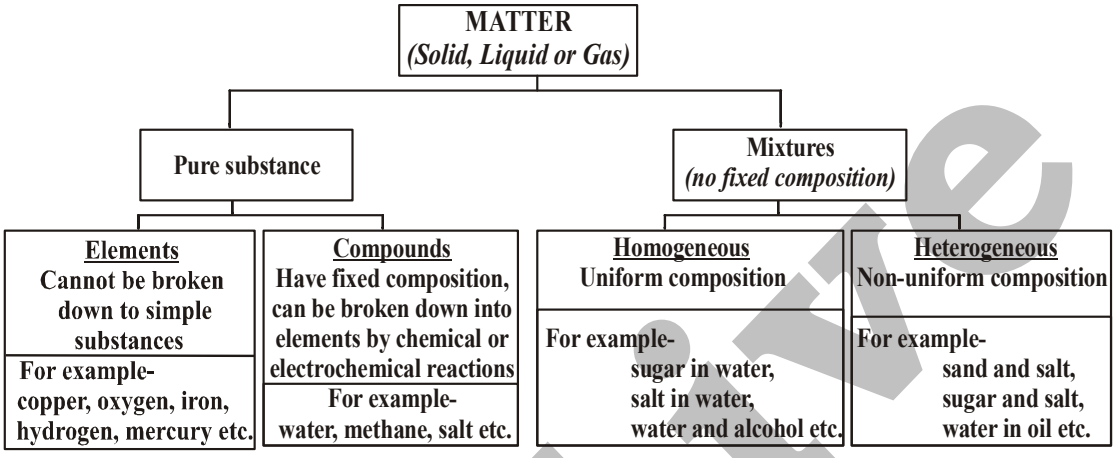
1. *Matter*

Contents

MATTER 1



MATTER:

Anything which occupies space and has mass is called matter.

Example: Air, water, hydrogen, oxygen, milk and oil etc.

Everything around us is made of tiny particles. The particles which make up matter are atoms.

The particles which make up the matter are constantly in motion. This motion of particles is known as Brownian Motion.

BROWNIAN MOTION:

The zig-zag movement of the small particles suspended in a liquid (or gas) is called Brownian motion.

Brownian motion increases on increasing the temperature.

The existence of brownian motion gives us two conclusions about the nature of matter:

1) That matter is made up of tiny particles and
2) That the particles of matter are constantly moving.

Example:

1) Water is made up of tiny particles which are moving very fast. The pollen grains move on the surface of water because they are constantly being hit by the fast moving particles of water.
2) When a beam of sunlight enters a room we can see tiny dust particles suspended in air which are moving rapidly in a very haphazard way. The tiny dust particles move here and there because they are constantly hit by the fast moving particles of air.

CHARACTERISTICS OF PARTICLES OF MATTER

The important characteristics of particles of matter are as follows:-

1) Matter is made up of Particles.
2) The particles of matter are very, very small.
3) The particles of matter have spaces between them.
4) The particles of matter are constantly moving.
5) The particles of matter attract each other.

RIGID AND FLUID:

Rigid means unbending or inflexible. A stone is rigid because it is unbending or inflexible. A solid is a rigid form of matter.

Fluid means a material which can flow

easily and requires a vessel (or container) to keep it. A liquid and a gas are a fluid form of matter.

SOLIDS: There is a strong force of attraction between the particles of a solid which holds them together in fixed positions. The particles of a solid only vibrate about their fixed positions. They cannot move from one position to another.

If a solid is heated, its particles start vibrating faster. The spaces (or distances)between the particles of a solid are very, very small. The particles of a solid have the minimum kinetic energy. Due to this solid have the most orderly arrangement of particles.

PROPERTIES OF SOLIDS

Solids have the following characteristic properties:

1) Solid have a fixed shape and a fixed volume.
2) Solid cannot be compressed much.
3) Solid have high densities. They are heavy.
4) Solid do not fill their container completely.
5) Solid do not flow.

LIQUIDS:

The spaces between the particles of a liquid are slightly more than that in a solid but they are still very small. There is a quite strong force of attraction between the particles of a liquid which holds them together but the force is not strong enough to hold the particles in fixed positions. So due to comparatively less strong interparticle forces the positions of particles in a liquid are not fixed. The particles of a liquid can move from one position to another within the liquid.

The particles of a liquid have more kinetic energy than the particles of a solid. Due to this liquid have a more disorderly arrangement of particles than solid. The particles in a liquid are also vibrating. If a liquid is heated then its particles begin to move faster.

PROPERTIES OF LIQUIDS

Liquids have the following characteristic properties :

1) Liquids have a fixed volume but they have no fixed shape.
2) Like solids, liquids cannot be compressed much.
3) Liquids have moderate to high densities. They are usually less dense than solids.
4) Liquids do not fill their container completely.
5) Liquid generally flow easily.

GASES:

The spaces (or distances) between the particles of a gas are very large. The force of attraction between the particles of a gas is negligible. So the particles of a gas are free to move in any direction. The positions of particles of a gas as well as the spaces between the particles of a gas are not fixed.

The particles of a gas have the maximum movement (or maximum kinetic energy). Due to this the gases have the most disorderly arrangement of particles. Because of high kinetic energy and negligible forces of attraction the particles of a gas move with high speed in all directions.

PROPERTIES OF GASES

Gases have the following characteristic properties:

1) Gases have neither a fixed shape nor a fixed volume.
2) Gases can be compressed easily.
3) Gases have very low density.
4) Gases fill their container completely.
5) Gases flow easily.

COMPRESSION:

The solids and liquids do not get compressed but gases can be compressed easily (by applying pressure).

Gases have high compressibility. They can be compressed into very small volume by applying large pressures. Due to its high compressibility fairly large mass of a gas can be put in a small metal cylinder by compression. Such gas cylinders can be transported conveniently from one place to another. The cooking gas (liquified petroleum gas-LPG) which we use in our homes is a compressed gas. The oxygen gas supplied to hospitals in cylinders is also in compressed form and compressed natural gas (CNG) filled in cylinders is being used increasingly as fuel to run vehicles like cars and buses.

DIFFUSION:

The spreading out and mixing of a substance with another substance due to the motion of its particles is called diffusion.

Diffusion is a property of matter which is based on the motion (or movements) of its particles. Diffusion occurs in gases, liquids and solids. Diffusion is fastest in gases and slowest in solids. The rate of diffusion increases on increasing the temperature of diffusing substance.

DIFFUSION IN GASES:

Diffusion in gases is very fast. This is because the particles in gases move very quickly in all directions.

1) The smell of food being cooked in the kitchen reaches us even from a considerable distance by the process of diffusion.
2) The smell of perfume spreads due to the diffusion of perfume vapours into air.
3) The leakage of cooking gas (LPG) in our homes is detected due to the diffusion of a strong smelling substance (ethyl mercaptan) present in the cooking gas into air.

DIFFUSION IN LIQUIDS

Diffusion in liquids is slower than that in gases. This is because the particles in liquids move slower as compared to the particles in gases.

DIFFUSION IN SOLIDS

Diffusion in solids is a very very slow process.

CHANGE OF STATE OF MATTER:

Matter can exist in three physical states: solid state, liquid state and gaseous state (or vapour state). Under normal pressure, water exists as a solid in the form of ice at a temperature 0^0C or below. It exists as a liquid in the form of water at room temperature and as a gas in the form of steam at a temperature of 100^0 C or above. The two factors which decide whether a given substance would be in a solid, liquid or gaseous state are: temperature and pressure.

MELTING:

The process in which a solid substance change into a liquid on heating is called melting (or fusion).

The temperature at which a solid substance melts and changes into a liquid at atmospheric pressure is called melting point of the substance. For example ice melts at a temperature of 0^0 C to form liquid water. So the melting point of ice is 0^0 C (zero degree Celsius). At melting point ice changes its state from solid to liquid.

The process in which a liquid substance changes into a gas on heating is called boiling. The temperature at which a liquid boils and changes into a gas at atmospheric pressure is called boiling point of the liquid. For example when water is heated to a temperature of 100^0 C, it boils rapidly to form gas called steam. So the boiling point of water is 100^0 C (hundred degrees Celsius). At boiling point water changes its state from liquid to gas (or vapour).

CONDENSATION:

The Condensation is the reverse of boiling (or vaporization).

The process of changing a gas to liquid by cooling is called condensation. When steam (or water vapour) changes into water on cooling, it is called condensation of steam.

FREEZING:

The freezing is the reverse of melting. The process of changing a liquid into a solid by cooling is called freezing. Freezing means solidification. When water freezes to form ice, then there is a change from liquid state to solid state.

LATENT HEAT:

The heat energy which has to be supplied to change the state of a substance is called its latent heat. Latent heat does not rise (or increase) the temperature. But latent heat has always to be supplied to change the state of a substance. The word latent means hidden.

Latent heat is of two types.

1) Latent heat of fusion.
2) Latent heat of vaporization.

The heat required to convert a solid into the liquid state is called latent heat of fusion (or latent heat of melting). The latent heat of fusion

of ice is $3.34x10^5$ joules per kilogram (or 3.34×10^5 j/kg). And the heat required to convert a liquid into the vapour state (or gas) is called latent heat of vaporization. The latent heat of vaporization of water is 22.5×10^5 joules per kilogram (or 22.5×10^5 j/kg).

SUBLIMATION:

The changing of a solid directly into vapours on heating and of vapours into solid on cooling is known as sublimation. The solid obtained by cooling the vapours of the solid is called a Sublimate.

$$\text{Solid} \underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}} \text{Vapour (or Gas)}$$

The solid substance which undergoes sublimation is said to sublimate. The common substances which undergo sublimation are: Ammonium chloride, Iodine, camphor, naphthalene and anthracene. Solid Carbon dioxide (Commonly called dry ice) sublimes to form Carbon-dioxide gas.

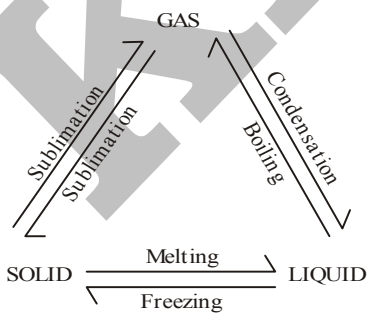
EVAPORATION

When a liquid turns into vapour (or gas), it is said to evaporate. The process of a liquid changing into water vapour even below its boiling point is called evaporation. Whatever be the temperature at which evaporation takes place, the latent heat of vaporization must be supplied whenever a liquid changes into vapour.

The evaporation of a liquid depends mainly on the following factors:

1) Temperature. 2) Surface area.
3) Humidity. 4) Wind speed.

The interconversion of the three states of matter can be shown by the following diagram:



Quick Recap

1. Matter is made up of small particles.
2. The matter around us exists in three states-
   Solid, Liquid and Gas
3. The force of attraction also called intermolecular attraction is maximum in solid, intermediate in liquid and minimum in gas.
4. Arrangement of particles in solid is most ordered in solid. In liquids layers of particles can slip and slide over each other while for gases, there is no order, particles just move about randomly.
5. Intermolecular space is minimum in solid, intermediate in liquid and maximum in gas.
6. The state of matter is inter-convertible i.e. the state can be changed by changing temperature or pressure.
7. Sublimation is the change of solid state directly to gaseous state without going through liquid state and vice versa.
8. Boiling is a Pulk phenomenon.
9. Evaporation is a surface phenomenon. Evaporation causes cooling.
10. Latent heat - Heat energy required to change the state of a substance without change in temperature. It is also called hidden heat.
11. Latent heat of vaporisation is the heat energy required to change 1kg of a liquid to gas at atmospheric pressure and its boiling point.
12. Latent heat of fusion is the amount of heat energy required to change 1 kg of solid into liquid at its melting point.
13. Diffusion is negligible in solid, slower in liquid and maximum in gases.
14. Substances showing sublimation are–
    (i) Camphor
    (ii) Iodine
    (iii) Ammonium chloride
    (iv) Napthalene
    (v) Anthracene
15. Brownian motion is the Zig-Zag movement of the small particle suspended in liquid (or gas).
16. Solid carbon dioxide (commonly known as dry ice) sublimes to form carbon dioxide gas.
17. Applying pressure and reducing temperature can liquefy gases.

2. *Pure Substance*

Contents

PURE SUBSTANCES 2

A pure substance is one which is made up of only one kind of particles, atoms or molecules. All the elements and compounds are pure substances because they contain only one kind of particles.

Example:

Hydrogen, oxygen, nitrogen, chlorine, carbon etc.

ELEMENTS:

An element is a substance which cannot be split up into two or more simpler substances by the usual chemical methods of applying heat, light or electric energy.

Example:

Hydrogen is an element because it cannot be split up into two or more simpler substance.

There are 115 elements known at present out of which 92 elements occur in nature while the remaining 23 elements have been prepared artificially. Every substance in this world is made up of one or more of these elements. Elements can be solids, liquids or gases. Only two elements (mercury and bromine) are liquids at the room temperature.

Even the human body is made up of complex compounds formed by the combination of only certain elements. For example the human body contains 65% oxygen element, 18% carbon element, 10% hydrogen element, 3% nitrogen element, 2% calcium element and 2% other elements.

Commonest element (lithosphere)	Oxygen
Commonest element (atmosphere)	Nitrogen
Commonest element (universe)	Hydrogen
Rarest element	Astatine
Lightest element (metal)	Lithium
Heaviest element (gas)	Radon
Lightest element (gas)	Hydrogen

On the basis of their properties all the elements can be divided into three groups:

1) Metals 2) Non metals
3) Metalloids

METALS:

A metal is an element that is malleable and ductile and conducts electricity.

Example:

Iron, copper, zinc, silver etc.

See the following representation :

Malleable.
Electricity Conductor.
Tensile strength hight.
Alloy can be formed.
Lustrous.
Sonorous.

NON-METALS:

A non-metals is an element that is neither malleable nor ductile and does not conduct electricity.

Example:

Carbon, sulphur, phosphorus, hydrogen etc.

All the non metals are solids or gases except bromine which is a liquid non metal at room temperature.

METALLOIDS:

There are a few elements which show some properties of metals and some other properties of non metals. They are called metalloids.

Example:

Boron (B), Silicon (Si), Germanium (Ge) etc.

Metalloids are also sometimes called semi metals.

MIXTURES:

A mixture is a substance which consists of two or more elements or compounds not chemically combined together.

Example:

Air is a mixture of gases like oxygen, nitrogen, argon, carbon dioxide, water vapour etc.

All the solutions are mixtures. Substances present in a mixture are known as constituents of the mixture or components of the mixture.

Mixtures are of two types:

1) Homogeneous mixture:

Those mixtures in which the substances are completely mixed together and are indistinguishable from one another are called homogeneous mixtures. All the homogeneous mixtures are called solutions.

Example : sugar solution, salt solution, Copper Sulphate solution, mixture of Petrol and Oil etc.

2) Heterogeneous mixture:

Those mixtures in which the substances remain separate and one substance is spread throughout the other substance as small particles droplets or bubbles are called heterogeneous mixtures. Suspensions of solid in liquids are also heterogeneous mixtures. Suspensions and colloids are heterogeneous mixtures.
Example:

Sugar and sand mixture, salt and sand mixture, polluted air etc.

Most of the mixtures are heterogeneous. Only solutions and alloys are homogeneous mixtures.

The properties of mixture :

1) A mixture can be separated into its constituents by physical processes (like filtration, evaporation, sublimation, distillation, solvents, magnet etc.)
2) A mixture shows the properties of its constituent elements.
3) Energy (in the form of heat, light etc.) is usually neither given out nor absorbed in the preparation of a mixture.
4) The composition of a mixture is variable. The constituents can be present in any proportion by mass. Hence a mixture does not have a definite formula.
5) A mixture does not have fixed melting point, boiling point etc.

COMPOUNDS:

A compound is a substance made up of two or more elements chemically combined in a fixed proportion by mass.

Example :

Ammonia (NH_3), Carbon dioxide (CO_2), water etc. Compounds can be further divided into three classes acids, bases and salts on the basis of their properties.

The properties of Compounds :

1) A compound cannot be separated into its constituent elements by physical processes (it can only be separated into its constituents by chemical processes).
2) The properties of a compound are entirely different from those of its constituent elements.
3) Energy (in the form of heat light etc.)is usually given out or absorbed during the preparation of a compound.
4) The composition of a compound is fixed. The constituents are present in fixed proportion by mass. A compound has a definite formula.
5) A compound has a fixed melting point, boiling point etc.

SOLUTIONS:

A solution is a homogeneous mixture of two (or more) substances. A homogeneous mixture means that the mixture is just the same throughout. The substance which is dissolved in a liquid to make a solution is called solute and the liquid in which solute is dissolved is known as solvent.

Example:

salt solution, sugar solution, etc.

The properties of a solution :

1) A solution is a homogeneous mixture.
2) The size of solute particles in a solution is extremely small. It is less than 1 nm in diameter.

   (1 nanometre=10^{-9} metre.)

3) The particles of a solution cannot be seen even with a microscope.

4) The particles of a solution pass through the filter paper. So a solution cannot be separated by filtration.

5) The solutions are very stable. The particles of solute present in a solution do not separate out on keeping the solution.

6) A true solution does not scatter light (this is because its particles are very, very small).

Concentration of a Solution:

The concentration of a solution is the amount of solute present in a given amount (mass or volume) of solution, or the amount of solute dissolved in a given mass or volume of solvent.

$$\text{Concentration of Solution} = \frac{\text{Amount of Solute}}{\text{Amount of Solution}}$$

There are two ways of expressing the concentration of a Solution.

(i) Mass by mass percentage of a Solution

$$= \frac{\text{Mass of Solute}}{\text{Mass of Solution}} \times 100$$

(ii) Mass by volume percentage of a Solution

$$= \frac{\text{Mass of Solute}}{\text{Volume of Solution}} \times 100$$

SUSPENSIONS:

A suspension is a heterogeneous mixture in which the small particles of a solid are spread throughout a liquid without dissolving in it.

Example:

Chalk water mixture, muddy water, milk of magnesia, sand particles suspended in water and flour in water etc.

The properties of a suspension:

1) A suspension is a heterogeneous mixture.

2) The size of solute particles in a suspension is quite large. It is larger than 100 nm in diameter.

3) The particles of a suspension can be seen easily.

4) The particles of a suspension do not pass through a filter paper. So a suspension can be separated by filtration.

5) The suspensions are unstable. The particles of a suspension settle down after some time.

6) A suspension scatters a beam of light passing through it (because its particles are quite large).

COLLOIDS:

A colloid is a kind of solution in which the size of solute particles is intermediate between those in true solutions and those in suspensions.

Example:

Soap solution, starch solution, milk, ink, blood, jelly and solutions of synthetic detergents etc.

The properties of colloids :

1) A colloid (or colloidal solution) appears to be homogeneous but actually it is heterogeneous.

2) The size of particles in a colloid (or colloidal solution) is bigger than those in a true solution but smaller than those in a suspension. It is between 1 nm and 100 nm in diameter.

3) The particles of most of the colloid (or colloidal solutions) cannot be seen even with a microscope.

4) The particles of a colloid (or colloidal solution) can pass through a filter paper. So a colloid cannot be separated by filtration.

5) The colloid (or colloid solution) are quite stable. The particles of a colloid do not separate out on keeping.

6) A colloid (or colloidal solution) scatters a beam of light passing through it (because its particles are fairly large).

Common examples of colliods

Dispresed Phase	Dispersing Medium	Type	Example
Liquid	Gas	Aerosol	Fog, clouds, mist
Solid	Gas	Aerosol	Smoke, automobile exhaust
Gas	Liquid	Foam	Shaving cream
Liquid	Liquid	Emulsion	Milk, face cream
Solid	Liquid	Sol	Milk of magnesina, Mud
Gas	Solid	Foam	Foam, rubber, sponge
Liquid	Solid	Gel	Jelly, cheese, butter
Solid	Solid	Solid sol	Coloured gemstone, milky glass

SOLUBILITY

The maximum amount of a solute which can be dissolved in 100 grams of a solvent at a specified temperature is known as the solubility of that solute in that solvent (at that temperature) For example: A maximum of 32 grams of Potassium Nitrate can be dissolved in 100 grams of water at 20^0C. Therefore the solubility of Potassium Nitrate in water is 32 grams at 20^0 C.

The effect of temperature and pressure on the solubility of a substance:

1) The solubility of solids in liquids usually increases on increasing the temperature and decreases on decreasing the temperature.
2) The solubility of solids in liquids remains unaffected by the changes in pressure.
3) The solubility of gases in liquids usually decreases on increasing the temperature and increases on decreasing the temperature.
4) The solubility of gases in liquids increases on increasing the pressure and decreases on decreasing the pressure.

PHYSICAL CHANGES:

Those changes in which no new substances are formed are called physical change.

Example :

Melting of ice (to form water), freezing of water (to form ice), Boiling of water (to form steam) etc.

The properties of physical change :

1) No new substance is formed in a physical change.
2) A physical change is a temporary change.
3) A physical change is easily reversible.
4) Very little heat or light energy is usually absorbed or given out in a physical change.
5) The mass of a substance does not alter in a physical change.

CHEMICAL CHANGES:

Those changes in which new substances are formed are called chemical changes.

Example :

Burning of a magnesium wire, burning of paper, Rusting of iron, Formation of curd from milk and cooking of food etc.

The properties of chemical change :

1) A new substance is formed in a chemical change.
2) A chemical change is a permanent change.
3) A chemical change is a usually irreversible.
4) A lot of heat (or light) energy is absorbed or given out in a chemical change.
5) The mass of a substance alter in a chemical change.

SEPARATION OF MIXTURES:

The method to be used for separating a mixture depends on the nature of its constituents. Different mixtures are separated by using different physical processes. The various physical processes which are commonly used to separate the constituents of mixtures are: sublimation, magnet, solvents, filtration, centrifugation, evaporation, crystallization, chromatography, distillation, fractional distillation and separating funnel. In some cases more than one of these processes are used for separating a mixture.

SEPARATION OF MIXTURE OF TWO SOLIDS

All the mixtures containing two solid substances can be separated by one of the following methods.

1) By using a suitable solvent.

2) By the process of sublimation.
3) By using a magnet.

1. Separation by a Suitable Solvent

One constituent of a mixture is soluble in a particular liquid solvent whereas the other constituent is insoluble in it. This difference in the solubilities of the constituents of a mixture can be used to separate them. For example sugar is soluble in water whereas sand is insoluble in it. So a mixture of sugar and sand can be separated by using water as solvent.

2. Separation by Sublimation

The changing of a solid directly into vapours on heating, and of vapours into solid on cooling is called sublimation. The process of sublimation is used to separate those substances from a mixture which sublime on heating. The solid substance obtained by cooling the vapours is known as sublimate. The substance like ammonium chloride, iodine, camphor, naphthalene and anthracene sublime on heating and can be recovered in the form of a sublimate by cooling their vapours. This means that ammonium chloride, iodine, camphor, naphthalene and anthracene change directly from solid to vapours on heating and from vapours to solid on cooling.

3. Separation by Magnet

Iron is attracted by a magnet. This property of iron is used to separate it from a mixture. So if a mixture contains iron as one of the constituents, it can be separated by using a magnet. For example a mixture of iron filings and sulphur powder can be separated by using a magnet. This is because iron filings are attracted by a magnet but sulphur is not attracted by a magnet.

SEPARATION OF MIXTURE OF A SOLID AND A LIQUID

All the mixtures containing a solid and a liquid are separated by one of the following processes:

1) By filtration.
2) By centrifugation.
3) By evaporation.
4) By crystallization.
5) By chromatography.
6) By distillation.

1. Separation by filtration

Filtration is used for separating insoluble substances from a liquid. The mixture of insoluble solid and liquid is poured into a filter paper cone fixed in a funnel by using a glass rod as a guide. The liquid passes through the filter paper and collects in the beaker kept below the funnel. The solid particles do not pass through the filter paper and remain behind on the filter paper. The solid substance left behind on the filter paper is called residue. The clear liquid obtained is called filtrate. In this way a mixture of insoluble solid in a liquid is separated into solid and clear liquid.

2) Separation by Centrifugation

If we have a mixture of fine suspended particles in a liquid we can separate it by the process of filtration by using a filter paper. This process is however very slow. But we can separate the suspended particles of a substance in a liquid very rapidly by using the method of centrifugation. Centrifugation is a method for separating the suspended particles of a substance from a liquid in which the mixture is rotated (or spun) at a high speed in a centrifuge.

3) Separation by Evaporation:-

Evaporation is used to separate a solid substance that has dissolved in water (or any other liquid).

4) Purification by Crystallization:-

The process of cooling a hot, concentrated solution of a substance to obtain crystals is called crystallization. The process of crystallization is used for obtaining pure solid from an impure sample.

5) Separation by Chromatography:

Chromatography is a technique of separating two (or more) dissolved solids which are present in a solution in very small quantities. Black ink is a mixture of several coloured substances (or dyes) which can be separated by paper chromatography.

6) Separation by Distillation:-

Distillation is the process of heating a liquid to form vapour, and then cooling the vapour to get back liquid.

SEPARATION OF MIXTURE OF TWO (OR MORE) LIQUIDS: All the mixtures containing two (or more) liquids can be separated by one of the following two methods:

1. By the Process of fractional distillation,
2. By using a separating funnel.

1. Separation by Fractional Distillation

Fractional distillation is the process of separating two (or more) miscible liquids by distillation, the distillate being collected in fractions boiling at different temperatures. The separation of two liquids by fractional distillation depends on the difference in their boiling points.

Petroleum is a mixture of hydrocarbons believed to have originated from bacterial decomposition of animal and vegetable fats under high pressure and atmospheric temperature. It is converted into a variety of products by fractional distillation, based on the principle that lower hydrocarbons boil at a lower temperature than the higher ones.

LPG

Domestic gas, also known as LPG or bottled gas or liquified petroleum gas is a by-product of petroleum refining and also obtained from natural gas. It is a mixture of hydrocarbons such as propane, butane and pentane. These gases can be liquified under moderate pressure at normal temperature. Because of low boiling point (-44°C) these gases are stored under pressure to keep in a liquid state in gas cylinders.

Products Obtained from Petroleum

	Fraction	***Distillation Temperature Range (K)***	***Approx.%***	***Uses***
1.	Gaseous hydrocarbons	<293	3	As fuel and for gasoline and rubber manufacture.
2.	Light distillates	293-393	3	As solvent in varnish, dry cleaning.
	Petroleum, ether, Petrol or gasoline,	343-473	32	Motor fuel.
	Kerosene oil	450-560	18	Fuel and illuminant.
3.	Intermediate distillates Gas oil, diesel or heavy oil	525-673	20	Fuel
4.	Heavy distillates Lubricating oils, gaseous and in toilet goods, petroleum jelly	>673	-	Used as a Lubricant, ointments.
	Paraffin (wax)	>673	-	Candles, boot polish, etc.
5.	Residue	Residue	>40	Fuel, for making electrodes.
	Asphalt, petroleum coke			

2. Separation by a separation funnel

A mixture of two immiscible liquids can be separated by using a separating funnel. A separating funnel is a special type of funnel which has a stop-cock (or top) in its stem to allow the flow of a liquid from it, or to stop the flow of liquid from it. The separation of two immiscible liquids by a separating funnel depends on the difference in their densities.

Example :

Water and kerosene oil are two immiscible liquids. So a mixture of water and kerosene can be separated by using a separating funnel.

