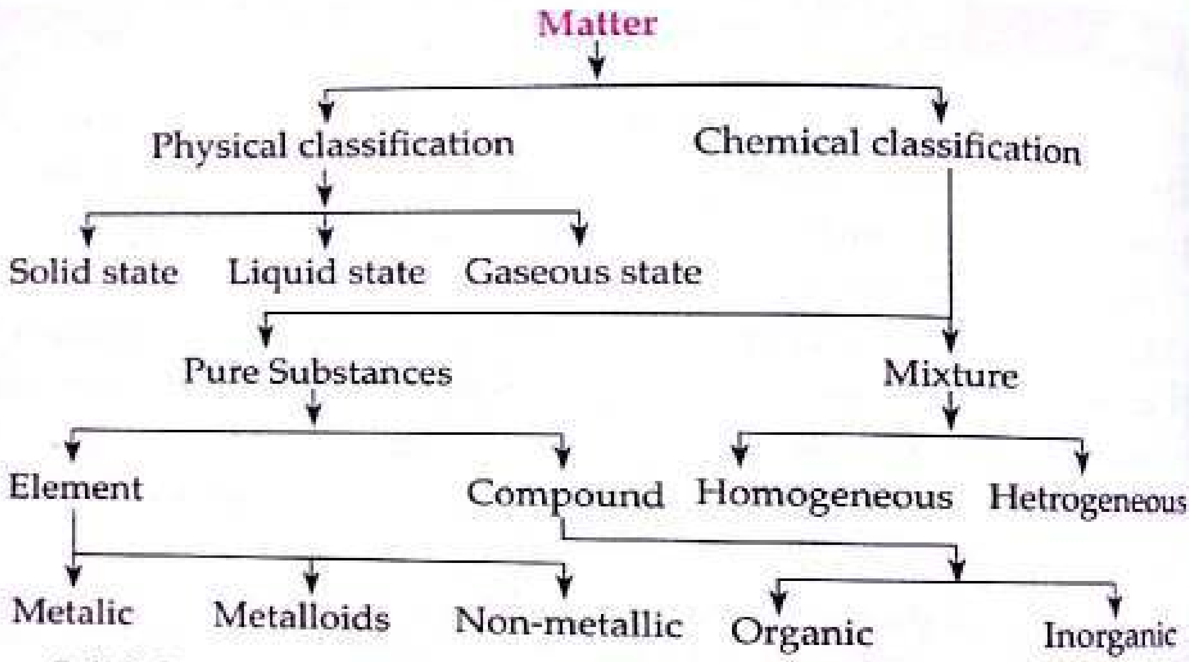
7 CHEMISTRY

1. Introduction

Chemistry is the branch of science which deals with the composition of matter and also the Physical and Chemical characteristics associated with the different material objects.

A French chemist, *Lavoisier (1743–1793)* is regarded as *father of modern chemistry*.

1. Substance and its nature : Anything that occupies space, possesses mass and can be felt by any one or more of our senses is called matter.



Solid State : A solid possesses definite shape and definite volume which means that it can not be compressed on applying pressure. Solids are generally hard and rigid. *Example*—metals, wood, bricks, copper etc.

Liquid State : A liquid possesses definite volume but no definite shape. This means that the liquid can take up the shape of container in which it is placed. *Example*—water, milk, oil, alcohol etc.

Gaseous State : A gas does not have either a definite volume or definite shape. It can be compressed to large extent on applying pressure and also takes the shape of the container where it is enclosed. *Examples*— Air, Oxygen, Nitrogen, Ammonia, Carbondioxide etc.

$$\text{Solid State} \underset{\text{Cool}}{\overset{\text{Heat}}{\rightleftharpoons}} \text{Liquid State} \underset{\text{Cool}}{\overset{\text{Heat}}{\rightleftharpoons}} \text{Vapour state}$$

Water exists in three different states.

$$\underset{\text{(Solid)}}{\text{Ice}} \rightleftharpoons \underset{\text{(Liquid)}}{\text{Water}} \rightleftharpoons \underset{\text{(Gas)}}{\text{Vapour}}$$

Pure substances : A single substance (or matter) which can not be separated into other kinds of matter by any physical process is called pure substance.

