reaction is exothermic or endothermic.

(5) It gives information about reversibility of reaction.

6.2.3 Limitations of chemical equation-

(1) It does not give information regarding completeness of reaction.

(2) The concentration of reactant and product is not clear through it.

6.3 Chemical reaction

When chemical change occurs in any substance, it differs in chemical composition and properties from main substance, this phenomenon is called chemical reaction i.e. **the chemical change in any substance is called chemical reaction.** During chemical reaction, reactants are converted into products but the total mass is conserved. Chemical reaction is represented by chemical equation. Eg.

$$2Mg(s) + O_{2(g)} \longrightarrow 2MgO_{(s)}$$

On burning magnesium ribbon in oxygen, white coloured powder of magnesium oxide is formed. Here, in reactants, number of atoms of Mg is 2 and number of atoms of oxygen (O_2) is 2 and after product formation also this number remains same. Mass of Mg and O_2 remains same before and after the reaction. Look at another example.

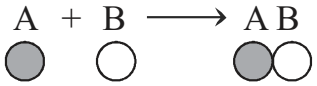
$C_{(s)}$	+	$O_{2(g)}$	$\longrightarrow CO_{2(g)}$
12		(2×16)	$(12+2\times16)$
12	+	32	$12+32$
	44		44

In this reaction, coal is burnt in presence of oxygen. Here coal (C) and oxygen (O_2) are reactants.Gas CO_2 formed as product have completely different properties than these two. Here 12 g Carbon reacts with 32 g oxygen to form 44 g CO_2. Total mass of reactants remain equal to the total mass of products.

In chemical reaction, bonds between atoms of compound break and new bonds are formed. There are many types of reactions on the basis of combination of the reactants, breakdown and formation of bonds, velocity and nature of reaction etc.

6.3.1 Addition reaction :-

The chemical reactions in which two or more reactants combine to form a single product, are called addition reactions. In these reactions, new bonds are formed between the reactants.



As reactants simply add in this reaction, so these are called addition or combination reaction

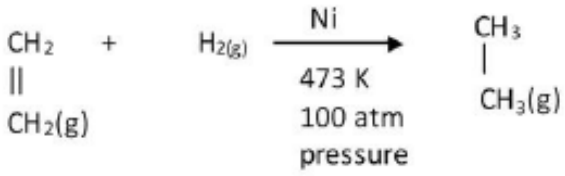
Eg- Burning of coal

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

Burning of magnesium ribbon

$$Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$$

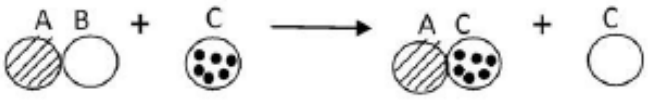
Hydrogenation of ethene



6.3.2 Replacement reaction:-

The chemical reactions in which atom or group of atoms present in reactant displaces atom or group of atoms of other reactant. In these reactions, the bond already present breaks and some new bonds are formed.

Eg.

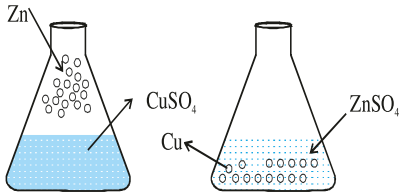


$$CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$$

copper sulphate + zinc → zinc sulphate + copper

On mixing zinc pieces in blue coloured solution of copper sulphate, blue colour of $CuSO_4$, solution disappear and Cu is precipitated, and formation of $ZnSO_4$ occurs in solution. In displacement reactions,

more reactive element displaces comparatively less reactive element. Zn is more reactive metal and Cu is less reactive, so Zn displaces Cu from $CuSO_4$.



Blue colour Blue colour disappear

Reactivity of elements can be known by their activity series as-

Table 6.1

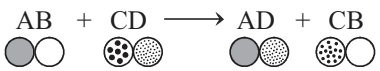
Activity series of some elements

Metals above H are more reactive than H	Potassium	K	More reactive elements
	Sodium	Na	
	Calcium	Ca	
	Magnesium	Mg	
	Zinc	Zn	
	Iron	Fe	
	Lead	Pb	
	Hydrogen	H	
Metals below H less reactive than it	Copper	Cu	
	Mercurry	Hg	
	silver	Ag	Less reactive elements
	Gold	Au	

Decreasing order of reactivity ↓

Double Replacement Reaction:-

In this type of chemical reaction, atoms or group of atoms of both reactants are displaced mutually and new compounds are formed.