Quick Recap

1. Pure substance consists of a single type of particle.
2. **Elements-** Cannot be broken down to simpler substances. Ex-Na, K, Cu etc.
3. **Compounds-** Have fixed composition, can be broken down into elements by chemical or

   electrochemical reaction. Ex - H_2O, NaCl etc.
4. Mixture is a substance which consists of two or more elements or compounds not combined chemically. Ex - Air.
5. Homogenous mixture in which the substances completely mixed together and have uniform composition throughout. Ex- Salt or Sugar in water.
6. Heterogenous mixture- Mixtures which contain physically district parts and have non-uniform compositions. Ex- Mixture of sodium Chloride and Iron filings, oil and water.
7. Solution is a homogenous mixture of two or more substances. Ex lemonade, soda water etc. Solid solution (Alloy) gaseous solution (Air).
8. Alloy are mixtures of two or more metals or a metal and a non-metal and cannot be separated into their components by physical methods.
9. The components of solution are a solute and a solvent.
10. Air is a homogenous mixture of Oxygen – 21%, Nitrogen 78% and other gases 1%.
11. Solubility - The amount of the solute present in the saturated solution at a given temperature is called solubility.
12. Saturated solution -When no more solute can be dissolved in a solution at a given temperature it is called saturated solution.
13. Unsaturated solution- If the amount of solute contained in a solution is less than the saturated level it is called unsaturated solution.
14. Concentration of solution

$$= \frac{\text{Amount of solute}}{\text{Amount of solvent}}$$

15. Suspension - A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended through out the bulk of the medium.
16. Colloids - A colloid is a kind of solution in which the size of solute particles is intermediate between those in true solutions and those in suspensions.
17. Tyndall effect - The scattering of a beam of light is called tyndall effect after the name of scientist who discovered it.
18. Colloidal particles can be separated by a special technique of separation known as centrifugation.
19. Heterogenous mixtures can be separated by simple physical methods like hand picking, sieving, filteration etc.
20. Two immiscible liquid can be separated by separating funnel.
21. Chromotography technique can be used for separation of those solutes that dissolves in the same solvent.
22. Sublimation process can be used for those substance which directly changes from solid to gaseous state on heating. Ex- Iodine, Camphor, Napthalene, Ammonium Chloride, Anthracene.
23. Two miscible liquid can be separated by distillation process.
24. Crytallisation method is used to purify solids.

3. *Atoms & Molecules*

Contents

ATOMS AND MOLECULES 3

Introduction:

Around 500 BC an Indian philosopher Maharishi Kauad said that if we go on dividing matter we shall get smaller particles. He named it Parmanu.

Later in the same era Greek Philosophers Domocritus and Leucippus suggested that it we go on dividing matter we shall get particles which cannot be divided. They name it atoms. By the end of eighteenth century scientist recognised the difference between elements and compounds. Antoine L. Lavoisier laid the foundation of chemical science by establishing two important laws of chemical combination.

I. Laws of Chemical Combination

(1) Law of Conservation of Mass:- This law states that mass can neither be created nor destroyed in a chemical reaction. The total mass of the products is the same as the total mass of reactants.

(2) Law of Constant Proportions:- This law was stated by Proust. It states that a pure chemical compound always consists of the same elements combined together in a fixed proportion by weight. e.g H_2O prepared from any source contains H & O in the ratio of 1:8 by mass.

Dalton's Atomic Theory

According to Dalton's atomic theory

1. All matter is made of very tiny particles called atoms.
2. Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction.
3. Atoms of a given element are identical in mass and chemical properties.
4. Atoms of different elements have different masses and chemical properties.
5. When elements react, their atoms combine in simple whole number ratio.

III Atoms

Atoms **-** An atom is the smallest part of an element that can take part in a chemical reaction. The size of an atom is indicated by its radius which is called atomic radius. Atomic radius is measured in nanometre

$$1 \text{ nanometre} = \frac{1}{10^9} = 1 \text{ nm}$$

$$1 \text{ m} = 10^9 \text{ nm}$$

Relative sizes Radii (in m)	**Example**
10^{-10}	Atom of Hydrogen (smallest atom of all)
10^{-9}	Molecule of water
10^{-8}	Molecule of haemoglobin
10^{-4}	Grain of sand
10^{-2}	Ant
10^{-1}	Watermelon

Symbols of Elements

The symbols of elements are formed from the first letter of the name and a letter appearing later in the name.

Ex are (i) Chlorine Cl (ii) Zinc Zn etc.

The chemical symbols of some of the important elements derived from their English names are given below.

Symbol derived from English name of the Elements

Sl. No.	Elements name	Symbol	Sl. No.	Elements name	Symbol
1.	Hydrogen	H	2.	Helium	He
3.	Lithium	Li	4.	Boron	B
5.	Carbon	C	6.	Nitrogen	N
7.	Oxygen	O	8.	Fluorine	F
9.	Neon	Ne	10.	Magnesium	Mg
11.	Aluminium	Al	12.	Silicon	Si
13.	Phosphorous	P	14.	Sulphur	S
15.	Chlorine	Cl	16.	Argon	Ar
17.	Calcium	Ca	18.	Manganese	Mn
19.	Nickel	Ni	20.	Zinc	Z
21.	Bromine	Br	22.	Krypton	Kr
23.	Iodine	I	24.	Barium	Ba
25.	Uranium	U	26.	Cobalt	Co

The chemical symbols of the important elements derived from their Latin names given below

Symbols Derived from the Latin names of the Elements

Sl. No.	English name of the element	Latin name of the elements	Symbol
1.	Sodium	Natrium	Na
2.	Potassium	Kalium	K
3.	Iron	Ferrum	Fe
4.	Copper	Cuprum	Cu
5.	Silver	Argentum	Ag
6.	Gold	Aurum	Au
7.	Mercury	Hydragyrum	Hg
8.	Lead	Plumbum	Pb
9.	Tin	Stannum	Sn

Atomic Mass

Atomic mass of an element can be defined as the number which indicates how many times the mass of one atom of the element is heavier in comparision to $\frac{1}{12}$ th part of the mass of one atom of carbon.

$$\text{Atomic mass} = \frac{\text{Mass of one atom of element}}{1/12\text{th part of mass of one atom of carbon}}$$

Atomic Masses of few element

Elements	Atomic mass (μ)	Elements	Atomic mass (μ)
Hydrogen	1	Carbon	12
Nitrogen	14	Oxygen	16
Sodium	3	Magnesium	24
Sulphur	32	Chlorine	35.5
Calcium	40		

Gram Atomic mass

The amount of a substance whose mass in grams is numerically equal to its atomic mass is called gram atomic mass. For example - Atomic mass of Oxygen, O = 16 μ .

So, gram atomic mass of Oxygen O = 16 grams (or 16g).

Molecules

A molecule is in general a group of two or more atoms that are chemically bonded together.

A molecule can be defined as the smallest particle of an element or a compound that is capable of an independent existence and shows all the properties of that substance.

Molecules of Elements

The molecules of an element are constituted by the same type of atoms chemically combined together. For example- A molecule of hydrogen contains 2 hydrogen atoms combined together and it is written as H_2 .

Atomicity

The number of atoms constituting a molecule is known as its atomicity. Atomicity of some elements (non-metals) are given below –

Name	Atomicity	Name	Atomicity
Argon	Monoatomic	Helium	Monoatomic
Oxygen	Diatomic	Hydrogen	Diatomic
Nitrogen	Diatomic	Chlorine	Diatomic
Ozone	Triatomic	Phosphorous	Tetra-atomic
Sulphur	Poly-atomic		

Molecules of compounds

Atoms of different elements join together in definite proportions to form molecules of a compound. For example- Hydrogen chloride is a compound. Its molecule contains two different types of atoms hydrogen atom (H) and chlorine atom (Cl).

Chemical formulae

A chemical formula represents the composition of a molecule of the substance in terms of the symbols of the elements present in the molecules. A chemical formula is also known as molecular formula. The formula can be of element or a compound.

Molecular formulae of some common elements

Element	Formula	Element	Formula	Element	Formula
Hydrogen	H_2	Nitrogen	N_2	Oxygen	O_2
Chlorine	Cl_2	Bromine	Br_2	Iodine	I_2
Phosphorous	P_4	Sulphur	S_6		

Formula of Compounds

The Chemical formula of a compound is a statement of its composition. The chemical symbol tell us which elements are represented and the subscripts tells us how many atoms of each element are presents in one molecule of the compound.

Formulae of some Molecular compounds

	Name	Formula	Elements present
1.	Water	H_2O	H & O
2.	Carbon dioxide	CO_2	C & O
3.	Sulphure dioxide	SO_2	S & O
4.	Ammonia	NH_3	N & H
5.	Methan	CH_4	C & H
6.	Ethanol	C_2H_5OH	C, H & O
7.	Carbon tetrachloride	CCl_4	C & Cl
8.	Hydrogen Chloride	HCl	H & Cl
9.	Hydrogen Sulphide	H_2S	H & S
10.	Carbon disulphide	Cs_2	C & S

Molecular Mass

The molecular mass of a substance is the relative mass of its molecule as compared with the mass of a carbon 12 atom taken as 12 units

$$\text{Molecular mass} = \frac{\text{Mass of one molecule of substance}}{\frac{1}{12}\text{th mass of one atom of C-12}}$$

Molecular mass of some common Elements

	Element	Symbol	Atomic mass	Molecular formula	Molecular Mass
1.	Hydrogen	H	1 µ	H_2	1×2=2 u
2.	Nitrogen	N	14 µ	N_2	2×14=24u
3.	Oxygen	O	16 µ	O_2	16×2=32u
4.	Chlorine	Cl	35.5 µ	Cl_2	2×35.5=71u

Gram Molecular Mass

The amount of a substance whose mass in gram is numerically equal to its molecular mass is called gram molecular mass of that substance.

For example -

Molecular mass of Oxygen O_2 =32u

So, gram molecular mass of Oxygen O_2 = 32 gram or 32 g

Ions : An ion is positively or negatively charged atom (or group of atoms)

Cations : A positively charged ion is known as cation. Sodium ion Na^+ and Magnesium ion Mg^{2+} are cations because they are positively charged. A cation is formed by the loss of one or more electron by an atom.

$$Na \xrightarrow{\text{-1 electon}} Na^+$$

Sodium atom Sodium ion

Anion : A negatively charged ion is known as Anion. Chloride ion (Cl^-) and oxide ion (O^{2-}) are anion because they are negatively charged ions.

An anion is formed by the gain of one or more electrons by an atom.

$$Cl \xrightarrow{+1\ electon} Cl^-$$

Chlorine atom — Chlorine ion (An anion)

Valency :The combining power of an Element is known as its Valency.

The valency of some common ions are given in the table below.

Valency	Name of ion	Symbol	Non-metallic element	Symbol
1	Sodium	Na^+	Hydrogen	H^+
	Potassium	K^+	Hydride	H^-
	Silver	Ag^+	Chloride	Cl^-
	Copper I	Cu^+	Bromide	Br^-
			Iodide	I^-
2	Magnesium	Mg^{2+}		
	Calcium	Ca^{2+}	Oxide	O^{2-}
	Zinc	Zn^{2+}	Sulphide	S^{2-}
	Iron(II)	Fe^{2+}		
	Copper(II)	Cu^{2+}		
3	Aluminium	Al^{3+}	Nitride	N^{3-}
	Iron (III)	Fe^{3+}		

Valency	Polyatomic ion	symbol
1	Ammonium	NH_4^+
	Hydroxide	OH^-
	Nitrate	NO_3^-
	Hydrogen carbonate	HCO_3^-
2	Carbonate	CO_3^{2-}
	Sulphite	SO_3^{2-}
	Sulphate	SO_4^{2-}
3	Phosphate	PO_4^{3-}

Ionic Compounds:

The compound which are made up of ions are known as ionic compounds.

Some ionic compounds are given below–

Sl. No.	Name	Formula	Ion Present
1.	Sodium Chloride	Nacl	Na^+ & Cl^-
2.	Potassium Chloride	KCl	K^+ & Cl^-
3.	Ammonium Chloride	NH_4Cl	NH_4^+ & Cl^-
4.	Magnesium chloride	$MgCl_2$	Mg^{2+} & Cl^-
5.	Calcium chloride	$CaCl_2$	Ca^{2+} & Cl^-

Mole Concept

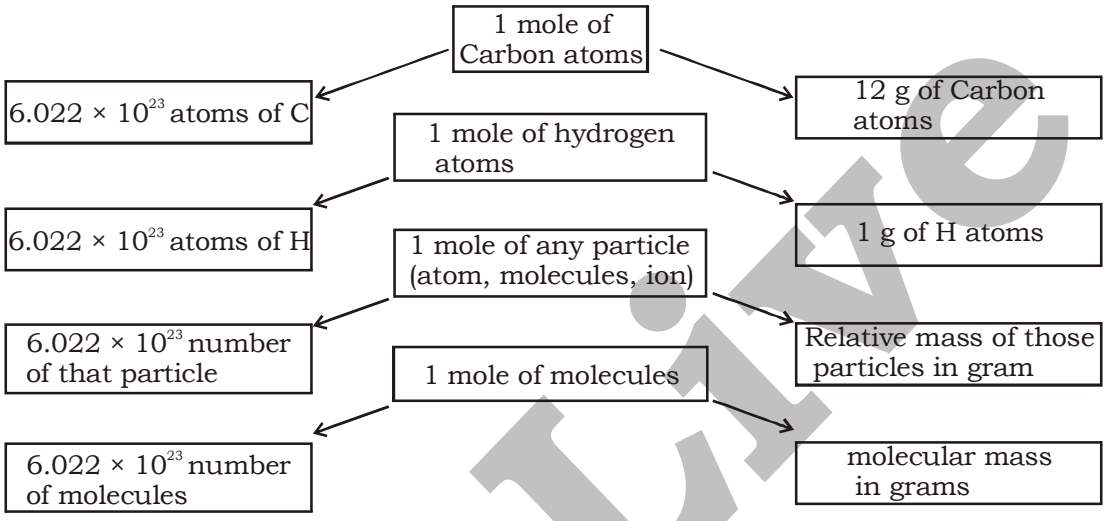
Mole is a link between the mass of atoms (or molecules) and the number of atoms (or molecules).

A group of 6.022×10^{23} particles (atoms, molecules or ions) of a substance is called a mole of that substance

1 mole of atoms = 6.022×10^{23} atoms

1 mole of molecules = 6.022×10^{23} molecules

Relationship between Avogadro number, mole & mass



Mole of Atoms

1 mole of atoms of an element has a mass equal to the gram atomic mass of the element.

1 mole of atoms of an element = Gram atomic mass of the element

1 atomic mass of Oxygen (O) is 16u, so gram atomic mass of oxygen will be 16 grams.

Mole of molecules

1 mole of molecules of a substance has a mass equal to the gram molecular mass of the substance Molecular formula of the substance represents 1 mole of molecules of that substance. For example-

(1) Formula O_2 represents 1 mole of oxygen molecules and $2O_2$ represents 2 moles of Oxygen molecules.

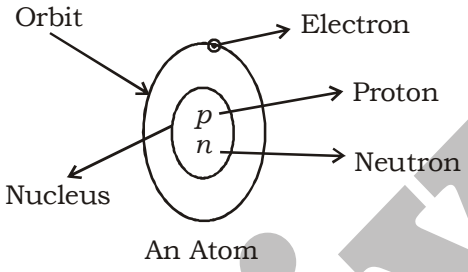
Substance	Symbol or formula	Mass of 1 mole (Molar mass)	1 mole contains
1. 1 mole of H atom	H	1 g	6.022×10^{23} Hydrogen atoms
2. 1 mole of Hydrogen molecule	H_2	$2 \times 1 = 2$ g	6.022×10^{23} Hydrogen moleculares
3. 1 mole of water	H_2O	2 + 16 = 18 g	6.022×10^{23} Water molecules
4. 1 mole of Ammonia molecule	NH_3	14 + 3 = 17 g	6.022×10^{23} ammonia molecules

Structure of Atom

Atoms are made up of three subatomic particles electron, proton and neutron.

Protons & neutrons are present in a small nucleus at the centre of atom and the electrons are present outside the nucleus in a fixed orbit.

The nucleus is always positive because it has **positively charges protons** in it. Atoms are electrically neutral because the number of protons is equal to number of electrons present in an atom.



Properties	Electrons	Proton	Neutron
1. Discovered by	J.J. Thomson in 1897.	E.Goldstein	Chadwick in 1932.
2. Charge	Negatively charged particle.	Positively Charge Particle.	Neutral in charge.
3. Location	Located outside the nucleus in a fixed path called orbit.	Located inside the nucleus.	Located inside the nucleus.
4. Mass	Mass of electron is about 1/1840 of the mass of H atom. Absolute mass is 9×10^{-28} gram.	Absolute mass of Proton is 1.6×10^{-24} gram.	Absolute mass is 1.6 × 10-24 gram
5. Absolute Charge	Absolute charge of electron is 1.6×10^{-19} Coulomb of negative Charge.	Absolute charge of a protons is. 1.6×10–19 coulomb of positive charge.	Electrically neutral

Arrangement of Electrons in the Atoms

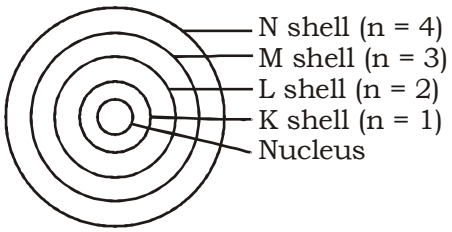
Electrons are arranged according to their potential energy in different energy levels of shells. The energy levels of the electrons are denoted by the numbers 1, 2, 3, 4, 5 and 6 whereas shells are represented by the letters K, L, M, N, O and P.

1st energy level is K shell

2nd energy level is L shell

3rd energy level is M shell

4th energy level is N shell and so on.



Energy level of electron shells in an atom.

Electronic configurations of Elements

The arrangement of electrons in the various shells (or energy levels) of an atom of the element is known as electronic configuration of the element.

(1) The maximum number of electrons present in a shell is given by the formula $2n^2$ where 'n' is the orbit number.

Hence the maximum number of electrons in different shells are as follows

(i) For 1st energy n = 1.
So the maximum number of electron in 1st energy level = $2n^2 = 2\times1^2 = 2$

(ii) For 2nd energy level n = 2
So the maximum number of election in 2nd energy level = $2n^2 = 2\times2^2 = 8$

(iii) For 3rd energy level n = 3
So the maximum number of electrons in 3rd energy level $2n^2 = 2\times3^2 = 18$

(iv) For 4th energy level n = 4
So the maximum number of electrons in 4th energy level = $2n^2 = 2\times4^2 = 32$

Electron shell	Maximum no. of electron
1. K	2
2. L	8
3. M	18
4. N	32

Atomic Number

Atomic number is defined as the total number of Protons present in the nucleus of an atom.

Atomic number of an element = Number of Protons in one atom of element.

Atomic number of an element is denoted by the letter z.

The atomic number of an element = number of electrons in one neutral atom.

Mass Number

Mass Number is defined as the sum of the total number of protons and neutrons present in the nucleus of an atom. Proton and neutrons are also called nucleons. Therefore the mass of an atom resides in its nucleus.

Mass number = No. of Protons + No. of Neutrons.

The mass number of an element is denoted by the letter A.

Mass number = Atomic mass

The atomic number and mass number can be indicated on the symbol of an element.

For example = ${}^{12}_{6}C$ or ${}_{6}C^{12}$

6 indictates the atomic number and 12 indicates the mass number of carbon.

Electronic configurations of first 20 elements

S.N.	Element	Symbol	Atomic number K,L,M,N	Electronic configuration	Valency
1.	Hydrogen	H	1	1	1
2.	Helium	He	2	2	0
3.	Lithium	Li	3	2,1	1
4.	Beryllium	Be	4	2,2	2
5.	Boron	B	5	2,3	3
6.	Carbon	C	6	2,4	4
7.	Nitrogen	N	7	2,5	3
8.	Oxygen	O	8	2,6	2
9.	Fluorine	F	9	2,7	1
10.	Neon	Ne	10	2,8	0
11.	Sodium	Na	11	2,8,1	1
12.	Magnesium	Mg	12	2,8,2	2
13.	Aluminum	Al	13	2,8,3	3
14.	Silicon	Si	14	2,8,4	4
15.	Phosphorus	P	15	2,8,5	3
16.	Sulphur	S	16	2,8,6	2
17.	Chlorine	Cl	17	2,8,7	1
18.	Argon	Ar	18	2,8,8	0
19.	Potassium	K	19	2,8,8,1	1
20.	Calcium	Ca	20	2,8,8,2	2

Valence electrons (or valency Electrons)

Those electrons of an atoms which take part in chemical reactions are called valence electrons. Valence electrons are located in the outermost shell of an atom.

For example- The atomic number of element X is 17, So one atom of X contain17 electrons. The electronic configuration will be.

K	L	M
2	8	7

Here M shell is the outermost shell or valance shell of the atom and it has 7 valence electrons.

Valency of Elements $\longrightarrow$ The combining capacity of an atom by gaining or loosing the valence electron to gain octate state is called the valency of that element.

For example- Chlorine; the atomic number of chlorine is 17. Its Electronic configuration is 2,8,7. Its has 7 valence electron but to gain octate state it needs 1 electron so its valency is1.

Inertness of Noble Gases

There are some elements which do not combine with other elements. These elements are known as inert elements, rare or noble elements. These elements are: Helium, Neon, Argon, Krypton, xenon and Radon.

Electronic configurations of Noble Gases (or inert Gases)

Noble gas	Symbol	Atomic No.	Electronic configuration	No. of elections is the Outermost shell (valence shell)
Helium	He	2	2	2
Neon	Ne	10	2,8	8
Argon	Ar	18	2,8,8	8
Krypton	Kr	36	2,81,8,8	8
Xenon	Xe	54	2,8,18,18,8	8
Radon	Rn	86	2,8,18,32,18,8	8

Chemical Bonding

The force that holds any two atoms to form a new entity is called chemical bond and the process is called chemical bonding.

There are three types of Bond

(i) Electrovalent bond or Ionic bond

(ii) Covalent Bond

(iii) Co-ordinates Covalent

1. Ionic or Electrovalent Bond

An ionic or Electrovalent bond is formed by the complete transfer of one or more electrons from the valence shell of one atom to the valence shell of other atom. In this way, both the atom acquire electronic configurations of the nearest noble gases. The atom which loses the electron acquires a positive charge and the atom that gains the electron acquires a negative charge.

For Example- Formation of Sodium chloride.

$$Na + \overset{\times\times}{\underset{\times\times}{\times Cl\times}} \longrightarrow Na^+ \overset{\times\times}{\underset{\times\times}{\times Cl\times}}^- \quad \text{or } Na^+ Cl^-$$

(2,8,1) (2,8,7) (2,8) (2,8,8)

Sodium has one electron more than the noble gas configuration & chorine has one electron less than the next noble gas configuration. Therefore is sodium loses one electron and chlorine takes up the electron both will acquire noble gas configuration and form an ionic or electrovalent bond.

Conditions for the formation of Ionic Bonds

1. **Low Ionization energy**- one of the two atoms forming the ionic bond must have low ionization energy so that it can easily lose electron and can form the cation.
2. **High electron affinity**- The other atom which is accepting electron should have high election affinity so that the electron lost by the first atom is readily accepted by the second atom.
3. Larger cation & smaller anion
4. High lattice energy & hydration energy

Properties

(1) Soluble in polar solvent (Ex-water)

(2) High melting point and Boiling point

(3) Good conductor in aqueous solution

(4) Non-inflammable

(5) Non-Volatile

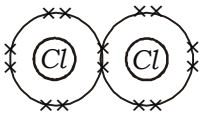
2. Covalent Bond

When a bond is formed by the mutual sharing of **electrons** it is known as covalent bond.

Example.

$Cl + Cl \rightarrow Cl^- \quad Cl^- \rightarrow Cl_2$

2,8,7 2,8,7 2,8,8 2,8,8



Conditions

1. Smaller the size, higher the covalency.
2. Electronegative element + Electronegative element.
3. High ionization potential & high electron affinity.
4. Smaller size of ions.

Properties

1. Insoluble in water but highly soluble in organic solvent.
2. Bad conductor of heat and electricity.
3. Low melting point and Boiling point.

3. Co-ordinate Covalent Bond

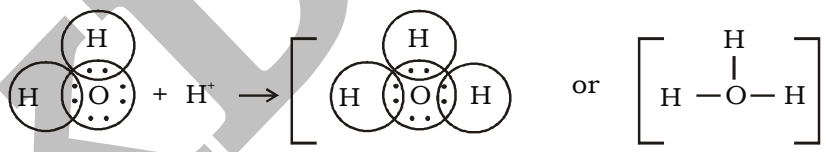
(i) The co-ordinate covalent bond is characterized by one sided sharing of electrons.

(ii) One of the combining atoms contribute both the electron that form a bond between them.

(iii) Other atom does not contribute any of its own electrons but aquires stable configuration by sharing the pairs of electrons contributed by the first atom.

Example-

(i) Formation of hydronium ion (H_3O+)



Oxygen atom in H_2O after sharing two of its valence electrons with two hydrogen atoms, still possesses two lone pairs of electrons, one of these pairs of electrons is shared with H+ ion to from H_3O^+ ion.

Radioactivity

The phenomenon of radioactivity was discovered by A.H Becquerel in 1886 purely by accident. He observed a peculiar property of uranium salt, affecting a photographic plate even when the plate was in a light proof package. He termed this property of uranium 'Radioactivity'. The phenomenon of spontaneous emission of radiation by heavy element is called radioactivity. Later Pierre and Madam curie showed similar phenomenon in other metals like plutonium, Francium and Radium.

Radioactive Emissions

(a) Alpha (α) particle –

(1) A positively charged helium atom.

(2) Has very less penetrating power.

(3) Can be absorbed by a sheet of paper or stopped by aluminum foil.

(b) Beta (β) particles –

(1) A negatively charged light particle.

(2) Penetrating power greater than alpha ray.

(c) Gamma (γ) rays –

(1) These are electromagnetic radiations of low wavelength, high frequency and high energy.

(2) Their penetrating power is very great and can pass through several centimetres of lead.

Radioactive Isotopes

The isotopes which are unstable (due to presence of extra neutrons in their nuclei) and emit various types of radiations are called a radioactive Isotope. For eg-

(1) Carbon-14 (2) Arsenic -74 (3) Sodium -24

(4) Iodine -131 (5) Cobalt-60 and uranium – 235

X-rays

(1) X-rays is a form of penetrating electromagnetic radiation similar to light.

(2) It has a shorter wavelength.

(3) Capable of penetrating solids.

(4) X-rays is produced when cathode ray fall on anti-cathodes (a metal of high atomic mass like tungsten)

Uses

Dense material like metal and bone absorb X-ray more strongly than material such as wood or flesh. Therefore it is possible to produce X- rays photographs for use in medical diagnoses.

Nuclear Reaction

A nuclear reaction is one in which a nucleus is bombarded with an elementary particle (like neutron, proton etc.) or with another nucleus to produce other products in a very short time span. The first nuclear reaction was discovered by Rutherford in 1919 when he bombarded nitrogen with alpha particles.

Nuclear Fission

Nuclear fission is the fragmentation of a large nucleus into two smaller nuclei and the liberation of large amount of energy. In 1939 the German scientists Otto Hahan and F. Steersman observed that when uranium was bombarded with slow neutrons then two smaller products were obtained with a tremendous amount of heat. The splitting of uranium is called nuclear fission.

Types of Nuclear Fission

(i) Controlled Nuclear Fission-Carried out in nuclear reactors in which rate of fission reaction is reduced and the energy produced can be used for constructive purposes.

(ii) Uncontrolled Nuclear Fission- In an atom bomb uncontrolled fission takes place. A very large amount of heat is produced and the process continues until the entire amount of fissionable material is exhausted.

First Atom Bomb

On August 6, 1945, an atom bomb was dropped on Hiroshima city in Japan. The second bomb was dropped on Nagasaki, another city of Japan on August 9, 1945. The bomb was made of plutonium -239.

Nuclear Fusion

It is a nuclear reaction in which lighter nuclei fuse to form a nucleus of greater mass. In this reaction also an enormous amount of heat is produced. By carrying on nuclear fusion under controlled conditions, the large amount of energy could be made available for useful purpose.

Atomic Energy (Nuclear Energy)

Energy produced by nuclear fission or nuclear fusion is called nuclear energy or atomic energy. In nuclear reactions there is loss of mass mechanical energy which can be used for various peaceful purposes. This mass is converted into energy.

Isotopes

Elements having same atomic number but different atomic mass.

e.g. (i) $_8O^{16}$ $_8O^{17}$ $_8O^{18}$

(ii) $_1H^1$, $_1H^2$, $_1H^3$

Isobars

Elements having the same atomic mass but different atomic number.

e.g. (i) $_{18}Ar^{40}$, $_{19}K^{40}$, $_{20}Ca^{40}$

(ii) $_6C^{14}$, $_7N^{14}$

Isotones

Elements having the same number of neutrons.

e.g. (i) $_1H^3$ $_2He^4$,

(ii) $_4Si^{30}$, $_{16}S^{32}$,

Isosters - Molecules & ions having same number of atoms as well as electrons.

e.g. (i) N_2O, CO_2

Chain reaction

Chain reaction is the phenomenon in which neutrons liberated during a fission process lead to a further fission of atoms, releasing a large amount of energy.