Pure substances have been classified as elements and compounds.

Elements : The simplest form of a pure substance which can neither be broken into nor built from simpler substances by ordinary physical and chemical methods is called element.

Elements are further classified into three types (i) Metals (ii) Non-metals and (iii) Metalloids.

Metals : Metals are solids (exception mercury which is liquid at room temperature) are normally hard. They have lustre, high *mp* and *bp* and also good conductor of electricity and heat. The conductivity of metal decreases with increase in temperature due to vibration of positive ions at their Lattice points. *Examples*—Iron, Copper, Silver, Gold, Aluminium, Zinc etc.

Non-metals : Non-metals are the elements with properties opposite to those of the metals. They are found in all states of matter. They do not possess lustre (exception–iodine). They are poor conductors of electricity (exception-graphite) and they are not malleable and ductile. *Examples*—Hydrogen, Carbon, Oxygen, Nitrogen, Sulphur, Phosphorous etc.

Metalloids : Metalloids are the elements which have common properties of both metals and non-metals. *Examples*—Arsenic, Antimony, Bismuth etc.

Compounds : Compounds are pure substances that are composed of two or more different elements in fixed proportion by mass. The properties of a compound are entirely different from those of the elements from which it is made. *Example*—Water, Sugar, Salt, chloroform, Alcohol, Ether etc.

Compounds are classified into two types

(i) Organic Compounds (ii) Inorganic Compounds,

Organic Compounds : The Compounds obtained from living sources are called organic compounds. The term organic is now applied to hydrocarbons and their derivatives. *Examples*—Carbohydrates, Proteins, Oils, Fats etc.

Inorganic Compounds : The Compounds obtained from non-living sources such as rocks and minerals are called inorganic compounds. *Examples*—Common Salt, Marble, Washing Soda etc.

Mixtures : A material obtained by mixing two or more substances in any indefinite proportion is called a mixture. The properties of the components in a mixture remain unchanged. *Example*— Milk, Sea water, Petrol, Paint, Glass, Cement, Wood etc.

There are two types of mixture—

(1) Homogeneous mixture (2) Heterogeneous mixture.

1. Homogeneous mixture : A mixture is said to be homogeneous if it has a uniform composition through out and there are no visible boundaries of separation between constituents. More over, the constituents can not be seen even by a microscope. *Examples*—Common salt dissolved in water, sugar dissolved in water, iodine dissolved in CCl_4, benzene in toluene and methyl alcohol in water.

2. Heterogeneous mixture : A mixture is said to be heterogeneous if it does not have a uniform composition throughout and has visible boundaries of separation between the various constituents. The different constituents of

the heterogeneous mixture can be seen even with naked eye. *Example*—A mixture of Sulphur & Sand, A mixture of Iron filings & Sand etc.

Separation of mixture : Some methods of separation of mixtures are given below—

1. Sublimation : In this process, a solid substance passes direct into its vapours on application of heat. The vapours when cooled, give back the original substance. This method can be used for the substances which are sublime in their separation from non-sublimate materials. *Examples* of sublimes are Naphthalene, Iodine, Ammonium Chloride etc.

2. Filtration : This is a process for quick and complete removal of suspended solid particles from a liquid, by passing the suspension through a filter paper. *Examples*—(i) removed of solid particles from the engine oil in car engine. (ii) filtration of tea from tea leaves in the preparation of tea etc.

3. Evaporation : If a solution of solid substance in a liquid is heated, the liquid gets converted into its vapours and slowly goes off completely. This process is called evaporation. *Example*—(i) Evaporation of water in summer from Ponds, wells & lakes. (ii) Preparation of common salt from sea water by evaporation of water.

4. Crystallization : This method is mostly used for separation and purification of solid substances. In this process, the impure solid or mixture is heated with suitable solvent (e.g. alcohol, water, acetone, chloroform) to its boiling point and the hot solution is filtered. The clear filtrate is cooled slowly to room temperature, when pure solid crystallizes out. This is separated by filtration and dried.

For the separation of more complex mixtures, fractional crystallization is used, in which the components of the mixtures crystallize out at different interval of time.