Some part of both reactants are displaced mutually and new products are formed.

Sulphate ions (SO_4^{-2}) of copper sulphate displaces hydroxide ions (OH^-) of sodium hydroxide and as a result ,copper hydroxide $[Cu(OH)_2]$ and formation of bonds, velocity and nature of reaction etc.

6.3.1 Addition reaction :-

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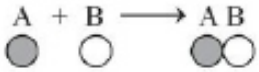


As reactants simply add in this reaction, so these are called addition or combination reaction

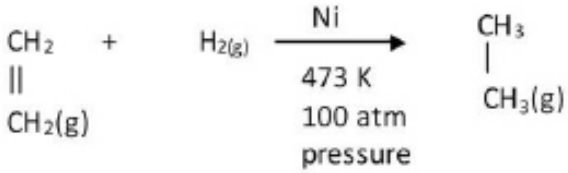
Eg- Burning of coal

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

Burning of magnesium ribbon

$$Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$$

Hydrogenation of ethene



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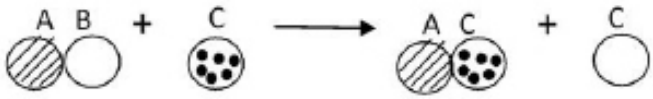

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On mixing zinc pieces in blue coloured solution of copper sulphate, blue colour of $CuSO_4$, solution disappear and Cu is precipitated, and formation of $ZnSO_4$ occurs in solution. In displacement reactions,

dissociates into calcium oxide and CO_2.

(c) Photolytic dissociation - In this type of dissociation reaction, compounds get energy from light and breaks into small molecules. As in these reactions, compounds dissociate in the presence of light, so these are called photolytic dissociation.

$$2HBr \xrightarrow{\text{light (hv)}} H_2 + Br_2$$

Hydrogen Bromide Hydrogen Bromine

6.3.4 Slow and fast reactions -

Chemical reactions are of two types on the basis of velocity i.e. time taken-slow and fast

(a) Fast reactions -

These reactions occur rapidly on mixing the reactants. Generally, such reactions are ionic reactions like the reaction between strong acid and strong base which gets completed in 10^{-10} s.

$$NaOH+HCl \rightarrow NaCl+ \underset{(10^{-10}\,s)}{H_2O}$$

$$AgNO_3+HCl \rightarrow \underset{\text{white ppt}}{AgCl} +HNO_3$$

As soon as we mix silver nitrate and hydrochloric acid, white precipitate of silver chloride (AgCl) is formed. In plants, speed of photosynthesis reaction is also very fast. Half life period of this reaction ($t_{1/2}$) is 10^{-12}sec. (The time taken for half of the reactant to convert into product is called half life period of that reaction)

(b) Slow reaction -

There are many reactions which take hours, days or years to complete, these are called slow chemical reaction. Eg- Reaction of rusting of iron continues till years, which is a good example of slow chemical reaction.

$$4Fe+3O_2+6H_2O \rightarrow \underset{\text{Rust}}{2Fe_2O_3.3H_2O}$$

Another eg.

$$2\ KClO_3 \xrightarrow{\Delta} 2KCl+O_2$$

$$CH_3COOH+C_2H_5OH \rightarrow CH_3COOC_2H_5+H_2O$$

Acetic acid Ethanol Ethyl acetate

6.3.5 Reversible – Irreversible Reaction -

(a) Irreversible reactions - In these reactions reactants react to form products. They only occur in one direction, so they are called irreversible reactions. In these reactions, concentration of reactants decreases slowly and the concentration of products increases. When these chemical reactions are written in form of chemical equation, then it is written as normal arrow sign $(\rightarrow)$ Eg.

Coal burns in air and form carbon dioxide.

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

Methane

On burning methane, carbon dioxide and water are formed and are stable also, so methane is not formed again. It means, in these reactions generally chemical change occur and products are formed. Reactants can not be formed again by products.