Half life is the time when the amount of radioactive element becomes half of the initial.

Quick Recap

1. Matter is neither created nor destroyed in a chemical reaction.
2. Atom is the smallest particle of an element that can take part in a chemical reaction.
3. Atom exist in two ways
   (i) In the form of molecules (ii) In the form of ions.
4. A molecules contains two similar atom combined chemically.
5. Formula represents the name of the substance.
6. Ions are positively or negatively charged atom.
7. Mole is a link between the mass of atoms (or molecules) and the number of atoms (or molecules)
8. The number 6.022×10^{23} represents a mole and is known as Avogadros number (L)
9. Atoms are made up of three subatomic particles-electron, neutrons and protons.
10. The nucleus is a small positively charged part at the centre of an atom.
11. The number of protons is one atom of an elements is known as atomic number.
12. Total number of neutrons and Protons present in one atom of an element is known as its mass number.
13. Hydrogen is the only element which has one electron, one proton but no neutron.
14. Maximum number of electrons accommodated is any energy level of the atom is $2n^2$ (Where n is the number of the energy level).
15. Isobors are Elements having same atomic mass but different atomic number.
    $_{18}Ar^{40}$, $_{19}K^{40}$, $_{20}Ca^{40}$
16. **Half life** – The time where the amount of radioactive elements becomes half of the initial.
17. **Nuclear fission** – Process of splitting a heavy into two lighter nuclei.
18. **Nuclear fusion**- Process in which two very light nuclei combine to form a nucleus with large mass. Nuclear fusions is the source of energy of all stars including our sum.
19. Isotopes are Elements having same atomic number but different atomic mass.
    Ex-$_8O^{16}$, $_8O^{17}$, $_8O^{18}$

4. *Chemical Equilibrium*

Contents

CHEMICAL EQUILIBRIUM 4

(1) Chemical Reactions:- Chemical reactions are the process in which new substances with new properties are formed. Chemical reactions involve chemical changes. During a chemical reaction, atoms of one element do not change into those of another elements. Only a rearrangement of atoms takes place

1. The substances which take part in a chemical reaction are called the reactants.
2. The new substances produced as a result of chemical reaction are called the products.

Fast and slow chemical reaction:-

1. The chemical reaction occurs at different speed.

Chemical reaction may be

(1) fast (2) slow or (3) very slow

(1) Fast reactions:- The reaction which occurs instantaneously on mixing the reactants.

Example: If we add silver nitrate solution to sodium chloride, a white precipitate of silver chloride is formed at once $AgNO_3(aq) + Nacl\ (aq) \rightarrow Agcl\ (s) + NaNO_3\ (aq)$

silver nitrate sodium chloride silver chloride sodium nitrate

the reaction is very fast because it takes place between the ions of the reactions.

(2) Slow reactions:- Those reactions which occur in a few minutes are called slow reactions.

Example: When ethyl alcohol and Acetic acid are heated in the presence of a little cocentrated H_2SO_4 (catalyst) the reactions takes place in a few minutes and an ester called Ethyl acetate is formed

$$CH_3COOH\ (aq) + C_2H_5OH \xrightarrow{Cone\ H_2SO_4}$$

Acetic acid

$$CH_3COO_2H_5\ (aq) + H_2O$$

Ethyl acetate

(3) Very slow reactions:- Those reactions which take days, weeks or even months to occur are called very slow reaction

Example:- Rusting of iron. It takes a period of weeks, so the rusting of iron is a very slow process.

$$4Fe\ (s) + 3O_2(g) + H_2O\ (g) \rightarrow 2Fe_2O_3 \cdot H_2O\ (s)$$

Iron + Oxygen + Water Vapour → Hydrated Iron (III) oxide (Rust)

Burning of fuels, ripening of fruits digestion of food etc are some examples of very slow reaction.

2. Rate of Chemical reaction:- The concentration of reactants goes on decreasing as a chemical reaction proceeds. The rate of chemical reaction is defined as the change in the concentration of a reactant or

(i) In term of the change in cone^n of a reactant:-

$$\text{Rate of reaction} = \frac{-\text{Change in concentration of a reactant}}{\text{Time taken for change}}$$

There is a minus sign in the above formula for the rate of reaction. Since the concentration of the reactant decreases during the reaction, the change in concentration is negative.

(ii) In terms of the change in concentration of a product, the formula for the rate of a reaction is:-

$$\text{Rate of rection} = \frac{\text{Change in concentration of a reactant}}{\text{Time taken for change}}$$

Since the concentration of a product increases during a reaction, the change in concentration of a product is positive. So, the rate of reaction will be positive. No minus sign is put in this formula.

(iii) Energy changes during a chemical reaction:- Most of the chemical reaction is accompanied by a change in energy. The energy is either released or absorbed during a chemical reaction.

1. Exothermic reaction:- The chemical reaction in which heat is evolved is called Exothermic reaction.

(1) All combustion reaction is exothermic reaction.

For example:- Burning of carbon in oxygen is exothermic reaction.

$C(s) + O_2(g) \rightarrow CO_2(g) + Heat$

3. An exothermic reaction is indicated by writing '+ heat' or + Heat energy' or just' + Energy' on the product side of an equation.

2. Endothermic reaction:-

(1) Those reactions in which heat is absorbed is called Endothermic reaction.

(2) We can also write this endothermic reaction by putting [–Heat sign] on the right side of the equation as:

$N_2(g)$ + $O_2(g)$ $\rightarrow$ $2NO(g) - Heat$

Nitrogen Oxygen Nitrogen monoxide

All the decomposition reaction is endothermic reaction. For example: when

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

Note: Compound NO is known by three names

(i) Nitrogen oxide
(ii) Nitrogen monoxide
(iii) Nitric oxide

3. Photochemical reactions:-

(1) Those chemical reactions which takes place in the presence of light are called photochemical reactions.

(2) Light energy is absorbed in photo chemical reactions.

(3) The light energy which causes photochemical reactions is usually sunlight or in some cases even artifical light.

(4) Photosynthesis in plants is an example of photochemical reaction. During photosynthesis, plants combine with carbon-dioxide gas and water, in the presence of sunlight and chlorophyll to form food like glucose and releases oxygen.

$$6CO_2(g) + 6H_2O(l) \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6(aq) + 6O_2(g)$$

carbon dioxide water glucose oxygen

(IV) Characteristics of chemical reactions:-

The conversion of rectants into products in a chemical reaction is often accompanied by some features. These important features of chemical reactions are known as characteristics of chemical reaction.

The important characteristics of chemical reactions are:

(i) Evolution of a gas.
(ii) Formation of a preciptate.
(iii) Change in colour.
(iv) Change in temperature.
(v) Change in state.

(V) Factors affecting the rate of reaction:- The molecules of all the subtance is in constant motion. When reactants are brought together, the molecules of one reactant collide with the molecules of the other reactant and the new substances known as products are formed. The rate of reaction depends on the number of collisions per unit time. This is known as the frequency of collision. Anything which increase the frequency of collision between reacting molecules will increase the rate of reactant and vice versa.

The various factors which can affect the rate of reaction are:-

1. Concentration of reactants.
2. Temperature.
3. Catalyst.
4. Physical nature of reactants and
5. Chemical nature of the chemical reaction.

Rate of some of the chemical reaction also depends on light.

(VI) Effect of catalyst on the Rate of Reaction:-
Some of the catalysts and their uses.

S.No.	Catalyst	Process in which used
1.	Fe + Mo	Synthesis of NH_3 by Habers process
2.	Ni	Synthesis of Vanspati Ghee (Hydrogenation)
3.	Pt	Synthesis of H_2SO_4 by contact process
4.	Mo	In the Manufacture of H_2SO_4 by the lead process
5.	Hot Al_2O_3	In the preparation of Ether from Alcohol
6.	$CuCl_2$	Preparation of Chlorine gas by Deacon process

(VII) Types of reaction:- Some of the important types of reactions are:-

1. **Combination reaction**:- Those reactions in which two or more substances combine to form a single subtance, are called combination reaction.
Examples:-Magnesium and Oxygen combine, when heated to form magnesium oxide:

$$2Mg\ (s) + O_2\ (g) \xrightarrow{\text{Combination}} 2MgO\ (s)$$

Magnesium + oxygen → Magnesium Oxide

2. **Decomposition reactions**:- Those reactions in which is compound splits up into two or more simpler substances are known as decomposition reaction.

Example:- $CaCO_3\ (s) \xrightarrow[\text{(Decomposition)}]{\text{Heat}} CaO\ (s) + CO_2\ (g) \uparrow$

Calcium oxide (lime) + Carbon oxide

3. **Displacement reaction**:- Those reactions in which one element takes the place of another element in a compound, are known as displacement reactions.
Example:- When a strip of zinc metal is placed in copper sulphate solution, then zinc sulphate solution and copper are obtained

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

Copper sulphate (blue solution) + zinc (silvery white) → zinc sulphate (colourless solution) + copper (red-brown)

This displacement reaction takes place because zinc is more reactive than copper.

4. **Double displacement reaction**:- Those reactions in which two compounds react by an exchange of ions to form two new compounds are called double displacement reactions.
Example:- When silver nitrate solution is added to sodium solution, then a white precipitate of silver chloride is formed alongwith Sodium nitrate solution.

$$AgNO_3\ (aq) + NaCl\ (aq) \rightarrow AgCl\ (s) + NaNO_3\ (aq)$$

silver nitrate + sodium chloride → silver chloride (white ppt) + sodium nitrate

5. **Oxidation and Reduction reaction**:-
(i) The addition of oxygen to a substance is called oxidation.
(ii) The removal of hydrogen from a substance is called oxidation.

Reduction:-

(i) The addition of hydrogen to a substance is called reduction.

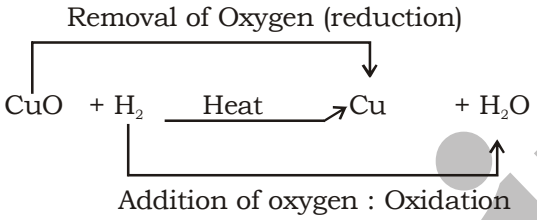
(ii) The removal of oxygen from a substance is called reduction.

1. The process of oxidation is just opposite of reduction.
2. Oxidation and reduction reactions are also called redox reaction.

(the term 'red' stands for reduction and 'ox' stands for oxidation)

Example:- When copper oxide is heated with hydrogen, then copper metal and water are formed.

$$\underset{\text{Copper oxide}}{CuO} + \underset{\text{Hydrogen}}{H_2} \xrightarrow{\text{Heat}} \underset{\text{copper}}{Cu} + \underset{\text{water}}{H_2O}$$



Oxidising agent:- The substance which gives hydrogen or removes oxygen is called reducing agent.

In the above example:-

1. Substance oxidised : H_2 2. Substance reduced : CuO
3. Oxidising agent : CuO 4. Reducing agent : H_2

6. **Disproportional reaction**:- A chemical reaction in which only one substance gets oxidized as well as reduced is known as disproportional reaction.

Example:- $P_4 + NaOH + 2H_2O \rightarrow 2NaH_2PO_2 + 2PH_3$

Here phosphorus is oxidized as well as reduced.

7. **Neutralization reaction**:- When an acid reaction with a base and forms salt and water is known as neutralization reaction.

Example:- $\underset{\text{Sodium hydroxide}}{NaOH} + \underset{\text{Hydrochloric acid}}{HCl} \rightarrow \underset{\text{sodium chloride}}{NaCl} + \underset{\text{water}}{H_2O}$

8. **Reversible reaction**:- If a reaction which proceeds in both directions is known as reversible reaction.

Example:- $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2O$

9. **Irreversible reaction**:- A reaction which proceeds in only one direction is known as irreversible reaction.

$CaCO_3 \rightarrow CaO + CO_2 \uparrow$

VIII. Equilibrium state of reversible reaction:- Equilibrium state is a dynamic state (changing state). Actually in these process rate of convertion of reactant into product and product into reactant becomes equal to each other. This state is called equilibrium or state of Equilibrium.

Rate of forward reaction = Rate of reverse reaction.

A reaction does not stop at Equilibrium state, only the rate of forward and the reverse reaction becomes equal.

IX. Characteristics of Chemical Equilibrium:-

1. At equilibrium, both the forward & the backward reactions proceed at the same rate and hence, the equilibrium is dynamic in nature.
2. At equilibrium all macroscopic properties such as pressure, concentration, density, and colour etc. of the system become constant and remain unchanged thereafter.
3. A chemical equilibrium can be established only when none of the products is allowed to escape out.
4. Chemical equilibrium can be approached from either direction.

X. Ionic Equilibria:-

1. Chemical reactions also take place in solution in which generally ions participate.
2. The substances which furnish ions are known as electrolytes which may be acids, bases or salts.
3. The equilibrium is present between the unionized molecules of a particular substance and the ions formed in the solution.
4. Since all of them are electrolytes, the equilibrium constant is related to the strength of these electrolytes.

Dissociation of Electrolytes:-

1. A compound which conducts electricity when dissolved in water or in molten state is called an electrolyte.
2. All the electrovalent compound consists of ions. Therefore all electrovalent compounds are electrolytes.
3. The ions act as carrier of electrocity in electrolytic solutions.

Example:- When solid chloride is dissolved in water to form sodium chloride solution, then the forces holding the ions together are broken up. The sodium ions and chloride ions become free to move in this aqueous solution.

$$NaCl\ (s) \xrightarrow{Water} \underset{\text{Sodium ion}}{Na^+\ (aq)} + \underset{\text{chloride ion}}{Cl^-\ (aq)}$$

Some common electrolytes:-

Electrolytes	Formula	Ions Present (in aq)
Sodium hydroxide	$NaOH$	Na^+ and OH^-
Ammonium hydroxide	NH_4OH	NH_4^+ and OH^-
Sodium chloride	$NaCl$	Na^+ and Cl^-
Magnesium chloride	$MgCl_2$	Mg^{2+} and $2Cl^-$
Silver Nitrate	$AgNO_3$	Ag^+ and NO_3^-
Copper Sulphate	$CuSO_4$	Cu^{2+} and SO_4^{2-}
Hydrochloric acid	HCl	H^+ and Cl^-
Nitric acid	HNO_3	H^+ and NO_3^-
Sulphuric acid	H_2SO_4	$2H^+$ and SO_4^{2-}
Carbon acid	H_2CO_3	$2H^+$ and CO_3^{2-}

XI: Types of Electrolytes:-

1. **Strong electrlytes**:- The electrolytes which completely ionises in dilute solution and thus produce lot of ions is called strong electrolytes. All electrovalent compounds are strong electrolytes.

   Example:- Sodium chloride fully dissociates into Na^+ & Cl^- on dissolving in water.

2. **Weak electrolytes**:- The electrolytes which are ionised to smaller extent in dilute solution are known as weak electrolytes.

   Some polar convalent compounds ionise only slightly when dissolved in water and give only a small amount of ions.

   Example:- $CH_3COOH\ (aq) + H_2O(l) \rightarrow CHCOO^{-3}\ (aq) + H_3O^+\ (aq)$

   Acetic acid water Acetate ion

Hydroxination

The covalent electrolytes like acetic acid do not ionise completely because their ionisation is a reversible process and an equilbrium is set up between the unionised molecule and ions. A weak electrolyte is a poor conductor of electricity because it produces only a few ions to carry the electric current.

Some important strong and weak electrolytes:-

Name	Formula	Name	Formula
Sodium chloride	NaCl	Water	H_2O
Sodium Hydroxide	NaOH	Acetic acid	CH_3COOH
Copper Sulphate	$CuSO_4$	Carbonic acid	H_2CO_3
Silver Nitrate	$AgNO_3$	Hydro Dynamic acid	HCN
Hydrochloric acid	HCl	Ammonium Hydroxide	NH_4OH
Nitric acid	HNO_3	Calcium Hydroxide	$Ca(OH)_2$
Sulphuric acid	H_2SO_4	Ammonium Chloride	NH_4Cl

XII. Non-Electrolytes:-

1. A compound which does not conduct electricity when dissolved in water or in molten state is called a non-electrolyte. Examples of other non-electrolytes are: Glucose, Urea, Alcohol, Benzene, Carbon Tetrachloride and most of the organic compound.
2. Non-electrolytes do not form any ion in solution so they do not conduct electricity.
3. Non-electrolytes are convalent compounds and exist as molecules.

XIII. Ostwald dilution law for weak electrolytets:- It states that "at constant temperature, the degree of dissociation for weak electrolytes is directly proportional to square root of its dilution."

Note:- This law is not for strong electrolytes because these are approximately 100% ionised at all dilutions and dilutions has no effect on their dissociation.

Application of Ostwald Dilution Law:-

1. In determining strength of weak acid or base.
2. In calculation of degree of dissociation.
3. In calculation of relative strength of acid or base.
4. In calculation of $[H^+]$ and pH of aqueous solution.

XIV. THEORIES OF ACIDS AND BASES:-

1. Arrhenius theroy of Acids and Bases:- Arrhenius in 1887, suggested that

(i) Substances which contain one or more hydrogen atom and which yield hydrogen ions (H^+) in aqueous solution are acids.

(ii) Substance which contain one or more hydroxyl groups and yield hydroxyl ions (OH^-) in aqueous solution are called bases.

Examples:- Substances like HCl, HNO_3, H_2SO_4, H_3PO_4 can be classified as acid since each of them furnishes H+ ions in aqueous solution.

$HCl \rightarrow H^+ + Cl^-$

$HNO_3 \rightarrow H^+ + NO_3^-$

Example:- Substances like NaOH, KOH, NH_4OH, $Al(OH)_3$ can be classified as bases. Each of them furnishes OH^- ions in its aqueous solution:

$NaOH \rightarrow Na^+ + OH^-$

$KOH \rightarrow K^+ + OH^-$

Limitation:-

1. Arrhenius theory is only limited to aqueous solution of the compound. In its absence it is unable to explain the acidic or basic character of substances.
2. Arrhenius theory could not explain that there are number of substances like CO_2, SO_2 etc. which do not contain hydrogen but still are acids. Similarly substances like NH_3, Na_2CO_3 etc. do not contain hydroxyl group but are known to be bases.

II. Bronsted-Lowry concept of Acids and Bases:-

According to his concept, an acid is a substances which has a tendency to donate a proton (H^+) and a base is a substance which has a tendency to accept proton.

In simple words,

1. An acid is a proton donar.
2. A base is a proton acceptor.

Advantage of Bronsted-Lowry concept:-

1. This concept also includes ions to be classified into acids and bases.
2. It could explain the basis character of substances like NH_3, Na_2CO_3 which do not contain OH^- group since these are proton acceptor.
3. It can explain the acid base behaviour even in the non-aqueous medium.

Limitation of Bronsted-Lowry concept:-

1. Substances like $AlCl_3$, BF_3, $SnCl_2$ etc. behave as acids although they do not contain hydrogen and hence cannot give a proton. This theory fail to explain it.
2. Acidic oxides such as anhydrous CO_2, SO_2 etc. can neturalise basic oxides like CaO and BaO even in the absence of a solvent.

III. <u>Lewis concept of Acids and Bases</u>:-

Lewis in order to cover all types of substances, put forward a more general concept which does not require hydrogen to be an essential part of all acids according to him:-

1. An acid is a substance (atom, ion or molecule) which can accept a pair of electrons.
2. A base is a substance which can donate a pair of electrons.

In simple words:-

1.An acid is an electron acceptor.

2.A base is a electron donar.

<u>Limitation of Lewis concept</u>:-

1. It fails to assign the stength of acids and bases.
2. Acid-base reactions are usually fast but the formation of dative bond is a slow process.
3. According to the theory, the acid-base reactions should be accompained by the formation of dative bonds, but not such bonds are formed when acids like HCl H_2SO_4 etc. react with NaOH or KOH.

<u>Property of Acid, Bases and Salt</u>: **Acids are substances which -**

1. Taste sour.
2. Change blue litmus into red.
3. Acid solutions conduct electricity (they are electrolytes).
4. Acids react with metals to form hydrogen gas.
5. Reacts with carbonates to evolve CO_2 gas.
6. React with bases to neutralise them.
7. Acids have corrosive nature so it is stored in glass container and not in metal container.

<u>Bases are sbubstacess which</u> :-

1. Have bitter taste.
2. Soapy in touch.
3. Turn red litmus into blue.
4. Conduct electricity in solution (they are electrolytes).
5. React with some metals to form hydgrogen gas.
6. React with acids to neutralise them.

XV.

<u>Classification of Acids</u>

Strength

Strong acid	**Weak Acid**	**Hydra acids**	**Oxy Acid**
HCl	CH_3COOH	NH_3	HNO_3
HNO_3	H_2CO_3	H_2S	H_2SO_4
H_2SO_4	HCOOH	HCl	$HClO_4$
		HBr	HlO_4
		HF	

No. of replaceable Hydrogen

(i) Mono basic acid HCl, HNO_3

(ii) Dibasic acid H_2SO_4, H_2CO_3

(iii) Tribasic acid H_3PO_4

The order of halogens according to its acidic nature are HF < HCl < HBr < HI.

Acids:- An acid is a substance which dissociates in water to give hydrogen ion (H^+).

Example:- Hydrochloric acid (HCl) dissociates (ionises) in water to give H^+ ion.

HCl (aq) $\rightarrow$ H^+ (aq) + Cl^- (aq)

Hydrochloric Acid — Hydrogen ion — Chloride ion

Acids are two types:-

1. **Strong acid**:- An acid which is completely ionizes in water and produces a large number of hydrogen ions is called a strong acid. The word 'strong' refers to the 'degree of ionisation' and not to the 'concentration'. Hydrochloric acid, sulphric acid and Nitric acid are all strong acids because they are fully ionized in aqueous solution.

   HCl (aq) $\rightarrow$ H^+ (aq) + Cl– (aq)

   H_2SO_4 (aq) $\rightarrow$ 2H+ (aq) + SO_4^{2-} (aq)

2. **Weak acids**:- An acid which partically ionized in water and thus produces a small number of hydrogen ions is called a weak acid. All organic acids are weak acid.

   Example:- CH_3COOH (aq) $\rightarrow$ H^+ (aq) + CH_3COO^- (aq)

   acetic acid

   Hydrocyanic acid and Phosphoric acid (H_3PO_4) are also weak acids. Weak acids have low conductivity because of low concentration of hydrogen ions in their solution.

XVI. Indicators for testing acids and bases:-

An indicator is a 'dye' that changes colour when it is put into an acid or a base.

Indicator	Colour changes in acid	Colour changes in base
1. Blue and red litmus paper.	1. Blue litmus turns red.	1. Red litmus turns blue.
2. Methyl orange.	2. Red in acid solution.	2. turns yellow in basic solution.
3. Phenolphtholein	3. Turns colourless in acid solution.	3. turns pink in basic solution.

VIII. Some acids & its uses:-

Name of Acids	Uses
1. HCl Hydrochloric acid	1. Hydrochloric acid (HCl) is used for removing oxide film from steel. Objects before they are galvanised. 2. Used as bathroom cleaner. 3. In the dying and textile industry. 4. HCl present in gastric juice are responsible for the digestion. 5. HCl is used in making plastics like polyvinylchloride (PVC). 6. In the tanning of leather
2. HNO_3 Nitric acid	1. In the manufacture of fertilizers like Ammonium Nitrate. 2. In the manufacture of explosives like TNT (Trinitrotolune) TNB. 3. In the manufacture of rayon. 4. In the manufacture of dyes and drugs.
3. H_2SO_4 Sulphuric acid	1. In a lead storage battery. 2. In the manufacture of HCl. 3. In the manufacture of Aluminium. 4. In the manufacture of fertilizers, drugs, detergents & explosives.
4. Boric acid H_3BO_3	As an antiseptic.
5. Phosphoric acid H_3PO_4	1. Its calcium salt makes our bones. 2. It form phosphoric fertilizers.
6. Ascorbic acid	Source of Vitamin C.
7. Citric and Acetic acid	Flavouring agent and food preservative
8. Tartaric acid	1. Souring agent for pickles.

XVIII. Bases and Alkalies:- Bases are substances which dissolve in water to produce hydroxide ion (OH^-) ions in solution.

Alkali:- A water soluble base is called an alkali, sodium hydroxide, potassium hydroxide, calcium hydroxide in water.

$NaOH\ (aq) \rightarrow \underset{\text{Sodium ion}}{Na^+\ (aq)} + \underset{\text{Hydroxide ion}}{OH^-\ (aq)}$

Bases are of two types:-

1. **Strong base**:- A base which completely ionises in water and thus produce a large amount of (OH^- ions) is called a strong base. Example:- KOH, NaOH.
2. **Weak base**:- A base which is partially gets ionised in water and thus produces a small amount of hydroxide ions (OH^- ions) is called a weak base. Example:- (NH_4OH), Calcium hydroxide ($Ca(OH)_2$)

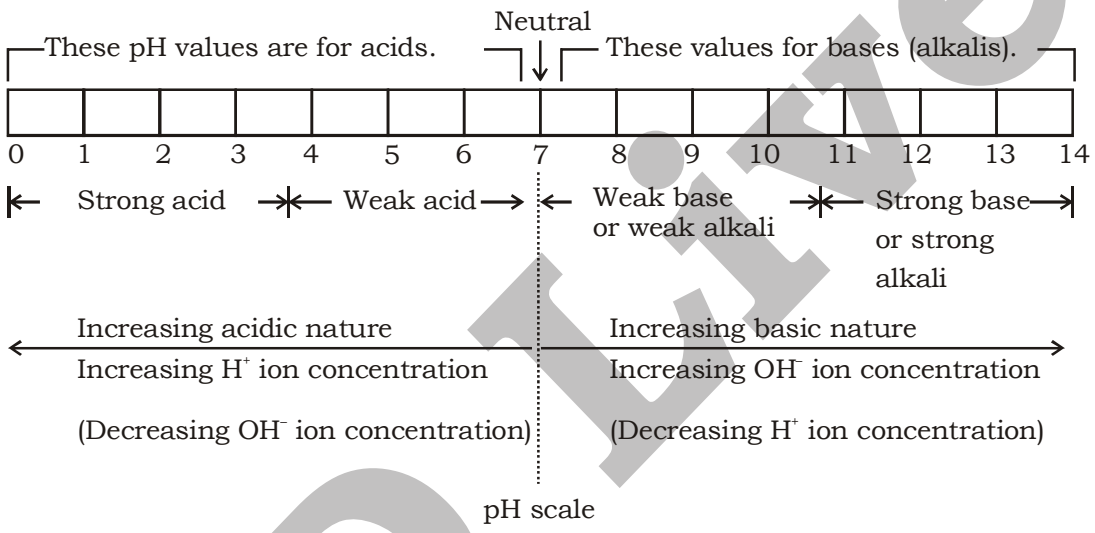
Ionic product of water:- Water dissoicates slightly to give hydrogen ion (H^+) and Hydroxide ions (OH^-). This is a reversible reaction in which most of the water remains in the undissociated molecular form (H_2O) at the equilibrium state.

XIX. pH scale:- It is more convenient to express the acidity or alkalinity of the solution in terms of the H^+ ion concentration only. Therefore S.P.L. Sorenson, a Danish biochemist in 1909 devised a scale known as pH to represent the H^+ ion concentration of a given aqueous solution.

Definition:- The pH of solution is referred as the negative logarithm of the hydrogen ion concentration in mole per litre.

Thus, pH $= -\log [H^+]$

$$= \log \frac{1}{[H^+]}$$



pH of Neutral Solution (Pure Water):-

pH of water is 7. Wherever the pH of a solution is 7, it will be a neutral solution. Such a solution will have no effect on any litmus solution or any other indicator.

pH of an Acidic Solution:-

All the acidic solutions have a pH less than 7. So, whenever a solution has a pH less than 7, it will be acidic in nature and it will turn blue litmus red as well as methyl orange pink and phenopthalein colourless.

pH of a Basic solution:-

All the alkalini solution have a pH of more than 7. So, whenever a solution has a pH more than 7, it will be basic in nature and it will turn red litmus, blue, methlyl orange yellow and phenopthalein pink.

Note:- pH is a pure number. It has no unit.

The pH values of the common substance from our daily life.