5. Distillation : It is a process of converting a liquid into its vapour by heating and then condensing the vapour again into the same liquid by cooling. Thus, distillation involves vaporisation and condensation both

Distillation = Vaporisation + Condensation

This method is employed to separate the liquids which have different boiling points or a liquid from non-volatile solid or solids either in solution or suspension. *Example*—A mixture of copper sulphate and water or a mixture of water (B.P 100°C) and methyl alcohol (B.P 45°C) can be separated by this method.

6. Fractional distillation : This process is similar to the distillation process except that a fractionating column is used to separate two or more volatile liquid which have different boiling points. *Example*–(i) Methyl alcohol (bp = 338 K) and acetone (bp = 329 K) can be separated by fractional distillation process. (ii) Separation of petrol, diesel oil, kerosene oil, heavy oil etc from crude petroleum. (iii) Separation of oxygen, nitrogen inert gasses and carbon dioxide from liquid air etc.

7. Chromatography : The name chromatography is derived from Latin word 'Chroma' meaning colour. The technique of chromatography is based

on the difference in the rates at which the components of a mixture are absorbed in the suitable absorbent.

There are many types of chromatography.

(a) Column (absorption) Chromatography
(b) Thin layer chromatography
(c) Paper - chromatography
(d) High pressure liquid chromatography
(e) In-exchange chromatography
(f) Gas chromatography

8. Sedimentation and Decantation : This method is used when one component is a liquid and other is an insoluble. Insoluble solid, heavier than liquid. i.e, mud and water.

If muddy water is allowed to stand undisturbed for sometime in a beaker, the particles of earth (clay and sand) settle at the bottom. This process is called sedimentation. The clear liquid at the top can be gently transferred into another beaker. This process is known as decantation.

Concept of change in state : (a) Melting Point : The temperature at which solid and the liquid forms of the substance exist at equilibrium or both forms have same vapour pressure is called melting point.

(b) Boiling point : The temperature at which the vapour pressure of the liquid is equal to atmospheric pressure is called boiling point.

Liquid	Water	Ethanol	Chloroform	Acetone
B.P.	373 K	349 K	334 K	329 K

(c) Freezing Point : The temperature at which the vapour pressure of its liquid is equal to the vapour pressure of the corresponding solid is called freezing point.

(d) Evaporation : The process of conversion of a liquid into its vapours at room temperature is called evaporation. Evaporation causes cooling. Actually, during evaporation, the molecules having higher kinetic energy escape from the surface of the liquid. Therefore, average kinetic energy of the rest of the molecules decreases. Therefore cooling takes place during evaporation because of temperature of liquid is directly proportional to average kinetic Energy. Evaporation is affected by following factors,

(i) Nature of liquid (ii) Temperature (iii) Surface area.

(e) Vapour pressure : The pressure exerted by the vapours of liquid in equilibrium with liquid at a given temperature is called vapour pressure. Vapour pressure depends upon—(i) its nature and (ii) temperature.

Higher the vapour pressure of a particular liquid lesser will be the magnitude of intermolecular forces present in molecules. Vapour pressure of a liquid increases with increase in temperature.

2. Atomic Structure

Atom : The smallest particle of an element is called an atom. An atom can take part in chemical combination and does not occur free in nature. The atom of the hydrogen is the smallest and lightest. *Example*—Na, K, Ca, H etc.

Molecule : A molecule is the smallest particle of an element or compound that can have a stable and independent existence. *Example*—O_2, N_2, Cl_2, P_4, S_8 etc.

Mole : A mole is a collection of 6.023×10^{23} particles. It means that

1 mole = 6.023×10^{23}

1 mole atom = 6.023×10^{23} atoms

1 mole molecule = 6.023×10^{23} molecules

1 mole ion = 6.023×10^{23} ions

1 mole mango = 6.023×10^{23} mangoes

1 mole Apple = 6.023×10^{23} apples

Avogadro's Number : The number 6.023×10^{23} is called Avogadro's Number.