(b) Reversible Reaction -

The reactions in which reactants react, to form products under same conditions, and at same time products also react to from reactants. These reactions are called reversible reactions. These reactions occur in both directions. In these reactions, amount of reactant is never zero. In reversible reaction, half arrow sign is written in both sides $\rightleftharpoons$.

$$A+B \underset{(2)}{\overset{(1)}{\rightleftharpoons}} C+D$$

Reversible reactions are divided into two reactions which occur simultaneously

(1) $A+B \rightarrow C+D$

It is called forward reaction

(2) $C+D \rightarrow A+B$

It is called backward reaction

In this way, reversible reaction occur on both sides (forward and backward) simultaneously. Firstly, products (C+D) is formed from reactants (A+B). After the products are formed in favourable quantity,

backward reaction starts and reactants start forming. Once the reaction is started, it never completes. Every time reactant and product are present in the reaction mixture. If gases are formed in reaction, then it is required for the reaction to occur in closed container.

$$N_2+3H_2 \rightleftharpoons 2NH_3$$

$$H_2O+H_2CO_3 \rightleftharpoons H_3O^+ +HCO_3^-$$

Example of one such chemical reaction is carrying of CO_2 and O_2 by haemoglobin.

6.4 Oxidation - reduction -

In chemistry, oxidation reduction reactions are very important. Many biological, physical and chemical reactions are related to these. Generally , all the elements react with O_2 and H_2 , so on this basis these are called oxidation reduction reactions. These reactions also define oxidizing and reducing agent. These reactions are explained on following basis.

6.4.1 Oxidation reduction on the basis of combination and dissociation of oxygen -

Addition of oxygen is called **oxidation**. Mainly, oxidation word is used for addition of oxygen

eg - $2Mg+O_2 \rightarrow 2MgO$

$S+O_2 \rightarrow SO_2$

sulphur dioxide

In reaction, removal of oxygen from substance is called **reduction**.

$$2KClO_3 \rightarrow 2KCl+3O_2$$

$$2MgO \rightarrow Mg+O$$

In this reaction, $KClO_3$ is reducing to KCl and MgO to Mg.

6.4.2 Oxidation reduction on the basis of addition and removal of hydrogen -

This definition was famous earlier but now it is also used in organic chemistry. Those chemical reactions in which hydrogen is removed from substances, are called oxidation.

$$2H_2S+O_2 \rightarrow 2H_2O+2S$$

Here, H_2S (Hydrogen sulphide) gas is oxidized to (Sulphur) S.

$$CH_3CH_2OH \xrightarrow{(o)} CH_3CHO+H_2$$

Ethanol Ethanal

In ethanol, number of H_2 atoms are 6 and in product formed ethanal, number of H_2 atoms are 4. So here ethanol is oxidized in ethanal and hydrogen is removed.

Those chemical reactions in which addition of hydrogen takes place are called **reduction**.

$$\underset{\text{Ethene}}{CH_2=CH_2} + H_2 \xrightarrow[\text{473 k/ 100 atm}]{\text{Ni}} \underset{\text{Ethane}}{CH_3-CH_3}$$

$$H_2+Cl_2 \longrightarrow 2HCl$$

Here, Ethene is reduced to Ethane and Chlorine to HCl.

It is not essential that hydrogen and oxygen take part in reactions. So definitions of oxidation and reductions were given in general form.

6.4.3 Oxidation - reduction on the basis of addition and removal of electropositive elements -

Those reaction in which electropositive element is removed, is called **oxidation**.

$$2KI+Cl_2 \rightarrow 2KCl+I_2$$

$$H_2S+Cl_2 \rightarrow 2HCl+S$$

Here Potassium iodide (KI) is oxidized to Iodine (I_2) and H_2S to sulphur (S). Those reactions in which electropositive element is added are called **reduction**.

$$Cl_2+Mg \rightarrow MgCl_2$$

Here Chlorine (Cl_2) is reduced to Magnesium chloride ($MgCl_2$).