Solution	pH	Solution	pH
1. Conic HCl	0	11. Saliva (before meals)	7.4
2. Oil HCl	1.0	12. Saliva (after meals)	5.8
3. Gastric Juice	1.4	13. Blood	7.4
4. Lemon Juice	2.5	14. Eggs	7.8
5. Vinegar	4.0	15. Toothpaste	8.0
6. Tomato juice	4.1	16. Baking Soda solution	8.5
7. Coffee	5.0	17. Washing Soda solution	9.0
8. Soft drink	6.0	18. Milk of Magnesia	10.5
9. Milk	6.5	19. Household ammonia	11.6
10. Pure water	7.0	21. Dilute sodium hydroxide	13.0
		20. Concentrated sodium hydroxide	14

It should be noted that :-

1. An acid solution having low pH is stronger than another solution having higher pH value. A solution having pH of 2 is a stronger acid than a solution having pH of 5.
2. An alkali solution having higher pH value is a stronger than a solution of pH 10.
3. Strong acids solution can have pH values less than zero and strong basic solutions can have pH greater than 14.

Importance of pH:-

1. **In Agriculture**:- By determining the pH of the soil. We can find whether it is acidic or alkaline. This helps in deciding the type of fertilizer to be used and the types of crop to be sown.
2. **In Biological processes**:- By knowing the pH we can adjust the medium of biological processes like fermentation, enzyme hydrolysis, sterilization etc.
3. **In corrosion research**:- By measuring the pH of sea-water, the effect of alkaline sea-water on the material used for building ships and submarines is studied.

XX. Universal Indicator:- Universal indictor is a mixture of different indicators (or dyes) which gives different colours at different pH vlaues of the entire pH scale.

The colours produced by universal indicators at various pH values are given below:

pH	Colour	pH	Colour	pH	Colour
0	Dark Red	5	Orange yellow	10	Navy blue
1	Red	6	Greenish yellow	11	Purple
2	Red	7	Green	12	Dark purple
3	Orange Red	8	Greenish yellow	13	Violet
4	Orange	9	Blue	14	Violet

XXI. Buffer solution:- A buffer solution or a buffer is defined as a solution whose pH does not change when small amount of an acid or a base is added in it.

Buffer action:- The property of the solution to resist a change in its pH value is called buffer action.

Types of Buffer:-

1. Simple buffer:- Salts of weak acids and weak bases is called simple buffer. Example:- CH_3COONH_4, NH_4CN, Protein, amino acids etc.

2. Mixed buffers:- It is of two types.

1. Acidic buffer:- The mixture of weak acid and its conjugated base or its salt formed with strong base is called acidic buffer.

Example:- Mixture of acetic acid and sodium acetate.

2. Basic buffer:- The mixture of weak base and its conjugate acid or its salt formed with strong acid is called as basic buffer.

Example:- Mixture of equimolar quantities of NH_4OH and NH_4Cl.

XXII. Salt:- A salt is a compound formed from an acid by the replacement of the hydrogen in the acid by a metal. Salts are formed when acids reacts with base.

Example:-

$$\underset{\text{sodium hydroxide}}{NaOH\ (aq)} + HCl\ (aq) \rightarrow \underset{\text{sodium chloride}}{NaCl\ (aq)} + \underset{\text{water}}{H_2O\ (l)}$$

The name of the salt comes from the name of acid.

(i) The salts of 'hydrochloric acid' are called 'chlorides'.

(ii) The salts of 'sulphuric acid' are called 'sulphates'.

(iii) The salts of 'Nitric acid' are called 'Nitrates'.

(iv) The salts of 'carbonic acid' are called 'carbonates'.

(v) The salts of 'acetic acid' are called 'acetates'.

The names of some important salts and their formulae:-

Salt	Formula	Salt	Formula
1. Sodium chloride	$NaCl$	10. Zinc sulphate	$ZnSO_4$
2. Calcium chloride	$CaCl_2$	11. Copper sulphate	$CuSO_4$
3. Magnesium chloride	$MgCl_2$	12. Ammonium sulphate	$(NH_4)_2SO_4$
4. Zinc chloride	$ZnCl_2$	13. Sodium nitrates	$NaNO_3$
5. Sodium sulphate	Na_2SO_4	14. Potassium nitrates	KNO_3
6. Potassium sulphate	K_2SO_4	15. Sodium carbonate	Na_2CO_3
7. Calcium sulphate	$CaSO_4$	16. Calcium carbonate	$CaCO_3$
8. Magnesium sulphate	$MgSO_4$	17. Zinc carbonate	$ZnCO_3$
9. Aluminium sulphate	$Al_2(SO_4)_3$	19. Sodium acetate	CH_3COONa

Common salt (Sodium chloride) NaCl

1. Common salt is a white powder which is used in preparing foods. Common salt is also known as just 'salt'.
2. Chemical name of common salt is sodium chloride (NaCl).

Preparation:- Sodium chloride can be made in the laboratory by combination of sodium hydroxide and hydrochloric acid.

$$\underset{\text{Sodium hydroxide}}{NaOH\ (aq)} + \underset{\text{Hydrochloric acid}}{HCl\ (aq)} \rightarrow \underset{\text{Sodium chloride (common salt)}}{NaCl\ (aq)} + H_2O\ (l)$$

Common salt is obtained from sea water by the process of evaporation.

2. Sodium hydroxoide (NaOH):-

1. Sodium hydroxide is commonly known as caustic soda.
2. The chemical formula of sodium hydroxides is NaOH.

Production of Sodium Hydroxide:-

Sodium hydroxides is produced by the electrolysis of a concentrated aqueous solution of sodium chloride (brine).

When electricity is passed through brine (cone aqueous NaCl) it decomposes to form sodium hydroxide, chlroine and hydrogen.

$$\underset{\text{Sodium chloride (Brine)}}{2NaCl\ (aq)} + \underset{\text{water}}{2H_2O\ (l)} \xrightarrow[\text{Electrolysis}]{\text{Electricity}} \underset{\text{sodium hydroxide}}{2NaOH\ (aq)} + Cl_2\ (g) + H_2\ (g)$$

Chlorine gas is produced at anode and hydrogen gas is produced at cathode. Sodium hydroxide is formed near the cathode.

The process of electrolysis of sodium chloride solution is called chlor-alkali process because of the product formed.

The three useful product obtained by electrolysis of brine (aq NaCl solution) or (chlor-alkali process) are sodium hydroxide, chlorine and hydrogen.

3. Washing soda (Na_2CO_3 - $10H_2O$)

(1) Washing soda is sodium carbonate containing 10 molecules of water of crystallisation.

(2) The formula of washing soda is $NaCO_3.10H_2O$.

(3) An thydrous Sodium Carbonate does not contain water of crystallisation and is commonly called Soda Ash. (anh.Na_2CO_3)

Production of washing soda:-

Washing soda is produced from sodium chloride (called brine) in following three steps.

(i) $\underset{\text{(common salt)}}{NaCl} + NH_3 + H_2O + CO_2\uparrow \longrightarrow \underset{\text{Sodium hydrogen carbonate}}{NaHCO_3} + \underset{\text{Ammonium chloride}}{NH_4Cl}$

(ii) $2NaHCO_3 \xrightarrow{heat} Na_2CO_3 + CO_2\uparrow + H_2O$

Sodium hydrogen (carbonate

(iii) $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O$

(Sodium carbonate-decahydrate)

washing soda

4. Baking Soda (Sodium hydrogen carbonate):-

(1) The chemical name of Baking soda is Sodium hydrogen carbonate.

(2) The formula of baking soda is $NaHCO_3$.

(3) It is also called sodium bicarbonate.

Production of Sodium hydrogen carbonate (Baking Soda):-

Baking soda is produced by reacting a cold and concentrated solution of sodium chloride (brine) with ammonia and carbon dioxide.

$NaCl + NH_3 + H_2O + CO_2 \longrightarrow NaHCO_3 + NH_4Cl$

(brine) (Ammonia) water carbon dixoide — Baking soda — Ammonium chloride

IV. Bleaching powder ($CaOCl_2$):-

1. Bleaching powder is called calcium oxychloride.
2. The chemical formula of $CaOCl_2$.
3. It is also called chloride of lime.

Bleaching powder is prepared by passing chlorine gas over dry slaked lime.

$Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$

slaked lime — chlroine — bleaching powder — water

Bleaching action of bleaching powder is due to the oxidising property of chlorine in it.

V. Plaster of Paris ($CaSO4.\frac{1}{2}H_2O$)

1. Plaster of Paris is calcium sulphate hemihydrate or half hydrate.
2. The chemical formula is $caSO_4.\frac{1}{2}H_2O$.
3. Plaster of Paris is commonly known as P.O.P.

Preparation of Plaster of Paris:-

Plaster of Paris is prepared from gypsum. Gypsum is calcium sulphate dihydrate.

$CaSO_4.2H_2O \xrightarrow[(373\ K)]{Heat\ to\ 100^\circ C} CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O$

Plaster of Paris — water

Uses of the important salts:-

Names	Uses
1. Common Salt (NaCl) Sodium chloride	1. Common salt is used in cooking gas. 2. It is used as a preservative in pickles and in curing meat and fish. 3. It is used in the manufacture of soap. 4. It is used to melt the ice in winter in cold countries. 5. Used in making large chemicals like washing soda, baking soda etc.
2. Sodium Hydroxide (NaOH) Sodium Hydroxide	1. used for making soap and detergent. 2. used for making artificial textile fibre (rayon) 3. used in the manufacture of paper. 4. used in purifying bauxite ore. 5. used in de-greasing metals, oil refining and making dyes and bleaches
3. Washing Soda ($Na_2CO_3.10H_2O$) Sodium Corporate	1. used as a 'cleansing agent' for domestic purposes like washing clothes. 2. used to remove permanent hardness of water. 3. used in the manufacture of glass, soap and paper. 4. used in the manufacture of sodium compounds such as borax.
4. Baking Soda ($NaHCO_3$) Sodium Bicarbonate	1. used as an antacid. 2. used in making baking powder which is used in making cakes, bread etc. 3. used in fire extinguishers.
5. Bleaching Powder ($CaOCl_2$) Calcium hypochlorite	1. used in textile industry for bleaching cotton and linen and in paper industry for bleaching wood pulp. 2. used for disinfecting drinking water. 3. used in the manufacture of chloroform ($CHCl_3$) 4. used for making wool unshrinkable. 5. used as oxidizing agent in many chemical industries.
6. Plaster of Paris ($CaSO_4\frac{1}{2}H_2O$) Calcium sulphate hemic hydrate	1. used in hospital for setting fractured bone. 2. used for making toys, decoration material cheap ornament, chalk etc. 3. used for fire-proofing material 4. used for making surface smooth.

COMMON NAMES OF SOME CHEMICAL COMPOUNDS

Common names of some chemical compounds:-

S.No.	CHEMICAL NAME	COMMON NAME	CHEMICAL FORMULA
1.	Calcium hydroxide	Slaked lime	$Ca(OH_2)$
2.	Sodium carbonate	Washing Soda	$Na_2CO_3.10H_2O$
3.	Sodium bicarbonate	Baking soda	$NaHCO_3$
4.	Magnesium hydroxide	Milk of magnesia	$Mg(OH)_2$
5.	Calcium hypochilorite	Bleaching powder	$CaOCl_2$
6.	Calcium sulphate digydrate	Gypsum	$CaSO_4.2H_2O$
7.	Calcuim sulphate hemihydrate	Plaster of Paris	$CaSO_4\frac{1}{2}H_2O$
8.	Sodium chloride	Common salt	NaCl
9.	Sodium hydroxide	Caustic Soda	NaOH
10.	Calcium carbonate	Chalk	$CaCO_3$
11.	Hydrated potassium aluminium sulphate	Alum	$K_2Al_2(SO_4)24H_2O$
12.	Calcium oxide	Quick lime	CaO
13.	Urea	Carbamide	$CO(NH_2)_2$
14.	Annhydrous sodium carbonate	Soda ash	ann Aa_2CO_3
15.	Copper sulphate pentahydrate	Blue vitriol	$CuSO_4.5H_2O$
16.	Ferrous sulphate	Green vitriol	$FeSO_4.7H_2O$
17.	Nitrous oxide	Laughing gas	N_2O
18.	No chemical name	Producer gas	$CO + H_2 + N_2$
19.	No cchemical name	Coal gas	Co, H_2 & CH_4
20.	No chemical name	Water gas	$CO + H_2$
21.	No chemical name	Bauxite	$Al_2O_3.2H_2O$
22.	Calcium carbonate	Lime stone	$CaCO_3$
23.	Silver chloride	Horn Silver	AgCl
24.	Conc. sulphuric acid	Oil of vitriol	Conc. H_2SO_4
25.	Fuming sulphuric acid	Oleum	$H_2S_2O_7$
26.	Sodium aluminosilicate	Zeolite	$Na_2Al_2Si_2O_8.XH_2O$ (Used to soften minerals water)

Quick Recap

1. Chemical reaction are the process in which new substances with new properties are formed.
2. Decomposition reaction is just opposite of combination reaction.
3. When decomposition reaction is carried out by heating, it is called 'Thermal decomposition'.
4. The more reactive metal displaces the less reactive metal from the solution.
5. The addition of oxygen to a substance is called oxidisation. The removal of oxygen from a substance is called reduction.
6. Acids on dissolving in water gives H^+ ion whereas bases on dissolving in water gives OH^- ion.
7. Litmus blue, Methye orange and phenopthalein are the indicators to test acids and bases.
8. Water soluble bases are called alkalies.
9. The strength of acid or base is measured on a scale of numbers called the pH scale. pH of water is 7, pH of acids is less than 7, and pH of base is more than 7.
10. Universal indicator is a mixture of many different indicators (or dyes) which give different colours at different pH values of the entire pH scale.
11. According to (i) Arrhenius, acids give H^+ ions in aqueous solution and bases give OH^- ions in aqueous solution.
12. According to Bronsted-Lowry theory, acids are proton donor and bases are proton acceptor.
13. According to Lewis, an acid is an electron acceptor and a base is an electron donor.
14. A substance which removes colour from coloured substances and make them colourless is called a bleaching agent. Example:- $CaOCl_2$.
15. A substances which is used to kill germs or bacteria is called disinfectant.
16. The water molecules which form part of the structure (of a salt) are called water of crystallisation.
17. Water of crystallisation is not free water, so it does not wet the salt and it appears perfectly dry.

5. *Metals and Non-Metals*

Contents

METALS AND NON-METALS 5

INTRODUCTION

There are 115 chemical elements known at present. There are similarities as well as differences is the properties of these elements on the basis of their properties, all the element can be divided into.

1. Metals 2. Non-metals 3. Metalloids

I. METALS

1. Metals are the elements that conduct heat and electricity, and are malleable and ductile.
2. They reflect light and have lustre (Shine).
3. Metals are heavy and sonorous (Which make ringing sound when struck).
4. Metals are elements (except hydrogen) which form positive ions by losing electrons (or donating electrons). For example Aluminum is a metal which forms positive ions Al^{3+} by losing electrons.

$$Al \longrightarrow Al^{3+} + 3e^{-}$$

5. Metals are known as Electropositive elements because they can form positive ions by losing electrons.
6. The most abundant metal in the earth's crust is **aluminium**. Second most abundant is **iron**.
7. The major metals is the earth's crust in the decreasing order of their abundance are Aluminum, Iron, Calcium, Sodium, Potassium and Magnesium.
8. All the metals are solid except mercury (Hg) which is in liquid state.

II. PHYSICAL PROPERTIES OF METALS

The important physical properties of metals are

(1) Metals are malleable, that is metals can be beaten into this sheets with a hammer (without breaking)

When a piece of Aluminum metal is beaten four or five times, the piece of Aluminum metal turns into a thin aluminum sheet, without breaking.

Malleability :-

The property which allow the metals to be hammered into sheets is called malleability.

1. Gold and silver are the best malleable metals.
2. Aluminum and Copper metals are highly malleable metals.

(2) Metals are ductile, that is metals can be drawn (or stretched) into their wires.

The metals such as copper, aluminum magnesium and iron are available in the form of wires.

Ductility :-

The property which allows the metals to be drawn into wires is called ductility.

1. Gold is the most ductile metal.
2. Silver is the best ductile metal.
3. Copper and aluminum are very ductile.
4. Iron, magnesium and tungsten metals are also quite ductile.
5. Their wires of Tungsten metal are used for making the filaments of electric bulbs.

3. Metals are good conductors of heat and Electricity.

Metals allow heat to pass through them easily.

1. Silver metal is the best conductor of heat and electricity.
2. It has highest thermal conductivity.
3. The poorest conductor of heat among the metals is **lead**.
4. Metals like **iron** and **mercury** offer greater resistance to the flow of current, so they have lower electrical conductivity.

4. Metals are lustrous (or shiny) and can be polished.

1. Metals have a shiny surface.
2. Gold, silver and copper are shiny metals and they can be polished so they are used for making jewellery.

5. Metals are generally hard.

Most of the metals are hard. But all metals are not equally hard. The hardness varies from metal to metal.

1. Metals like iron, copper, aluminum etc are very hard.
2. Sodium (Na) and potassium (K) are soft metals which can be easily cut with a knife.

6. Metals are solid at room temperature :- Most of the metals are solid at room temperature. Except mercury (Hg) which is liquid at room temperature.

7. Metals have high melting points and boiling points. Except sodium and potassium.

1. Iron metal has a high melting point of 1535°C.
2. Copper metal has also a high melting point of 1083°C.
3. **Exception : -** Sodium and potassium metals have low melting point (of 98°C and 64°C respectively).
4. Gallium and cesium metals have low melting point (of 30°C and 28°C respectively).

8. Metals have high densities, except sodium and potassium.

By saying that metals have high densities, we mean that metals are heavy substances.

Density of Iron (Fe) is $= 7.8\,g/cm^3$

Density of sodium (Na) $= 0.97\,g/cm^3$

Density of potassium (K) is $= 0.86\,g/cm^3$

Sodium and potassium are exceptions they have very low densities and hence they are very light metals.

9. **Metals are sonorous : -** Sonorous means capable of producing a deep or ringing sound. The property of metals of being sonorous is called sonorousness or sonority.
10. **Metals usually** have a silver or grey colour except copper and gold. Copper is reddish-brown in colour where as gold is yellow in colour.

III. CHEMICAL PROPERTIES OF METALS

The important chemical properties of metals are

1. Reaction of metals with oxygen (of air) : -

When metals are burnt is air, they react with the oxygen of air to form metal oxides.

$$\text{Metal} + \text{Oxygen} \longrightarrow \text{Metal Oxide}$$

$$4\,Na + O_2(g) \longrightarrow 2\,Na_2O$$

Sodium (Metal) + Oxygen (From air) → Sodium Oxide (Basic Oxide)

Note :-

(1) Potassium and Sodium are very reactive metals. They react vigorously with the oxygen (of air) and catch fire. Both the metals are stored under kerosene oil to prevent their reaction with oxygen, moistures and carbon dioxide of air.

(2) Most of the metal oxides are insoluble in water. But some of the metal oxides dissolves in water to form alkalis.

(3) Most of the metal oxides are basic in nature and turn red litmus blue.

(4) Some of the metal oxides show basic as well as acidic behaviour. These metal oxides are known as **Amphoteric Oxides**. Example Aluminum Oxide (Al_2O_3) & Zinc Oxide.

2. Reaction of metals with water : -

Metals react with water to form a metal hydroxides (or metal oxide) and Hydrogen gas.

Examples – Potassium and Sodium reacts violently ever with cold water to form hydroxide.

$$\underset{\text{Potassium}}{2\,K(s)} + \underset{\text{Water}}{2\,H_2O(l)} \longrightarrow \underset{\text{Potassium Hydroxide}}{2\,KOH(aq)} + \underset{\text{Hydrogen}}{H_2(g)} + \text{Heat}$$

(1) Magnesium Like Lead, Copper Silver and Gold Aluminum Zinc and Iron React with Steam.

(2) Metals Like Lead, Copper Silver and Gold do not React with Water or Even Steam.

(3) Only those metals displace hydrogen from water (or steam) which are above hydrogen in the reactivity series.

3. Reaction of metals with dilute acids :-

Metals usually displace hydrogen from dilute acids. Only less reactive metals like copper, silver and gold do not displace hydrogen from dilute acids.

$$\underset{\text{Sodium}}{2\,Na(s)} + \underset{\text{Hydrochloric acid}}{2\,HCl(aq)} \longrightarrow \underset{\text{Sodium Chloride}}{2\,NaCl(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

Sodium reacts violently with dilute hydrochloric acid and to form Sodium Chloride and Hydrogen.

Copper does not reactwith dilute hydrochloric acid (or dilute sulphuric acid) at all. This shows copper is less reactive than iron.

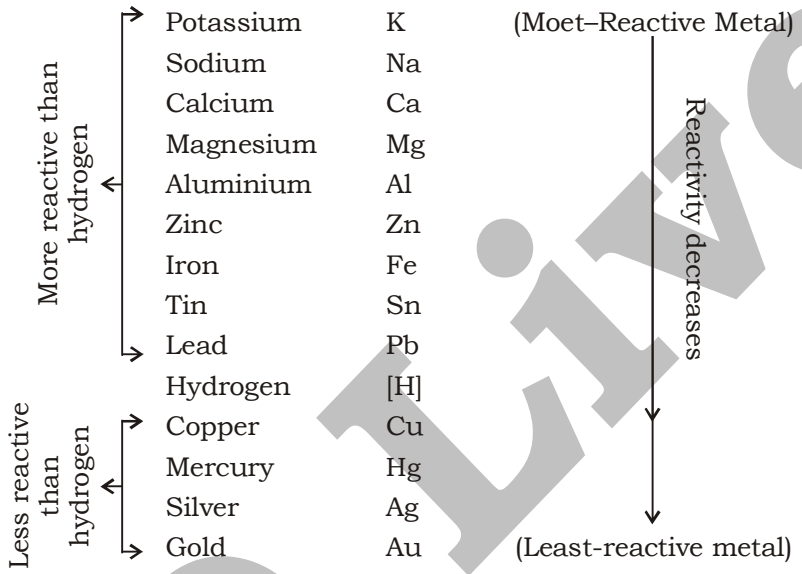
$$\underset{\text{Copper}}{Cu(s)} + HCl(aq) \longrightarrow \text{no reaction}$$

The reactivity series of metals (or activity series of metals) : -

The arrangement of metals is a vertical column in the order of decreasing reactivity is called the reactivity series, of metals.

In the reactivity series the most reactive metal is placed at the top whereas the least reactive metal is placed at the bottom.

The reactivity series (or Activity series) of Metals



(i) Metals which are more reactive than hydrogen displace hydrogen from its compounds like water and acids to form hydrogen gas. They are potassium, sodium, calcium, magnesium, aluminium zinc, iron, tin and lead.

(ii) Metals which are less reactive than hydrogen cannot displace hydrogen from its compounds like water and acids to form hydrogen gas. They are copper, mercury, silver and gold.

4. Reaction of Metal Salt Solutions :- A more reactive metal displaces a less reactive metal from its salt solution.

Example : - When a strip of zinc is put in copper sulphate solution then the blue colour of copper sulphate solution fades gradually due to the formation of colourless zinc sulphate solution and red-brown copper metal is deposited on the zinc strip.

$$\underset{\text{Copper sulphate (blue solution)}}{CuSO_4(aq)} + Zn(s) \longrightarrow \underset{\text{Zinc sulphate (Colourless Solution)}}{ZnSO_4(aq)} + \underset{\text{Copper (Red-brown)}}{Cu(s)}$$

5. Reaction of Metals With Chlorine :-

Metals react with chlorine to form electrovalent chlorides.

Sodium is a metal. Sodium is a metal so sodium readily reacts with chlorine to form an electrovalent chloride called sodium chloride.

$$\underset{\text{Sodium}}{2Na(s)} + \underset{\text{Chlorine}}{Cl_2(g)} \longrightarrow \underset{\substack{\text{Sodium chloride} \\ \text{(electrovalent chloride)}}}{2NaCl(s)}$$

6. Reaction of Metals With Hydrogen :-

Most of the metals do not combine with hydrogen. Only a few reactive metals like sodium, potassium, calcium and magnesium react with hydrogen to form metal hydrides.

Example :- When hydrogen gas is passed over heated sodium, then sodium hydride is formed.

$$\underset{\text{Sodium}}{2\ Na(s)} + \underset{\text{Hydrogen}}{H_2(g)} \longrightarrow \underset{\text{Sodium hydride}}{2NaH(s)}$$

IV. PHYSICAL PROPERTIUS OF NON-METALS

Physical properties of non-metals are just the opposite of the physical properties of metals.

1. Non-metals are neither malleable nor ductile:- Non-metals are brittle. Since non-metals are not malleable they cannot be hammer to form thin sheets. Since non-metals are not ductile they cannot be stretched to form thin wire

Brittleness:– The property of being brittle is called brittleness.

2. Non-metals do not conduct heat and electricity:- Non-metals do not conduct heat and electricity like metals, they have no free electrons.

Example :-Sulphur and phosphorus are non-metals which do not conduct electricity.

Exception :- There is one exception carbon (in the form of graphite) which is the only non-metal which is good conductor of electricity. So it is used for making electrodes.

3. Non-metals are not lustrous (not Shiny) :- Non-metals do not have lustre which means that non-metals do not have a shining surface. The solid non-metals have a dull appearance.

Exception :- Iodine is a non-metal having lustrous appearance.

4. Non-metals are generally soft (except diamond which is extremely hard non-metal):- Most of the solid non-metals are quite soft. For example. sulphur and phosphorous are solid non-metals which are quite soft. Only one non-metal carbon (in the form of diamond) is very hard.

5. Non-metals are not strong. They are easily broken.

6. Non-metals may by solid, liquid or gases at room temperature.

Non-metals can exist in all the three physical state solid, liquid and gas.

10 Non-metals are solid.

1 Non-metals are liquid.

11 Non-metals are gases.

7. Non-metals have comparatively low Melting point and Boning point (except graphite) which is a non-metal having a high melting point.

For example :-

(i) Melting point of sulphur is 115°C (388K) which is quite low.

(ii) Melting point of diamond is more than 3500°C, which is very high.

8. Non-metals have low densities, that is, non-metals are light substances.

For example, the density of sulphur is $2\,g/cm^3$ which is quite low.

9. Non-metals are non-sonorous. They do not produce sound when hit with an object.
10. Non-metals have many different colours.

For example :-

1. Sulphur is yellow.
2. Phosphorous is white.
3. Graphite is black.
4. Chlorine is yellowish-green.
5. Hydrogen and oxygen are colourless.

CHEMICAL PROPERTIES OF NON-METALS

The important chemical properties are

1. Reaction of Non- metals with oxygen :-

Non-metals react with oxygen to form acidic oxides or neutral oxides.

Carbon forms an acidic oxide (CO_2).

Hydrogen forms a neutral oxide (H_2O).

2. Reaction of non-metals with water :-

Non-metals do not react with water (or steam) to evolve hydrogen gas. This is because non-metals cannot give electrons to reduce the hydrogen ions of water into hydrogen gas.

3. Reaction of Non-metals with acids :-

Non-metals do not react with acids. In other words non-metals do not displace hydrogen from acids.

Reason :- In order to displace hydrogen ion (H^+) of an acid and convert them into hydrogen gas, electrons should be supplied to the hydrogen ion (H^+) of the acid. Now a non-metal being itself an acceptor of electrons, cannot give electrons to the hydrogen ions of the acid to reduce them to hydrogen gas and hence non-metal are not able to displace hydrogen from dilute acids.

4. Reaction of Non-Metals with salt solution :-

A more reactive non-metal displaces a less reactive non-metal from its salt solution.

For Example :- When Chlorine is passed through a solution of sodium bromide, then sodium chloride and bromide are formed.

$$\underset{\text{Sodium Bromide}}{2NaBr(aq)} + Cl_2(g) \longrightarrow \underset{\text{Sodium Chloride}}{2NaCl(aq)} + \underset{\text{Bromide}}{Ba_2(aq)}$$

In this displacement reaction, a more reactive non-metal is displacing a less reactive non-metal bromine from its salt-solution, sodium bromide solution.

5. Reaction of Non-Metals with chlorine :-

Non-metals reactwith chlorine to form covalent chlorides which are non- electrolytes. Non-metal chlorides are usually gases.

(i) Hydrogen : - Hydrogen is a non-metal, so hydrogen reacts with chlorine to form a covalent chloride called hydrogen chlorides.

$$\underset{\text{Hydrogen}}{H_2(g)} + \underset{\text{Chlorine}}{Cl_2(g)} \longrightarrow \underset{\text{Hydrogen Chloride}}{2HCl(g)}$$

6. Reaction of Non-Metals With Hydrogen :-

Non-metals react with hydrogen to form covalent hydrides. The non-metal hydrides are formed by the sharing of electrons.

(i) Sulphur is a non-metal which combines with hydrogen to form a covalent hydride called hydrogen sulphide H_2 .

$$\underset{\text{Hydrogen}}{H_2(g)} + \underset{\text{Sulphur}}{S(l)} \longrightarrow \underset{\text{Hydrogen Sulphide}}{H_2S(g)}$$

USES	
1. Metals	1. Copper and aluminium are used to make wires because they have very low electrical resistance 2. Iron, copper and aluminum are used to make household utensils. 3. Iron is used as a catalyst in the preparation of ammonia by Haber's prose. 4. Zinc is used for galvanizing iron to protect it from rusting. 5. Chromium and Nickel are used for electroplating and in manufacture of stainless steel. 6. Aluminum foil are used for packaging of medicines, cigarettes. 7. Silver and gold are used to make jewellery. 8. Sodium, titanium and zirconium are used is atomic energy. 9. The liquid metal 'mercury' is used for making thermometers. 10. Zirconium metal is used in making bullet-proof alloy steels. 11. Lead is used in making car batteries.
USES	
2. Non-metals	1. Hydrogenation is used in the hydrogenation of vegetable oils to make vegetable ghee. 2. Hydrogen is used in the manufacture of ammonia. 3. Liquid hydrogen is used as a rocket fuel. 4. Carbon (in the form of graphite) is used for making electrodes. 5. Nitrogen is used in the manufacture of ammonia, nitric acid and fertilizers. 6. Due to inertness, nitrogen is used to preserve food materials. 7. Compounds of nitrogen like trinitro toluene (TNT) and nitroglycerin are used as explosives. 8. Sulphur is used for manufacturing sulphuric acid. 9. Sulphur is used to fumigate and in making gun powder.

OCCURRENCE OF METALS

The earth's crust is the major source of metals. Most of the metals are quite reactive and

OCCURENCE OF METALS

The earth's crust is the major source of metals. Most of the metals are quite reactive and hence they do not occur as free elements in nature.

1. Metals found is the combined state are potassium, sodium, calcium, magnesium, aluminium, zinc, iron and lead.
2. Metals found in free state or native state are copper, silver, gold and platinum.
3. Metals found both in free state and combined state are copper and silver.

MINERALS AND ORES

Minerals :- The natural materials in which the metals or their compounds are found in earth are called minerals.

Ores :- Those minerals from which the metals can be extracted conveniently and profitably are called **Ores**.

An ore contains a good percentage of metal and there is no objectionable impurities in it. Thus, all the ores are minerals, but all the minerals are not **Ores**.

The relative abundance (by weight) of some important metals in the earth is given below in the table

Metals	% (Percentage)
1. Aluminum	7%
2. Iron	4%
3. Calcium	3%
4. Sodium	2.5%
5. Potassium	2.5%
6. Magnesium	2%
7. Titanium	0.6%

TYPES OF ORES

S. No.	Types of ores	Element	Names of ores
1.	Oxides	Aluminum	Bauxite ($Al_2O_3 \cdot 2H_2O$)
		Copper	Cuprites (Cu_2O)
		Iron	Hematite (Fe_2O_3)
		Tin	Casseterite (SnO_2)
2.	Carbonate ores	Calcium	Limestone ($CaCO_3$)
		Zinc	Calamine ($ZnCO_3$)
		Iron	Siderite ($FeCO_3$)
3.	Sulphide	Zinc	Zinc blende (ZnS)
		Copper	Copper glance (Cu_2S)
		Lead	Galena (PbS)
		Mercury	Cinnabar (HgS)
4.	Halide ores	Sodium	Rock salt ($NaCl$)
		Fluoride	Flourspar (CaF_2)
		Silver	Horn silver ($AgCl$)

CHIEF ORES AND METHODS OF EXTRACTION OF SOME COMMON METALS

Metals	Occurrence	Extraction method	Remark
1. Lithium	Spodumeme $LiAl(SiO_3)_2$ Lipidolite	Electrolysis of fused $LiCl / KCl$	Because of their high reactivity, they are extracted under anhydrous condition.
2. Sodium	Rock salt (NaCl)	Electrolyses of fused $NaCl/CaCl_2$	Sodium is highly reactive. It react with water.
3. Magnesium	Carnallite $KCl.MgCl2.6H_2O$ Magnesite $MgCO_3$	Electrolysis of fused MgO or $MgCl_2 / KCl$ carbon reduction of MgO	Carbon reduction is not possible with alkaline earth metals as carbide is formed with them
4. Calcium	Limestone $CaCO_3$ Dolomite $MgCO_3 \cdot CaCO_3$ Gypsum $CaSO_4 \cdot 2H_2O$	Electrolyses of fused $CaCl_2 / CaF_2$	Electrolysis in aqueous solution is not possible as calcium is highly reactive.
5. Copper	Copper pyrite $(CuFeS_2)$ Cuprites (Cu_2O) Copper glance (Cu_2S) Malachite $CuCO_3 \cdot Cu(OH)_2$ Azurite $2CuCO_3 \cdot Cu(OH)_2$	Roasting of sulphide partially and reduction $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$	It is self reduction in a converter. Sulphuric acid leaching is also employed.
6. Aluminum	Bauxite $Al_3O_3 \cdot 2H_2O$ Cryolite Na_2AlF_6	Electrolyses of Al_2O_3 dissolved in molten cryolite or in Na_3AlF_6	A good source of electricity is needed in the extraction of Al.
7. Zinc	Zinc blende (ZnS) Zencite (ZnO) Calamine $(ZnCO_3)$	Roasting and then reduction with C	The metal may be purified by fractional distillation.
8. Lead	Galena PbS	Roasting of sulphide ore, then reduction of the oxide.	Sulphide ore is concentrated by froth floatation process.

9. Iron	Hematite Fe_2O_3 Magnetite Fe_3O_4 Siderite $FeCO_3$ Iron pyrite FeS_2 Limonite $Fe_2O_3 \cdot 3H_2O$	Reduction with the help of CO and Coke in blast furnace, chemical reduction with CO, Calcination followed by reduction with CO. Roasting followed by reduction with CO	Limestone is added as flux which removes SiO_2 as calcium silicate (slag) floats over molten iron and prevents its oxidation Temperature approaching 2170K is required

METALLURGY

The various processes involved in the extraction of a metals from their ores and refining are known as metallurgy.

The various steps involved in the extraction of metal from its ore are.

1. **Concentration of Ore or (Enrichment of Ore) : -** The process of removal of unwanted materials like sand, clay, rocks etc. from the ore is known as concentration, ore dressing or beneficiation.

   This is done by using one or more of the following process.

   (a) Hydraulic washing :- Based on difference in densities of ore & gangue.

   (b) Magnetic separation :- Based on magnetic and non-magnetic properties of ore and gangue.

   (c) Froth floatation process :- This is done for sulphide ores. The sulphide ore is wetted with pine oil and gangue with water. A froth of sulphide is formed which is collected.

   (d) Leaching :- In this process ore is treated with suitable reagent which dissolves ore but not the impurities.

   Example :– Bauxite is purified by leaching process.

2. **Conversion of concentrated ore into metal oxides : -**

   (a) A carbonate ore is converted into metal oxide by **calcination**.

   (b) A sulphide ore is converted into metal oxide by roasting.

3. **Reduction of metal oxide to metal :-**

   Reduction :- The process of converting metal oxide into metal is called reduction. The metal oxide is reduced to metal by Carbon, Aluminium or electrolytic reduction.

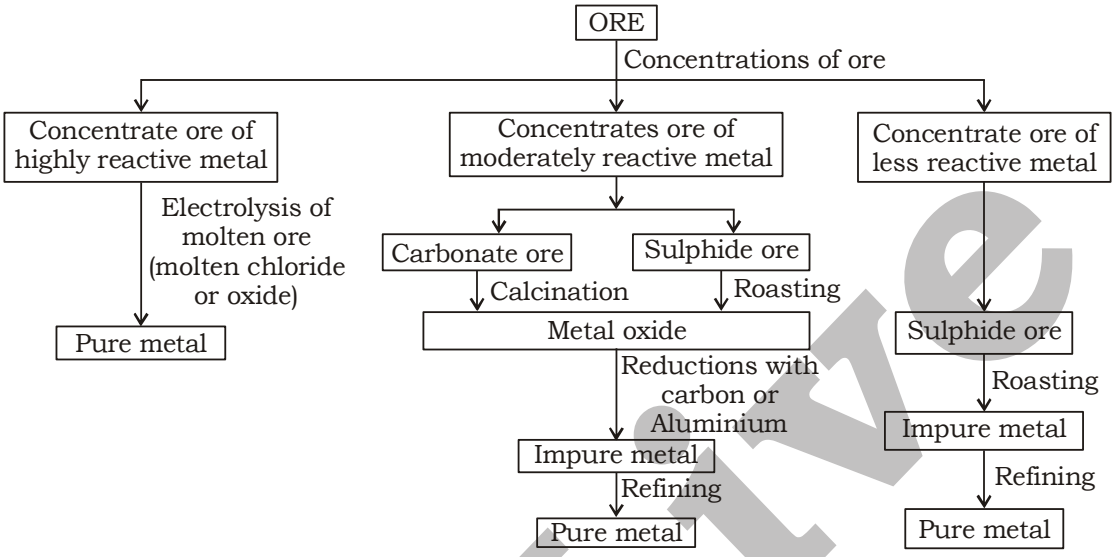
4. **Refining of impure metals :-** Refining means purification of metals. It can be done by

   (a) Electrolyte refining :- This method is used for refining Cu, Au, Ag, Pb, Zn and Aluminum.

   (b) Liquidation :- Those metals which have impurities the melting point of which are higher than the metal can be purified by this method.

   (c) Distillation :- This process is used to purify those metals which have low boiling points eg. Zinc, Mercury, Sodium, Potassium.

A summary of the various steps involved in the extraction of pure metals from their ores.



SOME IMPORTANT TERMINOLOGIES

1. **Gangue :-** The undesirable materials present in ore are known as gangue.
2. **Flux :-** The substance added to ores to remove gangue is known as flux.
3. **Slag :-** A substance formed as a result of flux and gangue is known as slag. Gangue + Flux = Slag.
4. **Concentration :-** The process of removal of gangue from the ore is known as concentration.
5. **Calcination :-** The process of heating ore below its melting point in the presence of air to remove impurities and convert it into oxide is called calcination.
6. **Smelting :-** The process of heating ore above its melting point in excess air to obtain pure metal is known as smelting.
7. **Sintering :-** It is a process of crushing ore to reasonable size before the concentration of ore.
8. **Thermite reaction :-** The reduction of a metal oxide to form metal by using aluminum powder as a reducing agent is called Thermite reaction.

THREE DIFFERENT TYPES OF IRON

1. **Pig Iron :-**
   (a) The iron obtained from blast furnace is called pig iron.
   (b) It is impure form of iron that contains 4% carbon and small amount of S P Si and Mn.
   (c) It can be cast into variety of shapes.
2. **Cast Iron :-**
   (a) It is made by melting pig iron with scrap iron.
   (b) It contains 3% carbon content.
   (c) It is hard and brittle.

3. **Wrought Iron :-**
   (a) It is the purest form of iron.
   (b) It is also called malleable iron.
   (c) It is prepared by oxidative refining of pig iron.

USES OF IRON

1. Cast iron is used for making stoves, railway sleepers, pipes, toys etc.
2. Nickel steel is used for making cables and automobiles, aeroplane parts and pendulum.
3. Chromium steel is used for making cutting tools.
4. Tungsten steel is used for marking drilling equipment.
5. Manganese steel is used for making helmets and railway lines.
6. Alnico is used for making permanent magnets.

CORROSION

The eating up of metals by the action of air, moisture or a chemical (such as an acid) on their surface is called corrosion.

The corrosion of iron is called rusting.

Rust :-

(a) When an iron object is left in damp air for a considerable time, it gets covered with a red brown flaky substance called rust.

(b) Rust is mainly hydrated iron (III) oxide $(Fe_2O_3 \cdot xH_2O)$.

Condition necessary for the rusting of iron are :-

1. Presence of air.
2. Presence of water or moisture.

Prevention of Rusting :-

1. By painting.
2. By applying grease or oil.
3. By galvanization.
4. By tin-plating and chromium plating.
5. By alloying it to make stainless steel. It is alloyed with chromium and nickel.

Anodizing :- Anodizing is a process of forming a thick layer of aluminum oxide on an aluminum object by making it anode during the electrolysis of dilute sulphuric acid. This protect the aluminum objects from further corrosion.

Corrosion of Copper :- The corrosion of copper is very, very slow. Due to corrosion a green coating of copper carbonate and copper hydroxide $(CuCO_3 \cdot Cu(OH)_2)$ is formed.

Corrosion of Silver :- Silver ornaments and articles gradually turns black due to the formation of a thin silver sulphide layer on their surface by the action of hydrogen sulphide (H_2S) present in air.

ALLOYS

An Alloy is a homogenous mixture of two or more metals. By Alloying we can improve the various properties of a metal like malleability, ductility, strength, hardness, resistance to corrosion, appearance etc.

The properties of an alloy are different from the properties of constituent metals. In general :-

1. Alloys are stronger than the metals from which they are made.
2. Alloys are harder.

3. Alloys are more resistant to corrosion.
4. Alloys have lower melting points than the constituent metals.
5. Alloys have lower electrical conductivity than pure metals.

Some of the common alloys are :-

Alloy	Alloy of	Composition	Uses
1. Duralumin	Aluminum	Al + Cu + Mg + Mn 95% 3% 2% 1%	For making pressure cooker, Aeroplanes, light tools.
2. Magnalium	Aluminum	Al + Mg 95% 5%	To make balance beams & light instruments.
3. Alnico	Aluminum	Al + Ni + CO + Fe	Used for making magnet
4. Stainless steel	Iron	Fe + Cr + Ni + C 75% 15% 9.5% 0.5%	Utensils, surgical cutlery.
5. Nickel steel	Iron	Fe + Ni 95% 5%	Electrical wire automobiles parts.
6. Steel	Iron	Fe + C 99% 1%	Nails, screws, bridges, railway lines.
7. Brass	Copper	Cu + Zn 70% 30%	Decorative material, handles.
8. Bronze	Copper	Cu + Sn 80% 20%	Statues, coins, medals and utensils.
9. German silver	Copper	Cu + Zn + Ni 50% 30% 20%	Ornaments, Decorative articles.
10. Rolled gold	Copper	Cu + Al 90% 10%	Cheap ornaments
11. Gun metal	Copper	Cu + Sn + Zn + Pb 88% 10% 1% 1%	Gun, Barrels, gears and bearings.
12. Dutch metal	Copper	Cu + Zn 80% 20%	Artificial Ornaments
13. Solder	lead and tin	Pb + Sn 50% 50%	For soldering electrical wire together.
14. Amalgam	Mercury	Hg + one or more metals Like Na, Sn, Zn etc	Used by dentist for filling in teeth.

IMPORTANT GASES

Oxygen :-

1. Oxygen is most abundant element in earth crust. Dry air contains 21% oxygen by volume.
2. Its atomic number is 8 and mass number is 16.

3. Its electronic configuration is $1s^2\ 2s^2\ 2p_x^2\ 2p_y^1\ 2P_z^1$.
4. It has 6 valence electrons and belongs to group 16 of periodic table.
5. It has three isotopes $^{16}_{8}O, ^{17}_{8}O, ^{18}_{8}O$.
6. It exists as diatomic molecule.
7. It has high ionization enthalpy.
8. Melting point is 218.4°C and Boiling point is -183°C.
9. Density at $0°C = 1.329\,kg/m^3$.
10. Valency of oxygen is 2.
11. Its solubility in water is $-30.8\,cm^3$ per litre at 293K.

PREPARATION

1. Oxygen is prepared in the laboratory by heating potassium chlorate $(KClO_3)$ with MnO_2, MnO_2 act as catalyst It helps to lower the temperature.

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

2. On large scale it is prepared by fractional distillation of liquid air.
3. Pure oxygen is obtained by electrolysis of water.

Note :- Oxygen is less reactive due to the presence of double bond.

HYDROGEN

1. Hydrogen is a colourless, highly inflammable gaseous element.
2. It is the most abundant element in the universe.
3. It is the first element in the periodic table and it is the lightest element.
4. It burns with a pale flame but does not help is combustion.
5. Its electronic configuration is $1s^1$ ie presence of only one electron in its valence shell.
6. Its atomic number is 1, Relative atomic mass : 1.008, Melting point is -259.14°C, Boiling point is -252°C, Density is $0.08988\,kg/m^3$, Valency is 1.

PREPARATION

1. Hydrogen can be obtained from water, acids and alkalis. In laboratory it is prepared by the action of dilute sulphuric acid on commercial zinc.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2 \uparrow$$

2. Industrial preparation of hydrogen by bosch process.

NITROGEN

1. Nitrogen is a colourless, tasteless and odourless gas constituting nearly four-fifths of air by volume.
2. It is inert diatomic gas, neither combustible nor a supporter of combustion.
3. It is slightly soluble in water.

4. It is first element of group 15 of periodic table.
5. Its atomic number is 7 and mass number is 14.
6. It is third most electronegative element after F and O.
7. It is less reactive at room temperature due to presence of triple bond.
8. Melting point of Nitrogen is -209.86°C and Boiling point is -195°C.
9. It shows oxidation states from -3 to +5 in various compound.

PREPARATION

1. In laboratory, it is prepared by heating an aqueous solution of NH_4Cl and $NaNO_2$.

$$NH_4Cl + NaNO_2 \xrightarrow{heat} N_2 + 2H_2O + NaCl$$

2. It is prepared commercially from air by liquefaction and fractional distillation.

CARBON DIOXIDE

1. Carbon dioxide is a colourless, odourless, incombustible gas.
2. It is heavier than air.
3. Carbon dioxide is acidic and turns lime water milky.
4. It is used in food refrigeration, carbonated beverages, fire extinguishers etc.

PREPARATION

1. Carbon dioxide is prepared by the action of dilute acids on carbonates or by fermentation of sugar.
2. In the laboratory it is prepared by treating marble pieces with dil hydrochloric acid.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 \uparrow H_2O$$

USEFUL GASES

Name	Uses
1. Acetylene, ethylene	To produce a hot flame for welding
2. Ammonia	Fertilizer, synthetic fibers, refrigeration
3. Butane	Cigarette lighters/domestic fuel
4. Ether	Anaesthetic and industrial processes
5. Ethylene	Plastics
6. Helium	Fluorescent tubes, laser, balloons
7. Krypton	Fluorescent tubes, high speed photography
8. Laughing gas (Nitrious oxide) N_2O	Mild anesthetic
9. Methane	To make chloroform
10. Neon	Illuminated sign
11. Propane	Fuel and refrigerant
12. Radon	Radio therapy, atomic research
13. Xenon	flash lamps and lasers.

NATURAL ACIDS		
	Name	**Source**
1.	Acetic acid	Vinegar
2.	Amino acid	Proteins
3.	Ascorbic acid	Vitamin C
4.	Citric acid	Lemon/citrus food
5.	Hydrochloric acid	Digestive juices
6.	Lactic acid	Milk
7.	Malic acid	Unripe apple/fruits
8.	Tannic acid	Tea
9.	Uric acid	Urine

WATER

1. Water was known by Cavendish, in the eighteenth century, to be a chemical compound.
2. Water is an colourless liquid at room temperature.
3. Water has higher specific heat, thermal conductivity and surface tension than most other liquids.
4. It act as excellent solvent.
5. It consist of hydrogen and oxygen in the ratio of 2 : 1 by volume and 1 : 8 by mass.
6. Boiling point of water is 100°C and freezing point is 0°C.

HARD AND SOFT WATER

Soft water :-

Water which easily forms lather with soap is known as soft water. Distilled water and rain water are common example of soft water.

Fard water :-

1. Water which does not easily produce lather with soap is known as hard water.
2. The hardness of water is due to the presence of soluble salts of calcium and magnesium such as bicarbonates, chlorides and sulphates.

Soap :- Soaps are sodium salts of fatty acids.

Types of hardness :-

1. **Temporary hardness :-** Is due to the presence of soluble bicarbonates of calcium and magnesium. Such water is also said to possess carbonate hardness.
2. **Permanent hardness :-** It is due to the presence of chlorides and sulphates of calcium and magnesium.

Such water is also said to possess non-carbonate hardness.

Softening of water :-

The process of removal of metallic ions (Ca^{+2} and Mg^{+2}) responsible for hardness of water is known as softening of water.

Hardness can be removed by following methods :-

Types	**Method**
1.Temporary	1. By boiling 2. By adding lime
2.Permanent hardness	1. By adding washing soda or caustic soda

HEAVY WATER (D_2O)

1. It was discovered by vrey.
2. It is prepared by fractional distillation of ordinary water.
3. Its boiling point is 101.42°C and freezing point is 3.82°C.

Uses of heavy water :-

1. As a neutron moderator.
2. In preparation of deuterium and compounds of deuterium.
3. As tracer compound.

ALLOTROPY

Substance which have the same chemical properties but different physical properties are known as allotropes and this property is called allotropy.

Different forms of carbon :-

Different forms of carbon are

1. Diamond
2. Graphite
3. Charcoal
4. Lamp black
5. Coke
6. Gas carbon
7. Coal
8. Animal charcoal

Diamond :-

1. It is transparent, lustrous, colourless or coloured in nature.
2. It is the purest form of carbon.
3. It is the hardest substance known to man.
4. It has very high refraction index 2.415.
5. It is a bad conductor of heat and electricity.
6. It has high melting point and density.

Graphite :-

1. It is a dark grey solid having a metallic luster.
2. It has a soft greasy touch. It marks the paper grey.
3. Its density is $2.25\,g\,cm^3$.
4. It is a good conductor of heat and electricity.
5. It is insoluble in ordinary solvent.

Charcoal :-

1. Wood charcoal is obtained from wood.
2. Sugar charcoal is obtained from cane sugar.
3. Bone or animal charcoal is obtained from animal bones.
4. Coke charcoal is obtained from coal.

Coke :-

1. It is used in the manufacture of water gas.
2. It is used as household fuel.
3. It is used in the manufacture of graphite.
4. It is used in the extraction of metals such as iron, copper, tin and zinc as it is an excellent reducing agent.

FUELS

A fuel is any substance which on burning in air or oxygen produces heat or any other form of energy. An ideal fuel should :-

1. Have high calorific value producing minimum heat.
2. Be cheaps easily available.
3. Produces minimum or no smoke and leaves no residue or minimum ash content.
4. Be regulated and controlled.
5. Should have low ignition temperature.

CLASSIFICATION OF FUEL

1. **Solid fuel :-** e.g., Wood, coal, charcoal, coke etc.
2. **Liquid fuel :-** e.g., petrol, kerosene oil, diesel, lubricating oil, ether, alcohol etc.
3. **Gaseous fuel :-** e.g., Natural gas, coal gas, LPG, producer gas, water gas.

COAL

On the basis of carbon percentage and calorific value, there are four types of coal.

	Types	Properties
1.	Peat	Low grade coal, produce less heat and more smoke and ash. Percentage of carbon : 50-60% calorific value (cal/gm) : 2500-3500
2.	Lignite	High moisture content, burns easily low calorific value Percentage of carbon – 60- 70% calorific value (cal/gm) : 3500-4500
3.	Bituminous	Black, hard, smoky flame, domestic fuel. Percentage of carbon: 75-80% calorific value (cal/gm) : 7500-8000
4.	Anthracite	Superior quality, hardest form high calorific value. Percentage of carbon : 75- 90% calorific value (cal/gm) : 6700-7500.

Compounds of metal and non-metal & their uses :-

1. **Iodine (I_2)** :- (i) Used as antiseptic (ii) Medicine (iii) Tincture of Iodine
2. **Chlorine (Cl_2)** :- (i) Mustard gas (ii) Bleaching agent (iii) Bleaching cloth and paper.
3. **Hydrochloric acid (HCl)** :- (i) In aqua regia (HCl + HNO_3) in the ratio 3 : 1 (ii) Dyes
4. **Sulphuric acid** (H_2SO_4) :- (i) Reagent (ii) Storage battery
5. **Sulphur dioxide** (SO_2) :- (i) Oxidants and reductants (ii) As bleaching agent
6. **Water gas** ($CO + H_2$) :- (i) As fuel (ii) Welding
7. **Coal gas** :- (i) As fuel (ii) Inert atmo sphere
8. **Nitrous oxide** (N_2O) :- (i) Laughing gas (ii) Surgery
9. **Carbon dioxide** :- (i) Soda water (ii) Fire extinguisher
10. **Carbon monoxide** :- (i) In phosgene gas ($COCl_2$)
11. **Graphite** :- (i) As electrodes
12. **Diamond** :- (i) Ornaments (ii) Glass cutting (iii) Rock drilling

13. **Alum** $[K_2SO_4Al_2(SO_4)_3 24H_2O]$ **:-** (i) Purification of water
(ii) Leather industry

14. **Mercury** (Hg) **:-** (i) Thermometer (ii) Vermillion
(iii) Amalgam

15. **Plaster of Paris** $(CaSO_4)½H_2O$ **:-** (i) Statue (ii) Surgery

16. **Heavy water** (D_2O) **:-** (i) Nuclear reaction reactor

17. **Liquid hydrogen** **:-** (i) Rocket fuel

Fertilizers :- Chemicals help to increase the fertility of the soil and growth of the plant. Natural manures : Cow dung, Compost dried leaves.

Artificial fertilizers :- Man made chemicals are urea, ammonium sulphate, super phosphate of lime, potassium chloride etc.

Nitrogenous fertilizers-for synthesizing proteins :-

1. Ammonium sulphate $[(NH_4)_2SO_4]$.
2. Urea $CO(NH_2)_2$.
3. Calcium nitrate and ammonium nitrate $Ca(NO_3)_2$.
4. Diammonium phosphate $(NH_4)_2HPO_4$.
5. Potassium Nitrate KNO_3.

Phosphate fertilizers - PO_4 **provides energy for biochemical reaction :-**

(i) Super phosphate of lime $[Ca(H_2PO_4)_2$ mixed with $CaSO_4 \cdot 2H_2O]$.

(ii) Diammonium phosphate $(NH_4)_2HPO_4$.

Potassium fertilizers :-

(i) It helps in the proper formation of roots.
(ii) Helps fight disease.
(iii) Helps in the synthesis of carbohydrates.

Following are some of the potasium fertilisers :-

(a) Potassium nitrate (KNO_3)

(b) Potassium chloride (KCl)

(c) Potassium sulphate (K_2SO_4)

Pesticides : - Many living organisms destroy crops or eat away grains. They are collectively known as pests. To kill them chemicals called pesticides are used.

(a) Insecticides : - D.D.T, Aluminum phosphate, Gammexane.

(b) Fungicide :- Hexachloro benzene (C_6Cl_6).

(c) Rodenticides : - Aluminum phosphide.

(d) Herbicides :- Benzopram, Benzabox.

Quick Recap

1. Elements can be classified into metals and non-metals.
2. Metals are lustrous, malleable, ductile and are good conductors of heat and electricity. They are solid at room temperature, except-**mercury** which is liquid.
3. Metals form positive ions by losing electrons to non-metals.
4. Metals have high melting point but **Gallium** and **Cesium** have very low melting point.
5. **Iodine** is a non-metal but it is lustrous.
6. Carbon is a non-metal that can exist in different forms. Each form is called allotrope. Diamond and graphite are allotropes carbon.
7. **Anodizing** is a process of forming a thick oxide layer of aluminum.
8. **Quenching**-Steel is heated to bright redress and then suddenly cooled in water or oil, it becomes extraordinarily hard and brittle. This process is called quenching.
9. **Tempering** – By controlled heating (250-250-325°C) of quenched steel, its brittleness can be removed without affecting its hardness. This process is called tempering.
10. **Annealing** – Steel is heated to a temperature well below red hot and then cooled which turns it soft and the process is called annealing.
11. The extraction of metals from their ores and then refining them for use is known as **metallurgy.**
12. An **alloy** is a homogenous mixture of two or more metals and non-metal.
13. When one of the metal is mercury then the alloy is known as **amalgam**.
14. Zinc phosphide is used for killing rats.
15. Wood furniture are coated with zinc chloride to prevent termites.
16. Calcium hydroxide is called **hydrolith**.
17. Nichrome wire is used in electrical heater.
18. Potassium carbonate (K_2CO_3) is known as **pearl ash**.
19. Radium is extracted from **pitch blende** (V_3O_8).
20. The filament of bulbs are made up of **tungsten**.
21. Cadmium rod is used in nuclear reactor to slow down the speed of neutron.
22. **CO (60)** is used in treating cancer.
23. Onion and garlic smell is due to **potassium**.
24. Fuse wire is made up of lead and tin.
25. **Tetra-ethyl** lead is used as anti-knocking compound.
26. Iron pyrite (FeS_2) is known as **fool's gold**.
27. Silver and copper are the best conductor of electricity.
28. D_2O (heavy water) is used as neutron moderator.