6.4.4 Oxidation-reduction on the basis of addition and removal of electronegative element-

Those reactions in which susbtance combines with electronegative element, are called **oxidation**.

$$Mg+Cl_2 \rightarrow MgCl_2$$

Here, Magnesium (Mg) is combining with more electronegative element Chlorine (Cl_2) and so it is oxidizing. Those reactions in which electronegative element is removed, are called **reduction**.

$$2FeCl_3+H_2 \rightarrow 2FeCl_2+2HCl$$

Here $FeCl_3$ is reducing to $FeCl_2$ due to removal of more electronegative element Chlorine. If all these facts are taken in a sequence then it can be said that oxidation are reactions in which oxygen or electronegative element add to a substance or hydrogen or electropositive element is removed.

In the same manner, reduction are those reactions in which hydrogen or electropositive element add to a substance or oxygen or electronegative element is removed. All these are long run concepts of oxidation reduction. At present, these terms are expanded. Oxidation reduction are explained on the basis of addition and removed of electrons.

6.4.5 On the basis of electron -

A. Oxidation-

Those reactions in which atom, ion or molecule donates electron (e^-), are called **oxidation**.

$$Na \rightarrow Na^+ + e^-$$
$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$
$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Here Sodium donates e^- and oxidizes to Na^+ cation. Ferrous (Fe^{2+}) ion donates one more e^- and oxidizes to ferric (Fe^{3+}) ion and chloride (Cl^-) ion donates e^- and oxidizes to neutral molecule. These reactions show that, in oxidation reaction, neutral atom becomes cation or charge on cation (positive ion) increases or charge on negative ion decreases.

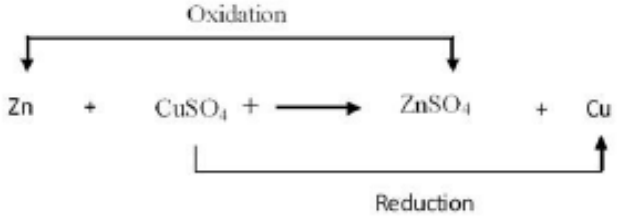
B. Reduction-

Those reactions in which atom, ion or molecule accepts e^-, are called **reduction.**

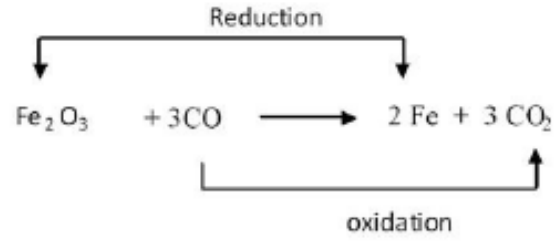
$$Cl+e^- \rightarrow Cl^-$$
$$MnO_4^- + e^- \rightarrow MnO_4^{-2}$$
$$Mg^{+2}+2e^- \rightarrow Mg$$

Here Chlorine accept e^- and reduce to chloride ion (Cl^-), permanganate ion (MnO_4^-) accept e^- and reduce in mangante ion (MnO_4^{2-}) and magnesium cation (Mg^{2+}) accept e^- and reduces to neutral Mg atom. These examples show that in reduction reactions, opposite to oxidation, e^- are accepted through which neutral atom forms anion or charge on anion increases or charge on cation decreases.

From above reactions, we can see that these are oxidation-reduction half reactions. One substance donates electron and another accept e^-. In these reactions, one substance is oxidized and another is reduced. These reactions occur simultaneously. So these are called redox reactions.



In above reaction, Zn is oxidizing to $ZnSO_4$ ($Zn \rightarrow Zn^{2+}+2e^-$) and Copper sulphate is reducing in Cu ($Cu^{2+}+2e^- \rightarrow Cu$)



In this reaction, ferric oxide (Fe_2O_3) is reducing to iron and carbon mono oxide (CO) is oxidizing to CO_2. Here in a reaction , one substance is oxidizing and another is reducing. It is called redox reaction.

In these reactions, substance which oxidize donates e^- and help another substance to reduce, is called reducing agent. The substance which reduces, accept e^- and oxidizes another substance is called oxidizing agent.

It means, reducing agent $\rightarrow$ e^- donor

oxidising agent $\rightarrow$ e^- acceptor

6-5 Neutralization

When acid and base react, then salt and water are formed, this reaction is called neutralization reaction. Here hydrogen ion (H^+) of acid reacts with hydroxyde ion (OH^-) of base and forms water.