6. *Carbon and its Compounds*

Contents

CARBON AND ITS COMPOUNDS 6

Introduction

Carbon is an element. The symbol of carbon is C. It is a non-metal. The name carbon is derived from the Latin word 'carbo' which means 'Coal'. The earth's crust contains only 0.02% carbon in the form of mineral and the atmosphere has only 0.03% of Carbon-dioxide gas. Carbon always forms Covalent bonds. Carbon shows self combination property which gives rise to an extremely large number of carbon compounds (or organic compounds).

Occurence of Carbon

Carbon occurs in nature in 'free state' as well as in the 'combined state'.

(1) **In Free State -** Carbon in nature is present in two forms-diamond and Graphite. Another naturally occurring form of carbon called buck-minsterfullerens has been discovered recently.

(2) **In combined state**

a. As Carbon dioxide gas in 'air'.
b. As Carbonate (like limestone, marble and Chalk)
c. As Fossil fuel like Coal, Petroleum and natural gas.
d. As Organic compounds like carbohydrates, fats and proteins.
e. Pusent Wood, Cotton and Wool etc.

Allotropes of Carbon

The various physical forms in which an element can exist are called allotropes of the element. The three allotropes of carbon are –

1. Diamond
2. Graphite
3. Buckminsterfullerene (new allotrope discovered recently.)

Diamond

1. Diamond is a colourless transparent substance having extra-ordinary brilliance.
2. It is the hardest natural substance known.
3. Does not conduct electricity
4. Diamond burns to form Carbon dioxide

Graphite

1. Graphite is a greyish black opaque substance.
2. It lighter than diamond.
3. It soft and slippery to touch.
4. It conduct electricity due to the presence of free electrons.

Buck-minsterfullerene

1. Buckminsterfullerene is an allotrope of carbon containing clusters of 60 carbon atoms joined together in a spherical molecule.
2. Its formula is C_{60} (C-sixty)
3. It is a football-shaped spherical molecule in which 60 carbon atoms are arranged.
4. There are 20 hexagons and twelve pentagons of carbon atoms in one molecule of buck-minsterfullerene.
5. It is a dark solid at room temperature.
6. It is neither very hard nor soft.

Organic Compounds.

The compounds of carbon are known as Organic Compounds. Most of the Organic Compounds are hydrocarbons (containing only Carbon and Hydrogen) or their derivatives.

Some examples of Organic Compounds and their Melting point, Boiling point and their physical state.

Carbon Compounds	Melting Point	Boiling Point	Physical state at room temperature
1. Methane	-182^0C	-161^0C	Gas
2. Trichloromethane (Chloroform)	-63^0C	61^0C	Liquid
3. Ethanol (Ethyl Alcohol)	-114^0C	78^0C	Liquid
4. Ethanoic acid (Acetic acid)	17^0C	118^0C	Liquid

The study of carbon compounds (such as hydrocarbon and their derivatives) is called Organic Chemistry.

Types of Organic Compounds

Some of common types of Organic Compounds are

1. Hydrocarbons
2. Haloalkanes (Halogenated hydrocarbons)
3. Alcohol
4. Aldehydes
5. Ketones
6. Carboxylic acid (Organic acid)

Hydrocarbons
(made of hydrogen and Carbon)

Saturated Hydrocarbons (Ex-alkanes)

Unsaturated Hydrocarbon (Ex-alkanes)

Saturated Hydrocarbons (Alkanes) or Paraffins

1. A hydrocarbon in which the carbon atoms are connected by only single bonds is called a saturated hydrocarbon. C-C or C-H.
2. Saturated hydro carbon is also called Alkanes or Paraffins
3. General formula of saturated hydrocarbons or alkanes is C_nH_{2n+2} where n is the number of carbon atoms in one molecule of alkane.

First five saturated hydro carbons or alkanes

Name of alkane (Saturated hydrocarbon)	Number or Carbon atoms (n)	Molecular formula
1. Methane	1	CH_4
2. Ethane	2	C_2H_4
3. Propane	3	C_3H_8
4. Butane	4	C_4H_{10}
5. Pentane	5	C_5H_{12}

The saturated hydrocarbons (or alkanes) are chemically not very reactive. They are quite unreactive

Unsaturated Hydrocarbons (Alkenes and Alkynes) or olefins

1. A hydrocarbon in which the two carbon atoms are connected by a 'double bond' or a triple bond is called an unsaturated hydrocarbons
2. Ethene ($H_2C = CH_2$) and ethyne (HC = CH) are two important unsaturated hydrocarbons.
3. The unsaturated hydrocarbons are obtained mostly from petroleum by a process called cracking.

The unsaturated hydrocarbons are of two types

1. Those containing carbon-carbon double bonds (alkenes)
2. Those containing carbon-carbon triple bonds (alkynes)

Alkenes

1. An unsaturated hydrocarbon in which the two atoms are connected by double bond is called Alkene.
2. An alkene contains the $\diagdown C = C \diagup$ group
3. The general formula of an alkene is C_nH_{2n}. where n is the number of carbon atoms in its one molecule.
4. The common name of ethene is ethylene.

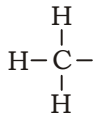
Name of alkene (Unsaturated hydrocarbon)	Number of Carbon atom (n)	Molecular formula
1. Ethene	2	C_2H_4
2. Propene	3	C_3H_6
3. Butene	4	C_4H_8

Alkynes

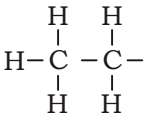
1. An unsaturated hydrocarbon in which the two carbon atoms are connected by a triple bond is called an alkyne.
2. The general formula of alkynes is C_nH_{2n-2}. where *n* is the number of carbon atom.
3. The simplest alkyne is ethyne having the molecular formula C_2H_2.
4. The common name of ethyne is acetylene.

Alkyl Groups

1. The group formed by the removal of one hydrogen atom from an alkane molecule is called an alkyl group.
   Examples of alkyl group are



Methyl group



ethyl group

2. The General formula of a alkyl group is C_nH_{2n+1}.

Functional Group

An 'atom' or a group of atom which makes a carbon compound (or organic compound) reactive and decides its properties (or functions) is called a functional group.

Some of the important functional groups present in organic compounds are

1. Alcoholic group
2. Aldehydic group
3. Ketonic group
4. Carboxyl group
5. Ester group
6. Halogen group
7. Amino group
8. Nitro group

1. **Alcoholic Group** : OH or – O - H

(a) The alcoholic group is made up of one oxygen atom and one hydrogen atom joined together.

(b) The alcoholic group is also known as alcohol group or hydroxyl group.

(c) The general formula of an alcohol can be written as R-OH (where R is an alkyl group like CH_3, C_2H_5 etc and OH is the alcoholic group.)

(d) The examples of a compounds containing alcoholic group are Methyl alcohol (or methanol) CH_3OH, ethyl alcohol (or ethanol C_2H_5OH).

2. **Aldehydic group** : CHO or $\overset{O}{\overset{\|}{C}}-H$

(a) The aldehydic group consist of one carbon atom, one hydrogen atom and one oxygen atom joined together.

(b) The compounds containing aldehydic group are called aldehydes.

(c) The aldehydes can be represented by the general formula R-CHO (where R is the alkyl group)

(d) The examples of compound containing an aldehydic group are methanal (HCHO) acetaldehyde also called ethanol (CH_3CHO).

3. **Ketonic Group** C = O or or $\overset{O}{\overset{\|}{C}}$ or –Co–

(a) The Ketonic group consists of one carbon atom and one oxygen atom.

(b) The oxygen atom of the ketonic group is joined to the carbon atom by double bond.

(c) The carbon atom of the ketonic group is attached to two alkyl groups (which many be same or different)

(d) Ketone group always occurs in the middle of a carbon chain. So a ketone must contain at least three Carbon atoms in its molecule.

(e) The simplest ketone is acetone. (CH_3COCH_3) which is also known as propanone.

IUPAC name of Ketone	Formula of Ketone
1. Propanone	CH_3COCH_3
2. Butanone	$CH_3COCH_2CH_3$
3. Pentanone	$CH_3COCH_2CH_2CH_3$
4. Hexanone	$CH_3COCH_2CH_2CH_2CH_3$

4. **Carboxyl Group :** –COOH or $\overset{O}{\overset{\|}{C}}-OH$

(a) The carbon compounds containing carboxylic acid group (–COOH group) are called carboxylic acid.

(b) Carboxylic acids are commonly called Organic acid.
(c) Another name of carboxylic acid is alkanoic acid.
(d) The carboxylic acids are made of three elements oxygen, carbon and Hydrogen.
(e) The most common carboxylic acids are formic acid and Acetic acid.

IUPAC name of acid	Fromula of acid
1. Methanoic acid	HCOOH (Formic acid)
2. Ethanoic acid	CH_3COOH (acetic acid)
3. Propanoic acid	C_2H_5COOH
4. Butanoic acid	C_3H_7COOH

4. Ester Group : –COOR or $-\overset{\overset{O}{\|}}{C}-OR$

(where R is an alkyl group like CH_3 or C_2H_5)
(a) The organic compound containing ester group (–COOR group) are called esters.
(b) Ester group is present in Methyl acetate (or Methyl ethanoate), CH_3–$COOCH_3$ (where R-CH_3) and in Ethyl acetate (or ethyl ethanoate) CH_3–$COOC_2H_5$ (here R = C_2H_5)

6. Halogen Group : X (X can be Cl, Br or I)
(a) The halogen group can be Chloro-Cl, Bromo - Br or Iodo - I depending upon whether a chlorine, Bromine or Iodine atom is linked to the carbon atom of the organic compound.
(b) Chloro group is present in chloromethane, CH_3-Cl. Bromo group is present in Bromo methane CH_3-Br. Indo group is present in Iodomethane, CH_3 – I.

7. Amino group: NH_2 or $-\overset{\overset{H}{|}}{N}-H$

(a) Amino group is made up of one nitrogen atom and two hydrogen atoms joined together.
(b) A carbon compound containing amino group (–NH_2) group is called an amine.
(c) Amino group is present in methenamine, CH_2–NH_2 and ethane amine, C_2H_5 – NH_2.
(d) Common name of C_2H_5–NH_2 is ethyl amine.

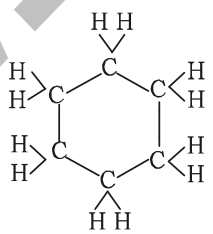
8. Nitro group: NO_2
(a) Nitro group is made up of one Nitrogen atom and two oxygen atoms.
(b) The compounds containing - NO_2 group are called Nitro compound.
(c) Nitro group is present in Nitro methane, CH_3-NO_2 and in Nitro ethane C_2H_5- NO_2.

Cyclic Hydrocarbons

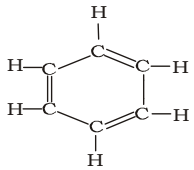
1, The hydrocarbons in which the carbon atoms are arranged in the form of a ring are called cylic hydrocarbons.
2. The cyclic hydrocarbons may be saturated or unsaturated.

Saturated Cyclic hydrocarbon

1. Saturated cyclic hydrocarbon is 'cycloheane'
2. The formula of cyclo hexane is C_6H_{12}.
3. A molecule of cyclo hexane contains 6 carbon atoms arranged in a hexagonal ring and each carbon atom has 2 hydrogen atoms attached to it.



4. General formula of Cyclohexane in C_nH_{2n}.
2. **An unsaturated Cyclic Hydrocarbon.**
   1. An unsaturated cyclic hydrocarbon is 'benzene'.
   2. The formula of benzene is C_6H_6.
   3. A molecule of benzene is made up of 6 carbon atoms and 6 hydrogen atoms.
   4. The structural formula of benzene is:



Structural formula of benzene

5. The unsaturated cyclic compounds like benzene are called aromatic compound.

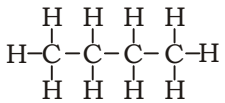
Note : (1)A saturated hydrocarbon contains single bond Ex. alkane

(2) An unsaturated hydrocarbon contains double or triple bond. Ex. alkene & alkyne.

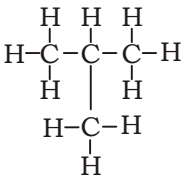
Isomers

The organic compounds having the same molecular formula but different structure are known an isomers.

Example - Normal butane and Iso-butane.



n-butane (C_4H_{10})



n-butane (C_4H_{10})

Normal-butane has a straight chain structure whereas iso-butane has a branch chain structure.

Isomerism - The existence of two (or more) different Organic compounds having the same molecular formula but different structures is called isomerism.

Isomerism is only possible with hydrocarbons having 4 or more carbon atoms.

Note - (A cooking gas cylinder) which is a butane fuel is a mixture of both its isomers : n-butane and isobutane. LPG also contains small amounts of propane and ethane.

Homologous Series

A homologous series is a group of organic compounds having similar structure and similar chemical properties in which the successive compounds differ by CH_2 group.

Homologous Series of Alkanes.

Alkane	Molecular formula
1. Methane	CH_4
2. Ethane	C_2H_6
3. Propane	C_3H_8
4. Butane	C_4H_{10}
5. Pentane	C_5H_{12}

All the hydrocarbons - alkanes, alkenes & alkynes form homologous series. The organic compounds such as alcohol, aldehydes etc also form homologous series.

Chemical properties of Carbon compounds

The most common carbon compounds are hydrocarbons (alkanes, alkenes and alkynes) The chemical properties are

1. Combustion reactions
2. Substitution reactions
3. Addition reactions

1. **Combustion reaction** - Occur in all types of hydrocarbons (saturated as well as unsaturated)
2. The process of burning of a carbon compound in air to give carbon dioxide, water, heat and light is known as combustion.
3. Alkanes burn in air to produce a lot of heat due to which alkanes are excellent fuels.

$CH_2 + 2O_2 \xrightarrow{\text{combustion}} CO_2 + 2H_2O +$ Heat+Light+Methane

4. Since natural gas (methane) produces a lot of heat it is used as fuel in homes, transport and industries.
5. The saturated hydrocarbons generally burn in air with a blue, non-sooty flame.
6. The unsaturated hydro carbons (alkenes and alkynes) burn in air with yellow, sooty flame (producing black smoke) but if it is burned in pure oxygen, then it will burn completely producing a blue flame without any smoke. Example- when acetylene and pure oxygen are burned, then acetylene burns completely producing a blue flame with high heat. This flame is called (oxy-acetylene) flame which is used for welding.

2. **Substitution Reaction**
   1. Saturated hydrocarbon, undergoes substitution reaction with chlorine in the presence of Sunlight.
   2. The reaction in which one (or more) hydrogen atom of a hydrocarbon is replaced by some other atom (like chlorine) is called a substitution reaction.

3. Unsaturated hydrocarbons do not give substitution reaction with halogens

4. **Addition Reaction**
   1. The reaction in which an unsaturated hydrocarbon combines with another substance to give single product is called an addition reaction.
   2. Addition reactions are characteristic property of unsaturated hydrocarbons.
   3. Addition reaction is given by all the alkenes and alkynes.

5. **Hydrogenation** -
   1. The addition of hydrogen to an unsaturated hydro carbon to obtain a saturated hydrocarbon is called hydrogenation.
   2. The process of hydrogenation takes place in the presence of nickel or palladium metals as catalyst.
   3. The process of hydrogenation has an important industrial application. It is used to prepare vegetable ghee (or Vanaspati ghee) from vegetable oils. Vegetable oils containing unsatuarted fatty acids are good for our health. Saturated fats like vegetable ghee, obtained by the hydrogenation of oils are not good for health. The animal fats (like butter and Ghee) are also saturated fats.

Important Reaction of Ethanol

When Ethanol reacts with Ethanoic acid in the presence of few drops of conc H_2SO_4 it forms a sweet smelling ester. ethyl ethanoate.

$CH_3COOH + C_2H_5OH \xrightarrow{conc H_2SO_4} CH_3COOC_2H_5 + H_2O$

(Ethyl acetate is a sweet Smelling ester)

1. **Esterification** - The reaction in which a carboxylic acid combines with an alcohol to form an ester is called esterification.

2. **Hydrolysis of Esters**- When an ester is heated with sodium hydroxide solution then the ester gets hydrolysed to from the parent alcohol and sodium salt of carboxylic acid.

$CH_3COOC_2H_5 + NaOH \xrightarrow{heat} CH_3COONa + C_2H_5OH$

Ethanol — Sodium ethanoate

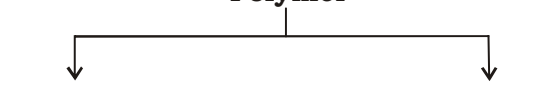
The alkaline hydrolysis of esters (using alkaline like NaOH) is known as **Saponification** (soap making)

Carbon compound	**Uses.**
1. Ethanol (Ethyl alcohol)	1. Ethyl alcohol (Ethanol) is used in the manufacture of paints; perfume, dyes, soaps & synthetic rubber 2. As a solvent. 3. In medicines such as tincture iodine, cough syrups and tonics. 4. As a fuel 5. In alcoholic drinks. 6. As an antiseptic to sterilize wounds & syringes.
2. Ethanoic acid (Acetic acid)	1. Dilute ethanoic acid is used as food preservative and as vinegar. 2. For making cellulose acetate which is an artificial fibre. 3. In the manufacture of acetone (Propanone) an ester used in perfumes. 4. In the preparation of dyes, plastic and pharmaceuticals. 5. Is used to coagulate rubber from latex.

Polymer

1. A polymer is a very big molecule formed by the combination of a large number of small molecules (called monomers)

2. Polythene, poly vinyl chloride, polystyrene, rubber, rayon , cellulose, nylon polyester (terylene) and proteins are called polymers.



Natural Polymer (Polymers found in plants and animals)	Synthetic Polymer (man made)
1. Cellulose	1. Polythene
2. Natural rubber	2. Polyvinyl chloride
3. Cotton	3. Polystyrene
4. Wool	4. Nylon
5. Silk	5. Polyester
6. Proteins	6. butadiene rubber
7. Skin	7. Neoprene
8. Wood	

Polymerization - The process of formation of polymers from respective monomers is called poly- merization

Example - The transformation of ethene to polythene.

(1) $nCH_2 = CH_2 \xrightarrow{\text{Polymerization}} (CH_2 - CH_2)_n$ polythene

Ethene

Monomer unit $CH_2 = CH_2$

The polymers are the backbone of four major industries such as plastics, elastomers, fibres and paints.

Difference between Thermoplastic polymers and Thermosetting polymers.

Thermoplastic Polymers

1. These are neither very strong nor weak and have no cross-links between the chains.
2. These are the linear or slightly branched long chain polymer which is capable of softening on heating and hardening on cooling.

Ex- Polythene, Polystyrene, Polyvinyl etc.

Thermasetting polymers

1. These polymers are cross-linked or heavily branched molecules.
2. On heating it undergoes extensive cross-linking between polymer chains to give a three-dimensional solid and again become infusible.

Ex- Bakelite, urea-formaldehyde resins etc.

Types of Polymerisation Reactions

There are two types of polymerisation reactions

1. Addition polymerisation
2. Condensation polymerisation

Addition polymerisation

In additional polymerisation, the molecules of the same monomer or different monomers add together to form a polymer.

Example : A large number of ethene molecules add together to form an addition polymer called polyethene commonly called polythene

$CH_2 = CH_2 + CH_2 = CH_2 + CH_2 \rightarrow CH_2®CH_2–CH_2–CH_2–CH_2$

Ethene molecules form Polythene (Polymer)
(monomers)

some important addition polymers are : polythens polyvinyl chloride (PVC), Teflon, polypropene and Natural rubber.

2. **Condensation polymerisation :** This type of polymerisation involves a repetitive condensation reaction between two bi-functional monomers.

Example- Formation of terylene or dacron.

3. **Copolymerisation:** When two or more different monomer units join together to get polymerised it forms a copolymer and the process is termed copolymerisation.

For example formation of styrene butadiene rubber (SBR)

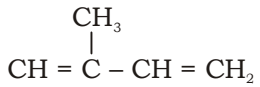
SBR is used for the manufacture of auto tyres, floor tiles, footwear components etc.

Rubber

Natural Rubber

1. It is a natural polymer and is also termed as elastomer.
2. It is manufactured from rubber latex which is a colloidal dispersion of rubber in water.
3. The latex is obtained from bark of rubber tree.

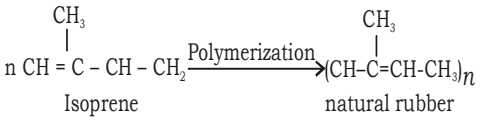
4. Natural rubber may be considered as a linear hydrocarbon polymer of Isoprene



Isoprene

2 Methyl - 1, 3-butadiene (Monomer)

Isoprene is the monomer of natural rubber.



There may be as many as 1000 to 2000 isoprene units in a polymer chain of natural rubber.

Some common man made polymers and their uses

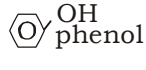
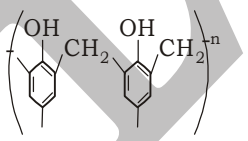
	Polymer	used to make
1.	Polythene	Packaging material, carry bags bottles.
2.	Polypropene	Bottles
3.	Poly Vinyl Chloride	Pipe insulation
4.	Nylon (polyester)	Fibres, ropes
5.	Teflon	Nonstike kitchenware
6.	Vinyl rubber	Rubber, erasers
7.	Polystyrene	Foam thermocole
8.	Poly (Styrene butatdiene)	Rubber, bubble gum
9.	Bakelite	Electrical insulation, buttons
10.	Lexan	Bullet proof glass
11.	Melamene	Crockery
12.	Perspex	windows for cars, trains, aircrafts
13.	Acrylic	Knit wear.

Vulcanisation of rubber

Natural rubber becomes soft & sticky at high temperature. Its tensile strength is low and elasticity is maintained over a low temperature. It is soluble in non-polar solvent. A vulcanisation reaction is carried out to improve these physical properties.

Vulcanisation process consists of heating a mixture of natural rubber with sulphur at a temperature range between 373K to 415 K. After this process, sulphur forms cross link at the reactive sites of double bonds and thus rubber becomes hard and more flexible.
In the manufacture of rubber tyre 5% of sulphur is used as a cross-linking agent.

Polymers of Commercial importance

S. No.	Name of Polymers	Monomer	Structure	Uses
1.	Poly Propene	Propene $CH_2=CH-CH_3$	$(-CH_2-\underset{\displaystyle CH_3}{\underset{\vert}{CH}}-)_n$	Manufacture of ropes, toys, fibres, pipes etc.
2.	Polystyrene	 Styrene	$(-CH_2-\underset{\displaystyle C_6H_5}{\underset{\vert}{CH}}-)_n$	As insulator, wrapping material, manufacture of radio and T.V. Cabinets
3.	Poly Vinyl Chloride (PVC)	$CH_2=CH-Cl$	$(-CH_2-\underset{\displaystyle Cl}{\underset{\vert}{CH}}-)_n$	Manufacture of raincoats hand bags, vinyl flooring, water pipes.
4.	Bakelite	(i)  phenol (ii) HCHO (Formaldehyde)		For making combs of electrical switches, handle of utensils etc.

Synthetic Rubber

Synthetic rubber is vulcanizable rubber which is capable of getting stretched to twice length. When the external force is released, it returns to its original shape and size.
Example- Neoprene.

Synthetic fibre

Fibre is a kind of thread which is strong enough to make clothes, nets, ropes etc. Nylon is the first synthetic fibre. It is a synthetic polyamide fibre.

Nylon

Nylon is made by the condensation polymerisation of hexamethylendiamine with adipic acid and under high pressure and temperature.

$$nHCOOC-(CH_2)_4-COOH+n.H_2N(CH_2)_6-NH_2$$

$$\xrightarrow[\text{High Pressure}]{553} (-\overset{\displaystyle H}{\underset{\vert}{N}}-(CH_2)_6-\overset{\displaystyle H}{\underset{\vert}{N}}-\overset{\displaystyle O}{\overset{\Vert}{C}}(CH_2)_6-\overset{\displaystyle O}{\overset{\Vert}{C}})_n$$

Nylon

Nylon is used in making sheets, bristles for brushes and in textile industry.

Properties of Nylon

1. Great strength
2. Good Elasticity
3. Low water absorption so dries quickly
4. Abrasion resistant so more durable
5. Lightness
6. Wrinkle resistant

Polyester

Polyester is a synthetic fibre which is prepared by reacting a dicarboxylic acid (having two - COOH group) with a dihydric alcohol (having two - OH groups). The reaction between the carboxylic acid group and hyroxyl group of these two compounds result in the formation of a long chain polymer called polyester.

Terylene

Terylene is a polyester of terephthalic acid and ethylene glycol.

Soap and Detergents

Any substance which has cleaning action in water is called a detergent. There are two types of detergents.

1. Soapy
2. Non-Soapy

Soapy detergents are called soaps and Non-soapy detergents are called 'synthetic detergent or just detergents.'

Soaps

A soap is the sodium salt (or potassium salt) of a long chain carboxylic acid (falty acid) which has cleansing properties in water.

A soap has a large non-ionic hydrocarbon group and an ionic group COO^-Na+.

Examples of soaps are: Sodium Stearate and Sodium Palmitate.

A soap is the salt of a strong base (sodium hydroxide) and a weak acid (carboxylic acid). So a solution of soap in water is basic in nature.

Soap is made by heating animal fat or vegetable oil with concentrated sodium hydroxide solution (caustic soda solution). The fats or oils react with sodium hydroxide to from soap and Glycerol.

$$\underset{\text{(An ester)}}{\text{Fat + Oil}} + \underset{\text{(An alkali)}}{\text{Sodium hydroxide}} \xrightarrow{\text{heat}} \underset{\text{(Sodium salt of fatty acid)}}{\text{Soap}} + \underset{\text{(An alcohol)}}{\text{Glycerol}}$$

Saponification- The process of making soap by the hydrolysis of fats and oils with alkalis is called saponification.

Common salt is added to precipitate out all the soap from the aqueous solution.

'Micelle' – A spherical aggregate of soap molecules in the soap solution in water is called 'micelle'

Detergents

Detergents are also called 'soap less soaps' because though they act like a soap in having the cleaning properties, they do no contain the usual 'soaps' like sodium stearate etc.

A detergent is the sodium salt of a long chain benzene sulphonic acid (or sodium salt of a long chain alkyl hydrogensulphate) which has cleansing properties in water.

Example : Sodium n-dodecyl benzene Sulphonate

(a Common detergent)

Soap	Detergent
1. Soap are the sodium salts (or potassium salts) of the long chain carboxylic acids (fatty acids) 2. The ionic group in soaps in $-COO^-Na^+$ 3. Soaps are not suitable for washing purposes when the water is hard. 4. Soaps are biodegradable 5. Soaps have relatively weak cleansing action.	1. Detergents are the sodium salts of long chain benzene sulphonic acids or long chain alky hydrogen-sulphates. 2. The ionic group in a detergent is $^-SO_3^-Na^+$ or $^-SO_4^-Na^+$. 3. Detergents can be used for washing even when the water is hard. 4. Some of the detergents are not biodegradable. 5. Detergents have a strong cleansing action.

Some important points

1. Ethanol containing 5% water is called **rectified spirit.**
2. Rectified spirit is the commercial alcohol.
3. 100% pure Ethanol is called **absolute alcohol.**
4. Ethanol is used as an additive in petrol.
5. **Denatured alcohol** is ethyl alcohol which has been made unfit for drinking purposes by adding small amounts of poisonous substances like methanol, pyridine, copper sulphate etc.
6. Bromine water test is used to distinguish chemically between a cooking oil and butter.
7. **Gasohol** is a mixture of gasoline and ethyl alcohol is used as a motor fuel.
8. **Fehling solution** is formed by mixing Fehling A and Fehling B solution in equal volume.

   Fehling A - Aqueous $CuSo_4$

   Fehling B- Aqueous solution of sodium potassium tartrate.
9. **Benedict's solution**- It is alkaline $CuSO_4$ complexed with sodium potassium citrate
10. **Bayer's reagent** - Cold dil alkaline $KMnO_4$.

Quick Recap

1. The atomic number of carbon is 6 and atomic mass is 12.
2. Carbon always forms covalent bonds.
3. The property of self combination is known as 'catenation'.
4. The compounds of carbon are known as organic compounds.
6. A compound made up of Hydrogen and Carbon only is called hydrocarbon.
7. Saturated hydrocarbon-In which the carbon atoms are connected by single bond Unsaturated hydro carbon-In which the carbon atoms are connected by double or triple bonds.
8. The organic compounds having the same molecular formula but different structures are known as isomers.
9. Homologous series is a group in which the successive compounds differ by CH_2 group.
10. Soap is made by heating animals fat or vegetable oil with conc. sodium hydroxide ($NaOH\ Sol^n$) Solution.
11. The process of making soap by hydrolysis of fats and oils with alkalis is called Saponification.
12. The reaction in which carboxylic acid combines with an alcohol to form an ester is called esterification.

7. *Periodic classification of Elements*

Contents

PERIODIC CLASSIFICATION OF ELEMENTS 7

I. GENESIS OF PERIODIC CLASSIFICATION

1. *Dobereiner's Triads*

Dobereiner arranged certain elements with similar properties in groups of three in such a way that the atomic mass of the middle element was nearly the arithmetic mean of other two. There traids are

I. Li, Na, K II. Cl, Br, I

III. Ca, Sr, Ba

Limitation of Dobereiner's Triad : Only few elements were arranged in the form of triads

2. *Newland's Law of Octaves* – "If elements are arranged in order of increasing atomic masses, every eight elements has properties similar to the first."

Limitation- This classification was successful only upto the element calcium. After that every eight element did not possess the same properties as the elements lying above it in the same group.

3. *Lother Mayer's Atomic Volume curve* Lother Mayer plotted a graph between atomic volume of the elements and their atomic masses. He found that similar elements occupied similar position in the Curve

4. *Mendeleev's Periodic Table* :He arranged all the elements in order of their increasing atomic weights. A table which has been formed is called Periodic Table. Mendeleev gave a periodic Law in 1869. According to this law "*The properties of elements are periodic function of their atomic weights*"

1. Periodic table consists of seven horizontal rows called periods and nine vertical columns called as groups.
2. All the groups from I to VII are divided into sub groups A and B.
3. The group number of an element represent its valency.
4. The elements of same subgroup resemble one another more closely and differ to some extent from the elements of the other sub-groups.
5. The Zero group contains noble gases.

Importance Of Mendeleev's Periodic Table.

1. Systematic study of the elements
2. Prediction of new elements and their properties.

Defects of Mendel eev's Periodic Table

1. The position of the isotopes could not be explained
2. The correct position could not be assigned to hydrogen in the periodic table.
3. Wrong order of atomic masses of some elements could not be explained
4. Position of Lanthanides and Actinides couldn't be justified on the basis of their atomic weights.

5. *Modern Periodic Law and the Present form of Periodic Table.* It is based on Bohr's scheme of the arrangement of elements into four types according to their electronic configuration.

The modern periodic law may be stated as "*The properties of elements are Periodic function of their atomic numbers.*"

Modern Periodic Table of Elements.

B= Solids Hg = Liquids Kr = Gases Pm = Not found in nature

1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.581538	14 Si 28.0855	15 P 30.97376	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6534	29 Cu 63.545	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.504	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Ru 102.90550	46 Pd 106.42	47 Ag 196.56655	48 Cd 112.411	49 In 114.818	50 Sn 11.8710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba 137.327	71 Lu 174.967	72 Hf 178.49	73 Ta 180.94.79	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.56655	80 Hg 200.59	81 TI 204.3833	82 Pb 207.2	83 Bi 208.58038	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	103 Lr (262)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (269)	111 Rg (272)	112 Cn (277)	113 Uut (277)	114 Uuq (227)	115 Uup (227)	116 Uuh (227)		118 Uuo (227)

57 La 138.9055	58 Ce 140.116	59 Pr 140.50765	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.26	69 Tm 168.93421	70 Yb 173.04
89 Ac 232.0381	90 Th 232.0381	91 Pa 231.035888	92 U 238.0289	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	10 Md (258)	102 No (259)

PERIODS

The horizontal rows of elements in a Periodic table are called periods.

Out of seven periods in all, the first three periods are known as short periods while the fourth, fifth and six periods are called long periods.

Period	Total No. of Electrons	Starts with Elements	End with Elements	Remark
1	2	Hydrogen (1)	Helium (2)	Very short period
2	8	Lithium (3)	Neon (10)	Short Period
3	8	Sodium (11)	Argon (18)	Short Period
4	18	Potassium (19)	Krypton (36)	Long Period
5	18	Rubidium (37)	Xenon (54)	Long Period
6	32	Cesium (55)	Radon (86)	Very Long Period
7	28	Francium (87)	Not named yet (118)	Incomplete Period

GROUPS

There are 18 groups in periodic table. All the elements of same group possess similar valence shell electronic configuration.

II. CLASSIFICATION OF ELEMENTS ON THE BASIS OF ELECTRONIC CONFIGURATION.

S-block elements

1. These elements contains 1 or 2 electrons in S-Subshell of the outer most shell.
2. These elements enter chemical reaction by losing valence electron. ns^1 (group 1) alkali metals ns^2 (group 2) alkaline earth metals

General characteristic

1. They are metal
2. They are highly electro positive
3. They have low ionization Energy

4. They form ionic compounds
5. Their oxides & hydroxides are strongly basic in nature.

P-block Elements

1. These elements contain 1 to 6 electrons in the P-sub shell of the outermost orbit (ns^2np^{1-6}).
2. Elements belonging to 13^{th} to 18^{th} group are P-block elements.

Ex.

13 Boron $1S^2\ 2S^2\ 2P^1$

General Characteristic

1. The non-metal character increases along a period.
2. They form covalent compounds.
3. Their oxides are generally acidic.

d-block Elements

1. They are called transition elements or'd block elements
2. Elements of group 3 to 12 belong to this class
3. There are 4-series in d-block having 10 elements

1. 3d-$_{21}$Sc to $_{30}$Zn
2. 4d – $_{39}$y – $_{48}$cd
3. 5d - $_{57}$La, $_{72}$Hf to $_{80}$Hg
4. 6d - $_{89}$Ac, $_{104}$Rf to $_{112}$UUb

Chacteristic

1. They are metals
2. They are good conductor of heats & electricity
3. They exhibit variable valency

f-block Elements

1. They are inner transition or f-block elements.
2. These elements are arranged in two rows at the bottom of the periodic table.
3. First row 14 elements from atomic No. 58 to 71 are known as Lanthanoids.
4. Second row from No. 90 to 103 are known as acti noids.

Characteristics

Similar to d-block elements.

Advantages of the long form of Periodic Table.

1. Placing of isotopes of an element at one place fully justified as its position is based on atomic no not are on atomic mass.
2. Four blocks of the periodic table make the study very simple.

Defects of the long-form of periodic table.

I. Position of hydrogen is still not settled.
II. He, IS^2 has been placed in 18^{th} group based on properties.
III. Lanthanides & actinides have not been accommodated in the Periodic table.

III. PERIODIC PROPERTIES OF ELEMENTS.

1. **Atomic Size**

Periods – On moving from left to right in a period of the periodic table, the size of atoms decreases.

Third Period	Na	Mg	Al	Si	P	S	Cl
Atomic radic	186	160	143	118	110	104	99

→ decreases

Groups

On going down in a group of periodic table the size of atoms increases.

Group

	Atomic Radii
Li	152
Na	186
K	231
Rb	244
Cs	262
Fr	270

↓ increase

2. **Ionisation Potential or Ionisation energy** :"The energy required to remove an electron from the outermost orbit of an isolated gaseous atom in its ground state" is called ionization Energy.

Along a Period

Ionisation energy increases while moving from left to right in a Period. It is due to increase in nuclear charge.

Li < Be > B < C < N < O < F < Nl (In this case B & N show abnormal behaviour)

⟶ Increase

Down a group

As we go down a group, the ionization energy goes on decreasing. It is due to increase in size.

eg. Li > Na > K > Rb > Cs. ↓ decrease

3. Electrons gain Enthalpy

When an electron is added to the neutral gaseous atom to convert into negative ion the change accompanying the process is called

electron gain Enthalpy.

$$X(g) + e \rightarrow x^-(g)$$

4. Electro negativity

"The tendency of an atom to attract shared electron pair towards itself in a molecule" is called Electro-negativity.

Group – In a group electronegativity decreases from top to bottom due to increase in the size of atoms.

Period – In a period Electro negativity increases from left to right.

IV. PERIODIC TRENDS IN VALENCY

The combining capacity of an element is linked with the number of electrons present in the outer most shell & is called valency.

Group- In group, the valency remains same from top to bottom because of the same no. of valence electrons.

Period – In the period from left to right the valency of the elements increases from 1 to 4 & then decreases to Zero.

elements	Na	Mg	Al	Si	P	S	Cl	Ar
Valency	1	2	3	4	3	2	1	0

V. DIAGONAL RELATIONSHIP

Some elements of second period resemble with the elements of third period diagonally as shown

It is due to similarity in ionization energy, electro negativity, size and electropositive characters.

VI. QUICK RECAP

1. **Mendeleev's Periodic Law**– Physical & Chemical properties of elements are periodic function of their atomic masses.
2. **Modern Periodic Law**- Physical & Chemical properties of elements are periodic function of their atomic numbers.
3. Representative elements are the elements of S and P-block.
4. Transition elements are the elements of d-block.
5. Inner transition elements are the elements of f-block
6. Transuranic elements are the elements of placed after uranium.
7. Electronegativity- Is the tendency of an atom in a molecule to attract the shared pair of electrons towards itself.
8. **Coinage metals** : Metals which are used to make coins Cu, Ag, Au.
9. **Helium** is the only S-block element which has been placed with P-block elements in the Periodic Table.
10. Atomic radii increases in a group & decreases in a Period.
11. Ionisation Energy (IE) decreases in a group and increases in a period.
12. Electron gain enthalpy of noble gases & Nitrogen is positive.
13. Electro negativity decreases in a group & increases in a Period.
14. Acidic nature of oxides increases in a period and decreases in a group.

(b) Factors on which ionization energy depends

1. Larger the size of the atom lower will be the ionization energy.
2. Nuclear Charge- Greater the nuclear charge, greater will be the attraction of the nucleus for the valence electrons, so will be ionisation energy.
3. **Screening or shielding effect :** Greater the number of shells between the nucleus and the valence electrons, lesser will be the ionization energy. S > P > d > f is the order. Ionisation energy is always greater than the first. Ex- Lower ionization of B than Be (Berryllium) is due to the presonce of more screening effect.
4. **Presence of Sub-Shells-** IE also depends upon the type s, p, d or f electrons which are to be removed. S-electrons are closer to the nucleus & more tightly held hence ionization energy decreases in that order.
5. **Stability of Configuration** - Completely filled and exactly half filled sub-shells impart extra stability which result in the higher IE. (IE of Nitrogen is greater than oxygen because Nitrogen has stable half filled 2P sub level) ***(SSC 2013)***

(a) Melting Point and Boiling Point of Some Important Elements

8

ELEMENTS	MELTING POINT	BOILING POINT
1. Aluminium (Al)	660.323 ^{0}C	2519 ^{0}C
2. Antimony (Sb)	630.63^{0}C	1587^{0}C
3. Argon (Ar)	–189.35^{0}C	–185.85^{0}C
4. Arsenic (As)	817^{0}C	614^{0}C (Sublime)
5. Beryllium (Be)	1287^{0}C	2471^{0}C
6. Boron (B)	2075 ^{0}C	4000^{0}C
7. Bromine (Br)	–7.2 ^{0}C	58.8^{0}C
8. Cadmium (Cd)	321.07^{0}C	767^{0}C
9. Calcium (Ca)	842^{0}C	1484^{0}C
10. Carbon (Graphite)	3550^{0}C	3825^{0}C
11. Chlorine (Cl)	–101.5^{0}C	–34.04^{0}C
12. Copper (Cu)	1084.62^{0}C	2562^{0}C
13. Fluorine	–219.62^{0}C	–188.12^{0}C
14. Gold (Au)	1064.18^{0}C	2856^{0}C
15. Helium (He)	–272.2^{0}C	–268.93^{0}C
16. Hydrogen (H)	–259.14^{0}C	–252.87^{0}C
17. Iodine (I)	113.7^{0}C	184.3^{0}C
18. Iron (Ferrum) Fe	1538^{0}C	2861^{0}C
19. Lead (Pb)	327.46^{0}C	1749^{0}C
20. Magnesium (Mg)	650^{0}C	1090^{0}C
21. Mercury (Hg)	–38.83^{0}C	356.73^{0}C
22. Nitrogen (N)	–210.00^{0}C	–195.79^{0}C
23. Oxygen (O)	–218.79^{0}C	–182.95^{0}C
24. Phosphorous (P)	44.2^{0}C	277^{0}C
25. Potassium (K)	63.38^{0}C	759^{0}C
26. Silicon (Si)	1414^{0}C	3265^{0}C
27. Silver (Ag)	961.78^{0}C	2162^{0}C
28. Sodium (Na)	97.80^{0}C	883^{0}C
29. Sulphur (S)	115.21^{0}C	444.6^{0}C
30. Tin (Sn)	231.93^{0}C	2602^{0}C
31. Zinc	419.53^{0}C	907^{0}C

(b) Periodic Properties in a Period and Group

	Periodic Property	In the period from left to right	In the group from top to bottom
1.	Ionization energy	Increases	Decreases
2.	Electron affinity	Increases	Decreases
3.	Electro negativity	Increases	Decreases
4.	Non-metallic Character	Increases	Decreases
5.	Oxidising Character	Increases	Decreases
6.	Acidic nature of Oxides	Increases	Decreases
7.	Atomic Size	Decreases	Increases
8.	Electro positivity	Decreases	Increases
9.	Metallic Character	Decreases	Increases
10.	Basic nature of Oxide	Decreases	Increases

(c) Boiling Point of Some Important Organic Compound

1.	C_4H_{10} (Butane)	273°K
2.	CH_3OCH_3	281°K
3.	$CH_3CH_2CH_2OH$ (Propanol)	370°K
4.	CH_3CH_2CHO (Propanal)	322°K
5.	CH_3COCH_3 (Acetone) or Propanone	329°K
6.	CH_3Cl (Chloroform)	334°K
7.	Carbon tetrachloride (CCl_4)	349.5°K
8.	Methanol (CH_3OH)	337°K
9.	Ethanol (CH_3CH_2OH)	351K
10.	CH_3CHO (acetaldehyde)	294K
11.	CH_3NH_2(Methylamine)	213K
12.	$CH_3CH_2NH_2$ (Ethylamine)	292K

IMPORTANT QUESTIONS 9

1. Alpha particle is the nucleus of an atom of
   (A) Lithium (B) Hydrogen
   (C) Helium (D) Oxygen
2. Silicone is a polymer of
   (A) Tetraalkyl silane
   (B) Silicon tetrachloride
   (C) Dialkyl dichloro silane
   (D) Silane
3. Which is a natural colloid?
   (A) Sodium chloride (B) Urea
   (C) Cane-sugar (D) Blood
4. Which one of the following does not contain Silver?
   (A) Ruby Silver (B) Lunar Caustic
   (C) German Silver (D) Horn Silver
5. The presence of Cobalt in Vitamin B_{12} was established for the first time by
   (A) Hydrolysis test
   (B) Spectroscopy
   (C) Borax-Bead test
   (D) Sodium Nitroprusside test
6. Ultraviolet rays can be used in water treatment as
   (A) Flocculator (B) Precipitator
   (C) Hydrolyser (D) Disinfectant
7. In a period from Li to F, ionisation potential
   (A) decreases
   (B) remains same
   (C) cannot be predicted
   (D) increases
8. Which of the following metals can deposit copper from copper sulphate solution?
   (A) Iron (B) Gold
   (C) Platinum (D) Mercury
9. When Arsenic atoms are added to Germanium lattice it become a/an
   (A) Intrinsic semiconductor
   (B) Extrinsic semiconductor
   (C) Insulator
   (D) Superconductor
10. The nuclear particle having no mass and no charge, but only spin is
    (A) Meson (B) electron
    (C) proton (D) neutrino
11. Which among the following is used to dilute oxygen in the gas cylinders used by divers?
    (A) Helium (B) Neon
    (C) Krypton (D) Argon
12. Which one of the following does not form oxyacid?
    (A) Nitrogen (B) Fluorine
    (C) Sulphur (D) Chlorine
13. Which of the following has zero electron affinity?
    (A) Oxygen (B) Fluorine
    (C) Nitrogen (D) Neon
14. Aluminium is obtained by the electrolysis of pure Al_2O_3 dissolved in
    (A) Bauxite (B) Cryolite
    (C) Feldspar (D) Alumina
15. Threshold limit value of copper in the atmosphere air is
    (A) 0.001 mg/m^3 (B) 0.01 mg/m^3
    (C) 1.0 mg/m^3 (D) 5.0 mg/m^3
16. An element of atomic no. 29 belongs to
    (A) s-block (B) d-block
    (C) p-block (D) f-block
17. Which among the following is used as a catalyst in the production of high octane fuels?
    (A) HNO_3 (B) H_2SO_4
    (C) HCl (D) HF
18. In electro-refining, the pure metal is deposited on
    (A) anode (B) vessel
    (C) electrolyte (D) cathode
19. Natural rubber is a polymer of
    (A) Styrene (B) Vinyl acetate
    (C) Propene (D) Isoprene
20. The pH of lemon juice is expected to be
    (A) more than 7
    (B) equal to 7
    (C) nothing can be predicted
    (D) less than 7
21. An example of heterocyclic compound is
    (A) Anthracene (B) Naphthalene
    (C) Furan (D) Benzene

22. An alloy used in making heating elements for electric heating device is
(A) German Silver (B) Solder
(C) Alloy Steel (D) Nichrome

23. The degree of dissociation of an electrolyte depends on
(A) method of dissolution
(B) dilution
(C) impurities
(D) atmospheric pressure

24. The gas causing acid rain in an industrial area is
(A) Methane (B) Carbon dioxide
(C) Carbon monoxide (D) Sulphur dioxide

25. Citric acid is present in free form in
(A) Tamarind (B) Milk
(C) Apple (D) Lemon

26. The purity of Milk is determined by
(A) Hydrometer (B) Lactometer
(C) Stalagmometer (D) Thermometer

27. $KMnO_4$ can be used as
(A) Insecticide (B) Fertilizer
(C) Pesticide (D) Disinfectant

28. A thick paste of cement, sand and water is called
(A) Concrete (B) R.C.C.
(C) Mortar (D) Kiln

29. Which of the following is not a chemical reaction?
(A) Burning of paper
(B) Digestion of food
(C) Conversion of water into steam
(D) Burning of coal

30. Which of the following is used as anesthetic?
(A) NH_3 (B) NO
(C) NO_2 (D) N_2O

31. The quality of petrol is expressed in term of
(A) Cetane number
(B) Gold number
(C) Octane number
(D) Added unleaded compounds

32. The percentage of Nitrogen in Air is
(A) 0.94 (B) 0.03
(C) 78.03 (D) 85.02

33. On heating Gypsum loses certain percentage of its water content and becomes
(A) Chalk
(B) Calcium sulphate
(C) Plaster of Paris
(D) a pearl

34. The name of the scientist who discovered neutron is
(A) Fermi (B) Rutherford
(C) Chadwick (D) Bohr

35. The bubbles in Champagne and Soda are
(A) Nitrogen (B) Oxygen
(C) Carbon dioxide (D) Hydrogen

36. Gobar gas contains mainly
(A) Butane
(B) Carbon monoxide
(C) Methane
(D) Carbon dioxide

37. The pH of pure water is
(A) Seven (B) Fourteen
(C) Zero (D) One

38. The process of separation of pure water from impurities is called
(A) Fractional crystallisation
(B) Decantation
(C) Distillation
(D) Sublimation

39. H_2SO_4 *cannot* be used as
(A) Disinfectant
(B) Food preservative
(C) Drying agent
(D) Dehydrating agent

40. The gas which is present in both the natural gas and the biogas is
(A) hydrogen
(B) carbon monoxide
(C) methane
(D) butane

41. Number of elements in the second period of the periodic table is
(A) two (B) ten
(C) eighteen (D) eight

42. Temporary hardness of water is due to the presence of
(A) Nitrates of calcium and magnesium
(B) Chlorides of calcium and magnesium
(C) Bicarbonates of calcium and magnesium
(D) Sulphates of calcium and magnesium

43. Plaster of Paris is made from
(A) Limestone (B) Gypsum
(C) Marble (D) Bauxite

44. Ozone hole is due to release of
(A) CFCs (B) SO_2
(C) NO_2 (D) PAN

45. The science which deals with drugs is
(A) Physiology (B) Odontology
(C) Pharmacology (D) Chronology

46. Brine refers to :
(A) Salt water (B) Sweet water
(C) Pure water (D) Starch water

47. Which is not an anaesthetic agent in surgical operations:
(A) Chloroform (B) Ether
(C) Nitrous oxide (D) Acetone

48. Brass is an alloy of :
(A) Cu, Al and Zn (B) Cu and Sn
(C) Cu and Zn (D) Al and Mg

49. Rectrified spirit is:
(A) 95% ethyl alcohol
(B) 100% ethyl alcohol
(C) methylated spirit
(D) tincture iodine

50. Nylon is made up of:
(A) Polyamide (B) Polyester
(C) Polyethylene
(D) Polypropylene

51. Radioactive materials should be kept in the container made of:
(A) Fe (B) Al
(C) Pb (D) Steel

52. Producer gas is extremely poisonous due to the presence of :
(A) Cabron monoxide
(B) Hydrogen sulphide
(C) Sulpur dioxide
(D) Nitrogen

53. The process of removing hardness of water is called :
(A) Distillation (B) Softening
(C) Sublimation (D) Purification

54. Old oil paintings become black due to the formation of :
(A) CuS (B) PbS
(C) CaS (D) Na_2S

55. Poisonous gas present in the exhaust fumes of car is:
(A) CO_2 (B) C_2H_4
(C) CH_4 (D) CO

56. The term reactor referred to in waste water treatment is
(A) Vessel (B) Settling tank
(C) Clarifier (D) Aeration tank

57. Tritium is an isotope of
(A) Oxygen (B) Hydrogen
(C) Phosphorous (D) Nitrogen

58. The three basic components of an atom are
(A) protons, neutrons and ions
(B) protons, neutrons and electrons
(C) protium, deuterium and tritium
(D) protons, neutrinos and ions

59. Alcohol obtained in the saponification process is
(A) Ethyl alcohol
(B) Methyl alcohol
(C) Wood spirit
(D) Glycerol

60. The product of equivalent weight and valency of an element is equal to
(A) Vapour density
(B) Specific heat
(C) Atomic weight
(D) Molecular weight

61. Chlorofluro carbons are widely used in
(A) Micro ovens
(B) Solar heaters
(C) Washing machines
(D) Refrigerator

62. The main pollutant responsible for Bhopal Gas Tragedy is
(A) Methyl iscocyante
(B) Bromine
(C) Chlorofluro carbon
(D) Chlorine

63. The gas used to extinguish fire is
(A) Neon
(B) Nitrogen
(C) Carbon dioxide
(D) Carbon monoxide

64. The non-metal found in the liquid state is
(A) bromine (B) nitrogen
(C) fluorine (D) chlorine

65. Ionisation energy of nitrogen is greater than that of oxygen because nitrogen has
(A) high bond dissociation energy
(B) smaller atomic radius
(C) stable half filled 2p sub level
(D) high nuclear charge

66. Sulphuric acid is
(A) monobasic (B) dibasic
(C) tribasic (D) tetrabasic

67. Heating of an ore below its melting point in the absence of air is known as
(A) Refining (B) Calcination
(C) Roasting (D) Smelting

68. The most electronegative element among the following is
(A) Fluorine (B) Sodium
(C) Chlorine (D) Oxygen

69. Mark the compound which possesses ionic, covalent and co-ordinate bonds.
(A) NH_4Cl (B) SO_3
(C) SO_2 (D) H_2O

70. An example of a covalent molecule is
(A) Carbon tetrachloride
(B) Potassium chloride
(C) Sodium chloride
(D) Lead chloride

71. The element common to all acids is
(A) Oxygen (B) Hydrogen
(C) Nitrogen (D) Sulphur

72. In medicine bottles containing tablets or capsules, a small pouch of silica gel is kept to
(A) kill bacteria
(B) absorb moisture
(C) absorb gases
(D) keep the bottle warm

73. Aluminium oxide is a/an
(A) acid oxide
(B) basic oxide
(C) neutral oxide
(D) amphoteric acid

74. "Table sugar" is which type of sugar?
(A) Sucrose (B) Fructose
(C) Galactose (D) Glucose

75. L.P.G. is a hydrocarbon consisting of a mixture of :
(A) Methane and Butane
(B) Propane and Butane
(C) Ethane and Propane
(D) Ethane and Butane

76. Gammaxene, D.D.T. and Bleaching powder are important compounds of
(A) Chlorine (B) Nitrogen
(C) Sulphur (D) Phosphorus

77. 'Amalgam' is a term used for an alloy of a metal with
(A) Copper (B) Mercury
(C) Lead (D) Aluminium

78. Which of the following substances undergo 'sublimation' on heating?
1.Iodine 2.Napthalene 3.Camphor
(A) 1 and 2 (B) 1 and 3
(C) 2 and 3 (D) All of them

79. Consider the following Statements:
1. Radon is the heaviest gas.
2. Astatine is the rarest element on the earth.
3. Graphite which is a non-metal is also an electrical conductor. Which among the above Statement(s) is/are correct?
(A) Only 2 (B) 1 and 2
(C) 2 and 3 (D) 1, 2 and 3

80. What are soaps?
(A) Salts of silicates
(B) Ester of heavy fatty acids
(C) Sodium or potassium salts of heavier fatty acids
(D) Mixture of glycerol and alcohol

81. Which of the following is used in making artificial sweetener saccharine?
(A) Benzene (B) Toluene
(C) Phenol (D) Aniline

82. In vulcanization, natural rubber is heated with -
(A) Carbon (B) Sulphur
(C) Silicon (D) Phosphorus

83. Which type of fire extinguisher is used for petroleum fire?
(A) Foam type (B) Soda acid type
(C) Powder type (D) None of these

84. Which of the following is the petroleum wax?
(A) Bees wax
(B) Carnauba wax
(C) Paraffin wax
(D) Jojoba wax

85. Which of the following fibres is generally preferred for making gauze and lint?
(A) Cotton (B) Rayon
(C) Nylon (D) Terylene

86. Rubber is coagulated from latex by adding-
(A) Hydrochloric acid
(B) Acetic acid
(C) Sulphuric acid
(D) Carbonic acid

87. Paper is manufactured by -
(A) Wood and resin
(B) Wood, Sodium and Bleaching powder
(C) Wood and bleaching powder
(D) Wood, Calcium, hydrogen sulphate and resin

88. Which synthetic fibre is known as artificial silk?
(A) Cotton (B) Rayon
(C) Terylene (D) Nylon

89. Deep blue colour is imparted to glass by the presence of -
(A) Iron oxide (B) Cupric oxide
(C) Nickel Oxide (D) Cobalt oxide

90. The combustible material at the tip of a safety match stick is -
(A) Sulphur
(B) Manganese dioxide
(C) Phosphorus
(D) Antimony sulphide

91. The material used for bleaching paper pulp is-
(A) Chlorine
(B) Caustic soda
(C) Sodium Hypochlorite
(D) Lime

92. Soap is a mixture of sodium or potassium salts of-
(A) Monocarboxylic acid
(B) Glycerols
(C) Dicarboxylic acid
(D) Tricarboxylic acid