Acid + Base $\rightarrow$ salt + water

$HCl + NaOH \rightarrow NaCl + H_2O$

When strong acid and strong base of same concentration react then pH of solution is 7, whereas if strong acid react with weak base, then its pH is less than 7. If strong base react with weak acid then pH of solution is more than 7.

It can be understood as when on mixing acid and base, same amount of acid neutralizes same amount of base and , salt is formed. One mole H^+ ion given by any acid reacts with one mole OH^- ion of base and are neutralised. Strong acid and strong base get completely ionised. So, in neutralization reaction, all H^+ and OH^- ions combine to form water and pH of solution is becomes 7.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

$$H^+ + Cl^- + Na^+ + OH^- \longrightarrow Na^+ + Cl^- + H_2O$$

So, total reaction is

$$H^+ + OH^- \longrightarrow H_2O$$

Whereas in neutralization reaction between weak base and strong acids, weak base do not ionise completely. Some amount of base remains in molecular form. On taking same moles of acid and base, quantity of H^+ ions is more than quantity of OH^- ions , so after neutralization reaction, H^+ ions are present in the solution and pH of solution is less than 7.

$$HCl + NH_4OH \longrightarrow NH_4Cl + H_2O$$

Here, NH_4OH is weak base.

In this way, in neutralization reaction of weak acid and strong base, acid do not completely ionise or dissociate and remains in undissociated form in some amount . On taking equal mole of acid and base in solution , OH^- ions are more in the solution, and pH of solution becomes more than 7.

$CH_3COOH + NaOH \rightarrow CH_3COONa + NaOH$

Acetic acid Sodium acetate

Here, acetic acid is a weak acid.

6.6 Catalyst

Those substance which change the velocity of chemical reaction but themselves remains unchanged, are called catalyst and this phenomenon is called catalysis.

$$2KClO_3 \xrightarrow[\Delta]{MnO_2} 2KCl + 3O_2$$

$$\text{Vegetable oil} + H_2 \xrightarrow{Ni} \text{Vegetable ghee}$$

Thermal dissociation of potassium chlorate occurs at low temperature on mixing MnO_2. In above reaction,

and powdered Ni metal act as catalyst.

These are divided into many types on the basis of action of catalysts, state etc.

6.6.1 Types of catalyst on the basis of physical state -

On the basis of physical state, catalysts are of

two types -

(a) Homogeneous catalyst - When in a chemical reaction, catalyst, reactants and products are in same physical state then catalyst is called homogeneous catalyst and reaction is called homogeneous catalysis.

Eg.

$$CH_3COOCH_{3(i)} + H_2O_{(i)} \xrightarrow{HCl(aq)} CH_3COOH_{(aq)} + CH_3OH_{(aq)}$$

Methyl acetate Acetic acid Methanol

$$2SO_{2(g)} + O_{2(g)} \xrightarrow{NO_{(g)}} 2SO_{3(q)}$$

Sulphur dioxide Sulphur trioxide

(b) Heterogeneous catalyst - When in a chemical reaction, physical state of reactants and catalyst are different, then catalyst is called heterogeneous catalyst and reaction is called heterogeneous catalysis.

Eg.

$$N_{2(g)} + 3H_{2(g)} \xrightarrow{Fe_{(s)}} 2NH_{3(g)}$$

$$\text{Vegetable oil}_{(i)} + H_{2(g)} \xrightarrow{Ni_{(s)}} \text{Vegetable ghee (s)}$$

In the presence of finely divided nickel metal (Ni) catalyst, vegetable oil is hydrogenated to form vegetable ghee. Here, oil is in liquid state, H_2 in gaseous state and Ni and ghee are in solid state.

6.6.2 Types of catalysts on the basis of action -

(a) Positive catalyst - Catalysts which increases the rate of chemical reactions are called positive cata lysts.

eg. $2KClO_3 \xrightarrow[\Delta]{MnO_2} 2KCl + 3O_2$

$$2SO_2 + O_2 \xrightarrow{No} 2SO_3$$

(b) Negative catalyst - Catalysts which decreases the rate (velocity) of chemical reactions are called negative catalyst.

eg. $2H_2O_2 \xrightarrow{glycreol} 2H_2O + O_2$

Hydrogen peroxide

In presence of glycerol, rate of dissociation of H_2O_2 decreases, for accumulating H_2O_2, some amount of glycerol is mixed in it.

$$2CHCl_3 + O_2 \xrightarrow{C_2H_5OH} 2COCl_2 + 2HCl$$

Chloroform Phosgene

Chloroform itself is oxidized by the oxygen in air and form phosgene gas (poisonous) for slowing down the speed of this reaction, some quantity of ethanol (C_2H_5OH) is added to it.

(c) Auto catalyst - When the product formed in a chemical reaction, itself act as catalyst i.e. increases the velocity of reaction, then the product is called auto-catalyst.

eg.

$$CH_3\ COO\ C_2H_5 + H_2O \rightarrow CH_3\ COOH + C_2H_5OH$$

ethyl acetate acetic cid ethanol

Here, initially reaction have slow speed but after the product acetic acid is formed in some amount, velocity of reaction increases. Here, acetic acid act as auto catalyst.

(d) Bio - catalyst - The substances which are used to increase the velocity of biochemical reactions are called bio-catalysts. These are generally called enzymes. Enzymes are complex nitrogenous organic compounds which are specific for different biochemical reactions.

Eg-

$$NH_2CONH_2 + H_2O \xrightarrow{Urease} 2NH_3 + CO_2$$

Urea

$$\text{Maltose} \xrightarrow{Maltase} \text{Glucose} + \text{Glucose}$$

In chemical reactions, some substances are also used, which affect the activity of catalyst-

(i) Catalyst promoter - Those substances which when added with catalyst in the reaction mixture, increases the activity of catalyst, are called catalyst promoters. They only increase the activity of catalyst and are not themselves catalyst.

Eg-

$$N_2 + 3H_2 \xrightarrow{Fe/Mo} 2NH_3$$

Here Mo (Molybdenum powder) increases

rate of reaction by increasing activity of catalyst iron (Fe).

Vegetable oil $+H_2 \xrightarrow{Ni/Cu}$ Vegetable ghee

Here Ni is catalyst and Cu is catalyst promoter.

(ii) Catalyst inhibitor - Those substances which when mixed in reaction mixture, decreases the activity of catalyst , are called catalyst inhibitor.

Eg. $N_2+3H_2 \xrightarrow{Fe} 2NH_3$

If carbon mono oxide (CO) gas is mixed in this reaction, then activity of catalyst iron (Fe) decreases.

6.6.3. Properties of Catalyst -

1. Catalyst are only responsible for the change in velocity of chemical reaction Their chemical composition and amount do not change.

2. Presence of catalyst in small amount in reaction mixture is sufficient.

3. For each reaction, there is a specific catalyst i.e. single catalyst can not catalyse all the reactions.

4. Catalyst do not initiate any reaction, it only increases the velocity.

5. In reversible reactions, catalyst affect rate of both forward and backward reaction in same way.

6. Catalyst are more active at a particular temperature only. With change in temperature, their activity is affected.

Important Points

1. The changes in physical properties of substances are called physical changes. These are temporary.

2. The changes in composition and chemical properties of substances are called chemical changes.These are permanent.

3. Chemical reactions are written in form of chemical equations. Balanced chemical equation give brief information about chemical reaction.

4. In combination reactions, two or more substances combine to form single product.

5. The displacement of an atom or group of atoms of a reactant by atoms or group of atoms of another reactant is called displacement reaction.

6. When a substance dissociate in two or more simple molecules, reaction is called dissociation reaction.

7. Reactions are called slow or fast on the basis of their velocity.

8. Reaction of an acid and base is called neutralization reaction.

9. Those reactions in which addition of oxygen or electronegative element or removal of hydrgoen or electropositive elements occur, are called oxidation reactions.

10. Those reactions in which addition of hydrogen or electropositive element or removal of oxygen or electronegative element take place, are called reduction reactions.

11. Donation of electron is oxidation and acception of electron is reduction.

12. Those reactions which proceeds in one direction only are called irreversible reactions.

13. Those reactions which proceed in both directions, i.e. reactant form product and again product form reactant, are called reversible reactions.