93. Which of the following material is used to prepare blue-black ink?
(A) Gallic acid (B) Tannic acid
(C) Ferrous sulphate (D) All of these

94. Carbon tetrachloride fire extinguisher should not be used in closed room because it produces poisonous glass called -
(A) Carbon Monoxide (B) Phosphine
(C) Phosgene (D) None of these

95. Which of the following is commonly called a polyamide?
(A) Rayon (B) Orion
(C) Terylene (D) Nylon

96. Preparation of vegetable ghee from vegetable oil is_____ reaction.
(A) chlorination (B) sulphonation
(C) hydrolysis
(D) hydrogenation

97. Brine is_____.
(A) Na2CO3 (B) NaHCO3
(C) NaCl (D) Na2SiO3

98. Which substance is a salt of weak acid and strong base?
(A) Slaked lime (B) Gypsum
(C) Bleaching powder (D) Washindg soda

99. _____ is used for making permanent magnets.
(A) Manganese steel
(B) Chromium steel
(C) Cobalt steel
(D) Silicon steel

100. The melting point of lime is_____ °C
(A) 1000 (B) 1200
(C) 1539 (D) 2572

101. Liquefaction method is used for the purification of metals with_____.
(A) high melting point
(B) low melting point
(C) high boiling point
(D) low boiling point

102. The true order of reactivity of metals is_____.
(A) Mg>Al>Zn>Fe
(B) Mg>Zn>Fe>Al
(C) Al>Mg>Zn>Fe
(D) Zn>Mg>Al>Fe

103. The formula of rust is_____.
(A) $FeSO_4$
(B) $Fe_2O_3.xH_2O$
(C) $Fe_3O_4.xH_2O$
(D) $FeCO_3$

104. How many nonmetals are in solid state?
(A) 10 (B) 12
(C) 13 (D) 14

105. Sulphur belongs to_____ group in periodic table.
(A) Boron (B) Carbon
(C) Oxygen (D) Halogen

106. _____ is a neutral oxide.
(A) CO_2 (B) NO_2
(C) CO (D) SO_3

107. The formula of butanol is_____.
(A) CH_3OH (B) C_2H5OH
(C) C_3H7OH (D) C_4H9OH

108. The boiling point of acetone is_____°C
(A) 40 (B) 48
(C) 56 (D) 64

109. Which of the following is a condensation polymer?
(A) Nylon (B) PVC
(C) Natural rubber (D) TEFLON

110. Oxidation of ethanol in presence of alkaline potassium permanganate gives...
(A) acetaldehyde
(B) ethane
(C) potassiumethoxide
(D) acetic acid

111. The enzyme which converts milk into curd is...
(A) lactase (B) invertase
(C) zymase (D) cellulase

112. Vinegar is...
(A) methanol (B) ethanal
(C) methanoic acid (D) ethanoic acid

113. The formula of carbonic acid is _____.
(A) H2CO3 (B) H3CO2
(C) HCO3 (D) H2CO2

114. How many nonmetals are in gaseous state?
(A) 7 (B) 8
(C) 9 (D) 11

115. The transition temperature of sulphur is ___ °C.
(A) 90 (B) 92
(C) 94 (D) 96

116. Liquefaction method is used for the purification of metals with _____.
(A) high melting point
(B) low melting point
(C) high boiling point
(D) low boiling point

117. Pure gold is _____ carats.
(A) 20 (B) 22
(C) 24 (D) 100

118. The melting point of iron is _____ °C.
(A) 1539 (B) 1639
(C) 1739 (C) 1839

119. Steel is an alloy of _____.
(A) iron and silica
(B) iron and nickel
(C) iron and chromium
(D) iron and carbon

120. The formula of baking soda is _____.
(A) $NaHCO_3$
(B) $Na_2CO_3.10H_2O$
(C) Na_2CO_3 (D) Na_2SiO_3

121. During a chemical reaction, the concentration of reactants...
(A) does not change (B) increases
(C) decrease (D) may increase

122. _____ defined pH in 1909.
(A) Arrhenius (B) Sorensen
(C) Lewis (D) Haber

123. Preparation of vegetable ghee from vegetable oil is _____ reaction.
(A) chlorination
(B) sulphonation
(C) hydrogenation (D) hydrolysis

124. Bombardment of neutron on 6Li3 gives _____.
(A) 1H0 (B) 1H1
(C) 2H1 (D) 3H1

125. Conversion of milk into curd is _____.
(A) a physical change
(B) a chemical change
(C) not a chemical change
(D) neither a physical nor a chemical change

126. The acid-base theory of Lewis is based on_____.
(A) proton transfer
(B) litmus test
(C) theory of ionisation
(D) transfer of electron pair

127. An organic acid + an alcohol _____.
(A) an aldehyde (B) a ketone
(C) an ester (D) an amide

128. Which of the following is the monomer of natural rubber ?
(A) Isoprene (B) Chloroprene
(C) Neoprene (D) TEFLON

129. Liquefaction method is used for the purification of metals with _____.
(A) high melting point
(B) high boiling point
(C) low melting point
(D) low boiling point

130. A bucky ball is a molecule consisting of _____ carbon atoms.
(A) 50 (B) 60
(C) 70 (D) 100

131. The acid-base theory by Bronsted and Lowry...
(A) is based on donation of electron.
(B) does not give importance to the solvent.
(C) gives importance to the solvent.
(D) gives operational definition of acid and base.

132. The formula of soda ash is _____.
(A) $NaHCO_3$ (B) Na_2CO_3
(C) $Na_2CO_3.10H_2O$ (D) NaOH

133. What is the boiling point of acetic acid ?
(A) 98 °C (B) 108 °C
(C) 118 °C (D) 128 °C

134. _____ is the formula of cuprite.
(A) Cu_2O (B) Cu_2S
(C) $CuCO_3$ (D) $CuCl_2$

135. _____ is a neutral oxide.
(A) Na_2O (B) CO_2
(C) CO (D) SO_3

136. During a chemical reaction, the concentration of reactants_____.
(A) does not change
(B) increases
(C) decreases
(D) never decreases

137. What is used as an antacid ?
(A) Na2C O3 (B) NaHCO3
(C) NaCl (D) NaOH

138. _____ is an ore of calcium.
(A) Magnetite (B) Siderite
(C) Malachite (D) Gypsum

139. _____ is a poor conducting metal for heat.
(A) Copper (B) Silver
(C) Aluminium space (D) Lead

140. There are _____ nonmetallic elements.
(A) 20 (B) 22
(C) 24 (D) 25

141. Which of the following is artificial rubber?
(A) Isoprene (B) Chloroprene
(C) Neoprene (D) TEFLON

142. "There is plenty of room at the bottom." This was stated by...
(A) Issac Newton
(B) Albert Einstein
(C) Richard Feynman
(D) Eric Drexler

143. During the refining of petroleum, the fraction having highest boiling temperature...
(A) condenses first
(B) condenses last
(C) does not condense
(D) remains in gaseous form

144. During electrolytic reduction, _____ acts as reducing agent.
(A) anode (B) cathode
(C) electrolyte (D) metal

145. There are _____ nonmetals in solid state.
(A) 10 (B) 12
(C) 13 (D) 14

146. Sulphur belongs to _____ group in periodic table.
(A) Boron (B) Carbon
(C) Oxygen (D) Halogen

147. Formation of petroleum in earth's crust is a _____ reaction.
(A) geochemical (B) biochemical
(C) physiochemical (D) physical

148. Pyrex glass is _____.
(A) plasticized glass
(B) polymeric glass
(C) heat-resistant glass
(D) opaque glass

149. Ethylethanoate is _____.
(A) an alcohol (B) an acid
(C) an ester (D) a ketone

150. Which of the following is not an oxidising agent ?
(A) NaBH4 (B) KMnO4
(C) Cr2O3
(D) Fehling's solution

151. What is used generally as a connecting material in solar panels ?
(A) Silicon (B) Silver
(C) Selenium (D) Germanium

152. _____ invented artificial radioactivity.
(A) Marie Curie (B) Berkley
(C) Lord Rudherford (D) Maxwell

153. _____ have fruity smell.
(A) Alcohols (B) Organic acids
(C) Esters (D) Ketones

154. The first synthetic fibre made by man was-
(A) Rayon (B) Nylon
(C) Polyester (D) Terycott

155. Which of the following is used for removing air bubbles from glass during its manufacture?
(A) Feldspar
(B) Arsenic oxide
(C) Potassium Carbonate
(D) Soda Ash

156. Which of following is used as a filter in rubber tyres?
(A) Graphite (B) Coal
(C) Coke (D) Carbon Black

157. Which is/ are the important raw materials in cement industry?
(A) Limestone
(B) Gypsum & Clay
(C) Clay
(D) Limestone & Clay

158. Which of the following roofs provide better protection against fire?
(A) Cement slab (B) Asbestos sheet
(C) Reinforced concrete
(D) None of these

ANSWER KEY

1.	(C)	33.	(C)	65.	(C)	97.	(C)	129.	(C)
2.	(C)	34.	(C)	66.	(B)	98.	(D)	130.	(B)
3.	(D)	35.	(C)	67.	(B)	99.	(A)	131.	(B)
4.	(A)	36.	(C)	68.	(A)	100.	(D)	132.	(B)
5.	(C)	37.	(A)	69.	(A)	101.	(B)	133.	(C)
6.	(D)	38.	(C)	70.	(A)	102.	(A)	134.	(A)
7.	(D)	39.	(B)	71.	(B)	103.	(B)	135.	(C)
8.	(A)	40.	(C)	72.	(B)	104.	(A)	136.	(C)
9.	(D)	41.	(A)	73.	(D)	105.	(C)	137.	(B)
10.	(D)	42.	(C)	74.	(A)	106.	(C)	138.	(D)
11.	(A)	43.	(B)	75.	(B)	107.	(D)	139.	(D)
12.	(B)	44.	(A)	76.	(A)	108.	(A)	140.	(B)
13.	(D)	45.	(C)	77.	(B)	109.	(C)	141.	(C)
14.	(B)	46.	(A)	78.	(D)	110.	(D)	142.	(C)
15.	(C)	47.	(D)	79.	(D)	111.	(A)	143.	(B)
16.	(B)	48.	(C)	80.	(C)	112.	(D)	144.	(B)
17.	(D)	49.	(A)	81.	(B)	113.	(A)	145.	(A)
18.	(D)	50.	(A)	82.	(B)	114.	(D)	146.	(C)
19.	(D)	51.	(C)	83.	(C)	115.	(D)	147.	(B)
20.	(D)	52.	(A)	84.	(C)	116.	(B)	148.	(C)
21.	(C)	53.	(B)	85.	(B)	117.	(C)	149.	(C)
22.	(D)	54.	(B)	86.	(B)	118.	(A)	150.	(A)
23.	(B)	55.	(D)	87.	(D)	119.	(D)	151.	(B)
24.	(D)	56.	(C)	88.	(B)	120.	(A)	152.	(A)
25.	(D)	57.	(B)	89.	(D)	121.	(C)	153.	(C)
26.	(B)	58.	(B)	90.	(C)	122.	(B)	154.	(B)
27.	(D)	59.	(D)	91.	(C)	123.	(C)	155.	(B)
28.	(A)	60.	(D)	92.	(A)	124.	(D)	156.	(D)
29.	(C)	61.	(D)	93.	(D)	125.	(B)	157.	(D)
30.	(D)	62.	(A)	94.	(C)	126.	(D)	158.	(B)
31.	(A)	63.	(C)	95.	(D)	127.	(C)		
32.	(C)	64.	(A)	96.	(D)	128.	(A)		

MODEL QUESTIONS 10

1. Galena & Litharge are ores of which of the following metals?
   (A) Mercury (B) Lead
   (C) Zinc
2. Graphite, Carbon and Diamonds are _____?
   (A) Isomers (B) Isotopes
   (C) Allotropes
3. Bleaching Powder is a compound of _____?
   (A) Sodium (B) Calcium
   (C) Magnesium
4. To keep the hot glass items' finishing and transparency , they go through a process called annealing. This process involves _____?
   (A) cooling rapidly.
   (B) cooling very slowly.
   (C) cooling slowly and uniformly under controlled environment.
5. See the filament of a bulb. The Coil is very fine and thin. This shows_____?
   (A) The metal (tungsten) which is used to make it is highly dutile.
   (B) The metal is sonorous.
   (C) The metal is lustrous.
6. Which among the following is strongest oxidizing agent?
   (A) Chlorine (B) Fluorine
   (C) Bromine
7. Water at 4 degree centigrade has____?
   (A) minimum density.
   (B) maximum density.
   (C) none of them.
8. Sodium is stored under kerosene because sodium is _____?
   (A) Very reactive
   (B) Very dry
   (C) Cannot be stored alone as it sublimes.
9. Which among the following is not a use of Graphite?
   (A) making of electrodes.
   (B) lubricant.
   (C) manufacturing of crucibles.
   (D) glass cutting.
10. Which of the following group characterizes alcohols?
   (A) OH group.
   (B) COOH group.
   (C) COO group.
11. Sodium Alkyl Sulphate and Benzene Sulphate are examples of _____?
   (A) Explosives.
   (B) Synthetic Detergents.
   (C) Insecticides.
12. Rayon is an example of _____?
   (A) a synthetic fiber.
   (B) a natural fiber.
   (C) semi-synthetic fiber.
13. Which among the following sentence is true?
   (A) thermoplastic can be moulded again and again into different shapes.
   (B) thermosetting plastic can be moulded again and again into different shapes.
   (C) PVC is a thermosetting plastic.
14. Which among the following sentences is true?
   (A) Ammophos is an organic fertilizer while Urea is an inorganic fertilizer.
   (B) Ammophos is an inorganic fertilizer while Urea is an organic fertilizer.
   (C) Both of them are organic fertilizers.
15. Which among the following is correct full form of DDT?
   (A) Dichloro-diethyl-trifluoromethane.
   (B) Dichloro-diphenyl-trichloroethane.
   (C) Dichloro-diphenyl-trichloromethane.

16. Cobalt oxide is used to impart which color to glass?
(A) Brown (B) Blue
(C) Red

17. Aqua regia is
(A) a Compound
(B) Capable of dissolving noble metals and is a mixture of HCl and HNO_3 in the ratio 3:1
(C) a mixture of different acids

18. Phenolphthalein is used in chemistry as a _____?
(A) solvent (B) dye
(C) catalyst

19. Calcium Magnesium Silicate is commonly called _____?
(A) Asbestos (B) Borax
(C) Baking Soda

20. Which among the following is true about solubility of "Lipids"?
(A) They are soluble in water but insoluble in organic solvents.
(B) They are insoluble in water but soluble in organic solvents.
(C) They are soluble in water as well as organic solvents.

21. Which among the following is incorrect regarding the chemical nature of Diamond & Graphite?
(A) Density of Diamond is higher than that of Graphite.
(B) Diamond is chemically unreactive while graphite is mild reactive.
(C) Both Diamond and Graphite are good conductors of electricity.

22. Which among the following is not a constituent of gobar gas?
(A) Methane (B) Propane
(C) Carbon Dioxide

23. Calcium is required in plants in the formation of which of the following ?
(A) Cell Membrane
(B) Cell Wall
(C) Cholorophyll

24. Which among the following is most electronegative element?
(A) Fluorine (B) Chlorine
(C) Bromine

25. Which among the following is the property of Tungsten which makes it eligible to use in the bulbs?
(A) highest melting point.
(B) highest resistance.
(C) Highest malleability.

26. Froth & Foams are examples of which of the following ?
(A) solid suspended in gas
(B) liquid suspended in gas
(C) gas suspended in liquid

27. Which among the following was the first artificially produced element?
(A) Neptunium (B) Ununbium
(C) Technetium

28. Duralumin which is used in making aero planes is an alloy consisting of _____?
(A) Aluminum & Copper
(B) Aluminum, Copper & Manganese
(C) Aluminum, Copper,, Manganese & Magnesium.

29. Which of the following compound was recently in news as it is being used in some Gutkha (chewing mix of Betel nut, tobacco, lime etc) and was found to be a carcinogenic?
(A) Magnesium Hydroxide.
(B) Magnesium Carbonate.
(C) Magnesium Oxide.

30. As per Avogadro's hypothesis , equal volumes of different gases at the same temperature and pressure contain equal number of _____?
(A) atoms
(B) molecules
(C) particles

31. The process of purifying water by spraying water on to a bed of stones where microorganism live so that the microorganisms feed on the pathogens in water and make the water free from harmful pathogens is called?
(A) Stone bed method.
(B) biofilter method.
(C) aerobic filtration.

32. An article of Jewellery was left exposed to the atmosphere for some time and it becomes coated with green carbonate. The Jewellery is made up of which of the following?
(A) Copper (B) Silver
(C) Zinc

33. When we buy a Jewellery of 22 carat Gold, this means that we are getting a purity of gold with _____?
(A) 90% (B) 91.67 %
(C) 95.5 %

34. The atomic weight of Chlorine is 35. It consists of _____?
(A) 17 Protons + 18 Neutrons
(B) 17 Neutrons + 18 protons
(C) 17 Neutrons + 17 Protons + 1 electron

35. Who among the following suggested that there must be present at least a third type of fundamental particles which should be electrically neutral and possess mass that is nearly equal to Proton? (this led to the discovery of Neutron)
(A) Rutherford
(B) Chadwick
(C) Goldstein

36. Which among the following is correct ?
(A) Oxidation takes place at Cathode and Reduction takes place at Anode
(B) Oxidation takes place at Anode and Reduction takes place at Cathode
(C) none of them is correct

37. Which among the following is an ionic solid?
(A) Diamond (B) Dry Ice
(C) Table Salt

38. Hard Water contains which of the following ?
(A) Aluminum (B) Chlorine
(C) Calcium

39. The noble gases are a group of chemical elements with very similar properties: under standard conditions, they are all odorless, colorless, monatomic gases, with a very low chemical reactivity. How many Noble gases occur naturally ?
(A) 5 (B) 6
(C) 7

40. Which among the following of a catalyst does not change at the end of a reaction?
(A) Quantity
(B) Chemical Composition
(C) Both of them.

41. In which city of India, 90% of world's small diamonds processed?
(A) Baroda (B) Mumbai
(C) Surat

42. Which is lightest gas among these three?
(A) ozone (B) helium
(C) hydrogen

43. When ozone is heated its volume will....?
(A) increase (B) decrease
(C) remain unchanged.

44. Which acid is not Vitamin too?
(A) Oxalic Acid (B) Folic Acid
(C) Citric Acid

45. Which acid is described as HOOCCOOH?
(A) Oxalic Acid (B) Acetic Acid
(C) Carbonic Acid

46. Carbonic Acid decomposes quickly into ?
(A) Co_2 & H_2O
(B) CO_2 & H_2 and O_2
(C) CO & H_2O_2

47. What is Heavy Water Among these?
(A) D_2O (B) H_2O_2
(C) He_2O

48. Which among following is rich in Ozone?
(A) Stratosphere (B) Mesosphere
(C) Ionosphere

49. Which among the following is quick Lime?
(A) CaO (B) Ca(OH)2
(C) KOH

50. Which among following is white gold?
(A) Nickel (B) Rhodium
(C) Platinum

51. A primary fuel is that which is used in the same form as it occurs in nature. Which of the following is not a primary fuel?
(A) Kerosene (B) Wood
(C) Coal
(D) Natural Gas

52. What is the process used to separate the different components of oil?
(A) Deadly Distillation.
(B) Simple Distillation.
(C) Fractional Distillation.
(D) Destructive Distillation.

53. What is the main constituent of coal gas?
(A) Oxygen (B) Water
(C) Nitrogen (D) Methane

54. Which variety of coal contains the highest percentage of carbon?
(A) Anthracite (B) Peat
(C) Bituminous (D) Lignite

55. Coal is formed due to the process of...?
(A) Evaporation
(B) Centrifugation
(C) Conjugation
(D) Carbonization

56. Which of these has the highest calorific value?
(A) Rubber (B) Wood
(C) Coal (D) Hydrogen

57. What is the main component of biogas and natural gas?
(A) Ethane (B) Methane
(C) Propane (D) Butane

58. Heating fuels in the absence of air is called 'Destructive Distillation', as it 'destroys' it to form simpler substances. What do we get when we do the same to wood?
(A) Tar (B) Acetic Acid
(C) Charcoal (D) All of these

59. If you wanted to lighten your hair at home, what is the active ingredient in the dye preparation that will lighten your hair?
(A) Hydrogen peroxide.
(B) Acetic acid.
(C) Sodium hydroxide.
(D) Phenol.

60. "Antifreeze" is used in car radiators to stop the liquid that cools the engine from freezing when it gets cold outside. Water is one component of antifreeze; what is the other main component?
(A) Ethylene glycol.
(B) Acetone.
(C) Sodium chloride.
(D) Benzene.

61. Nail polish remover is something that girls just can't do without. But what exactly is it in nail polish remover that does the polish removing?
(A) Methanol (B) Ethanol
(C) Acetone (D) Limonene

62. Bleach is another useful household chemical. It is often referred to as "chlorine bleach". What is the main component of household bleach?
(A) Sodium chloride.
(B) Sodium hypochlorite.
(C) Hydrochloric acid.
(D) Sodium hydroxide.

63. Most people have used superglue at one stage or another, but what is its major chemical component?
(A) Styrene.
(B) Acetone.
(C) Specially-treated honey.
(D) Alpha-cyano acrylate.

64. Methylated spirit is a very common household chemical - but what is its main component?
(A) Acetone
(B) Turpentine
(C) Ethanol (alcohol)
(D) Water

65. There are currently how many periods on the periodic table?
(A) 6 (B) 7
(C) 8 (D) 9

66. Which element has close to 10,000,000 known compounds?
(A) Oxygen (B) Carbon
(C) Hydrogen

67. What element's three isotopes have different names?
(A) Helium (B) Oxygen
(C) Carbon (D) Hydrogen

68. What is the lightest element with an atomic symbol not related to its English name?
(A) Potassium (K)
(B) Sodium (Na)
(C) Iron (Fe)
(D) Tungsten (W)

69. What is the heaviest of the naturally occuring Noble gases?
(A) Radon (B) Xenon
(C) Helium (D) Argon

70. Which chemical compound occurs naturally in tea and coffee and is a popular additive to soft drinks?
(A) Cellulose (B) Nicotine
(C) Maltose (D) Caffeine

71. At room temperature, which element conducts electricity better than any other element?
(A) Pb (B) Au
(C) Ag (D) Cu

72. The candela is one of the seven base units in the SI system. It measures...?
(A) Magnetism.
(B) Luminous intensity.
(C) Combustion rate.
(D) Luminance.

73. Which of the "rare" gases is the most common in the atmosphere?
(A) Radon (B) Neon
(C) Xenon (D) Argon

74. What scientist discovered the radioactive element radium?
(A) Isaac Newton.
(B) Albert Einstein.
(C) Benjamin Franklin.
(D) Marie Curie.

75. Who invented Bakelite?
(A) Charles Goodyear.
(B) Leo Hendrik Baekeland.
(C) Roy Plunkett.
(D) Henry Ford.

76. Which of the two metals are mixed in manufacturing of stainless steel ?
(A) Zinc, chromium.
(B) Chromium, nickel.
(C) Chromium, iron.
(D) Nickel, iron.

77. What products are, as a general rule, the result of an acid and a base reacting together?
(A) Hydrogen gas and Carbon dioxide.
(B) Methane gas and Nitrogen.
(C) Water and a salt.
(D) Water and Ethanol.

78. What the main particles of an atom are?
(A) Photon, electron, and neutron.
(B) Neutron, electron, and proton.
(C) Photon and electron.
(D) Proton and electron.

79. The least reactive elements of the periodic table are...?
(A) Alkaline Earth Metals.
(B) Noble Gases.
(C) Alkali Metals.
(D) Transition Metals.

80. The law that "the physical and chemical properties of elements are periodic functions of their atomic weights" was given by...?
(A) Mendeleev (B) Bohr
(C) Lothar Meyer (D) Moseley

81. The Law of Octaves was given by...?
(A) Mendeleev (B) Dobereiner
(C) John Newlands (D) Bohr

82. Elements in the modern periodic table are arranged on the basis of their...?
(A) Atomic Mass.
(B) Atomic Number.
(C) Boiling Point.
(D) Chemical Symbols alphabetically.

83. Elements in the same group have similar...?
(A) Atomic masses.
(B) Chemical properties.
(C) Atomic radii.
(D) Atomic numbers.

84. The horizontal rows in a periodic table are called...?
(A) Groups
(B) Lanthanides
(C) Periods
(D) Atomic Structures

85. The law that "the properties of elements are periodic functions of their atomic numbers" was given by...?
(A) Linus Pauling (B) Mendeleev
(C) Heisenberg (D) Moseley

86. The first element in the modern periodic table is...?
(A) Hydrogen (B) Lithium
(C) Oxygen (D) Helium

87. With which metal does Oxygen combine to form rust?
(A) Iron (B) Platinum
(C) Gold (D) Silver

88. Rust on iron is basically...?
(A) An Oxide (B) A Nitride
(C) A Chloride (D) A Sulphide

89. Which of the following metals is often found in the pure state?
(A) Iron (B) Aluminum
(C) Gold (D) Magnesium

90. Metals that can be easily beaten into sheets are known as _____ metals.
(A) Beatable (B) Polymer
(C) Malleable (D) Ductile

91. Rocks that are rich in metals are known as...?
(A) Metalloids (B) Allotropes
(C) Slag (D) Ores

92. Which metal is extracted from the ore 'Bauxite'?
(A) Magnesium (B) Iron
(C) Tungsten (D) Alluminium

93. Which of the following does not belong to this group?
(A) Iron (B) Sodium
(C) Oxygen (D) Lead

94. Which of the following is a pure substance made up of one type of atoms?
(A) A mixture (B) An element
(C) A compound (D) An atom

95. Which of the following is a pure substance made up of two or more types of atoms or elements?
(A) A mixture (B) An element
(C) A compound (D) An atom

96. Copper sulphate can be further subdivided into simpler substances by chemical means only. Therefore, it is...?
(A) A compound (B) A mixture
(C) An element (D) An atom

97 Which of the following is the smallest part of a compound, whose properties are the same as those of the compound?
(A) Molecule (B) Mixture
(C) Element (D) Atom

98 A heat engine can have a maximum efficiency of
(A) 1 (B) >1
(C) <1 (D) Q2/Q1

99 A process of sudden cooling is known as
(A) quenching
(B) sedimentation
(C) annealing
(D) diffusion

100. A process of very slow regulated cooling is known as
(A) quenching
(B) sedimentation
(C) annealing
(D) diffusion

ANSWER KEY

1.	(B)	14.	(B)	27.	(C)	40.	(C)	53.	(D)	66.	(B)	78.	(B)	90.	(C)
2.	(B)	15.	(B)	28.	(C)	41.	(C)	54.	(A)	67.	(D)	79.	(B)	91.	(D)
3.	(B)	16.	(B)	29.	(B)	42.	(B)	55.	(D)	68.	(B)	80.	(A)	92.	(D)
4.	(C)	17.	(B)	30.	(B)	43.	(C)	56.	(D)	69.	(A)	81.	(C)	93.	(C)
5.	(C)	18.	(B)	31.	(B)	44.	(A)	57.	(B)	70.	(D)	82.	(B)	94.	(B)
6.	(B)	19.	(A)	32.	(A)	45.	(A)	58.	(D)	71.	(C)	83.	(D)	95.	(C)
7.	(B)	20.	(B)	33.	(B)	46.	(A)	59.	(A)	72.	(B)	84.	(C)	96.	(A)
8.	(A)	21.	(C)	34.	(B)	47.	(A)	60.	(A)	73.	(C)	85.	(D)	97	(A)
9.	(D)	22.	(B)	35.	(A)	48.	(A)	61.	(C)	74.	(D)	86.	(A)	98	(C)
10.	(A)	23.	(B)	36.	(B)	49.	(A)	62.	(B)	75.	(B)	87.	(A)	99	(A)
11.	(B)	24.	(A)	37.	(C)	50.	(C)	63.	(D)	76.	(C)	88.	(A)	100.	(C)
12.	(A)	25.	(A)	38.	(C)	51.	(A)	64.	(C)	77.	(C)	89.	(C)		
13.	(B)	26.	(C)	39.	(B)	52.	(C)	65.	(B)						