14. Those substance which affect the velocity of chemical reaction without changing themselves are called catalysts.

15. Catalysts are of four types → positive, negative, auto-catalyst and bio-catalyst.

16. Catalysis are of two type → Homogeneous catalysis and heterogeneous catalyst.

17. Catalyst promoter and catalyst inhibitor- affect the activity of catalyst.

Practice Questions

Objective type questions

1. Conversion of in is called-
   (a) Oxidation (b) Reduction
   (c) Dissociation (d) Combination
2. A substance breaks in two simple small molecules then reaction is called-
   (a) Dissociation (b) Displacement
   (c) Oxidation (d) Reduction
3. Substance which donate electron are called-
   (a) Oxidizing agent (b) catalyst
   (c) Reducing agent (d) None of these
4. Reactions which proceed in both directions-

(a) Oxidation (b) Reduction
(c) Irreversible (d) Reversible

5. Those which increase rate of reaction-
(a) Catalyst (b) Oxidizing agent
(c) Reducing agent (d) None of these

6. Enzymes are -
(a) Negative catalyst (b) Positive catalyst
(c) Auto catalyst (d) Bio catalyst

7. $2Mg+O_2 \rightarrow 2MgO$ In this reaction, magnesium metal is-
(a) Oxidized (b) Reduced
(c) Dissociated (d) Displaced

8. Which sign is used for reversible reaction-
(a) $\rightarrow$ (b) $\uparrow$
(c) $\downarrow$ (d) $\rightleftharpoons$

9. The reaction which is catalysed by the product formed-
(a) Bio chemical (b) Reversible
(c) Auto-Catalysed (d) Irreversible

10. In exothermic reaction, heat is
(a) released (b) absorbed
(c) soluble (d) None of these

Very short type questions

11. What is chemical change?
12. Name catalyst which changes vegetable oil in vegetable ghee?
13. How many types of catalyst are there ? Write their name.
14. $Zn+CuSO_4 \rightarrow ZnSO_4+Cu$
This is an example of which type of reaction ?
15. Give an example of redox reaction
16. What are reversible reactions ?
17. What is the work of catalyst promoter and catalyst inhibitor ?
18. What is the reaction between acid and base called?
19. How many types of reactions are there on the basis of velocity ?
20. Write an example of thermal dissociation reaction.
21. What is the work of catalyst in any reaction ?
22. What is the fundamental principle a balancing of chemical reaction ?
23. What is redox reaction ?
24. What type of reaction is burning of coal ?
25. What will be the pH of solution, when strong acid and strong base react ?

Short type questions

26. Write difference between physical and chemical change.
27. Write one example of combination and decomposition reaction.
28. $AgNO_3+KCl \rightarrow AgCl+KNO_3$
Which type of reaction is this ? Write the name and explain.
29. Explain oxidation and reduction on the basis of electronic change.
30. What are the types of catalyst ? Write their name.
31. Explain the types of dissociation reactions?
32. Why some amount of ethyl alcohol is added in chloroform ?
33. Aqueous solution of salt formed by weak acid and strong base is alkaline. Why ?
34. Are these reactions possible ? Write answer with reason.
(i) $Cu+ZnSO_4 \rightarrow CuSO_4+Zn$
(ii) $Fe+CuSO_4 \rightarrow FeSO_4+Cu$
35. Identify oxidation - reduction in following reactions.
(i) $C+O_2 \rightarrow CO_2$
(ii) $Mg+Cl_2 \rightarrow MgCl_2$
(iii) $ZnO+C \rightarrow Zn+CO$
(iv) $Fe_2O_3+3CO \rightarrow 2Fe+3CO_2$

Essay type questions

36. How many types of chemical reactions are there? Explain.

37. What do you mean by oxidation - reduction ? Explain with examples.
38. What do you know about types and properties of catalyst ?
39. Write steps of writing chemical equation and its properties.
40. Write differences-
    (a) Reversible - irreversible reactions.
    (b) Catalyst promoter - Catalyst inhibitor
    (c) Homogeneous - Heterogeneous catalysis
    (d) Oxidation - Reduction inhibitor.

Answer key

1. (b) 2. (a) 3. (c) 4. (d) 5. (a)
6. (d) 7. (a) 8. (d) 9. (c) 10. (a)