Atomic Mass : It is the ratio of mass of one atom of the element to $\frac{1}{12}$th part of the mass of one atom of carbon–12.

$$\text{Atomic mass of an element} = \frac{\text{Mass of one atom of the element}}{\frac{1}{12} \times \text{mass of one atom of carbon-12}}$$

Actual mass of 1 atom of an element = atomic mass in amu $\times 1.66 \times 10^{-24}$ g

Molecular mass : It indicates how many times one molecule of a substance is heavier in comparison to $\frac{1}{12}$th mass of one atom of Carbon–12.

Constituents of an atom : Fundamental particles of an atom are Electron, Proton & Neutron.

Electron : (i) Electron had been discovered by J.J. Thomson.

(ii) The name of electron was given by Stoney.

(iii) Charge on an electron
- relative: – 1 unit
- absolute: -1.6×10^{-19} coulomb or -4.8×10^{-10} e.s.u.

(iv) Mass of an electron
- relative: 0.000543 amu
- absolute: 9.1×10^{-28} g

(v) $\frac{\text{charge}}{\text{mass}}\left(\frac{e}{m}\right)$ ratio of electron = $-1.76 \times 10^{8} \frac{C}{g}$

(vi) An electron was obtained from Cathode rays experimental.

Proton : (i) A proton had been discovered by Goldstein

(ii) A proton was named by Rutherford.

(iii) Charge on proton
- relative: + 1 unit
- absolute: $+1.6 \times 10^{-19}$ C or $+4.8 \times 10^{-10}$ e.s.u.

(iv) Mass of proton
- relative: 1.00763 amu
- absolute: 1.673×10^{-24} g

(v) $\frac{\text{charge}}{\text{mass}}$ ratio for proton = $9.58 \times 10^4 \frac{C}{g}$

(vi) An proton was obtained from anode rays experiment.

Neutron : (i) A neutron had been discovered by James Chadwick.

(ii) Charge on neutron—zero

(iii) Mass of proton — relative: 1.00863 amu; absolute: 1.675×10^{-24} g

(iv) $\frac{\text{charge}}{\text{mass}}$ ratio for neutron = zero

(v) A neutron was obtained from radioactivity phenomenon.

$$^{9}_{4}Be + ^{4}_{2}He \xrightarrow[\alpha\text{-particle}]{} ^{12}_{6}C + ^{1}_{0}n$$

Atomic number (Z) : The number of proton or electron in an atom of the element is called atomic number. It is denoted by Z.

$Z = e = p$ where, e = no. of electrons and p = no. of protons.

Mass number (A) : The sum of number or protons and neutrons in an atom of the element is called mass number. It is denoted by A.

$A = p + n$ where, p = no. of protons and n = no. of neutrons

Let, $^{23}_{11}Na$,

In Na, $Z = 11$, $A = 23$ and,

$e = 11, p = 11$

$\therefore \quad n = A - p = 23 - 11 = 12$

Isotopes : These are atoms of the elements having the same atomic number but different mass number.

Isotopes of Carbon—$^{12}_{6}C$, $^{13}_{6}C$, $^{14}_{6}C$

Isobars : These are atoms of the elements having the same mass number but different atomic numbers. e.g.

$^{40}_{18}Ar$, $^{40}_{19}K$, $^{40}_{20}Ca$

Isotones : These are atoms of different elements having the same number of neutrons.

$^{14}_{6}C$, $^{15}_{7}N$, $^{16}_{8}O$

Isoelectronic : These are atoms/molecules/ions containing the same number of electrons.

(i) O^{2-}, F^{-}, Ne, Na^{+}, Mg^{2+} (ii) CN^{-}, N_2, O_2^{2+} etc.

Thomson's model of an atom : According to Thomson, an atom is treated as sphere of radius 10^{-8} cm in which positively charged particles are uninformally distributed and negatively charged electrons and embedded through them. This is also called Plum-Pudding model of an atom or water-melon model of an atom.

Rutherford's model of an atom : On the basis of scattering experiment, Rutherford proposed a model of the atom which is known as nuclear atomic model.

According to this model,

(i) An atom consists of a heavy positively charged nucleus where all protons and neutrons are present. Protons & neutrons are collectively called nucleons. Almost whole mass of the atom is contributed by these nucleons.

(ii) Radius of a nucleus = 10^{-13} cm

Radius of an atom = 10^{-8} cm

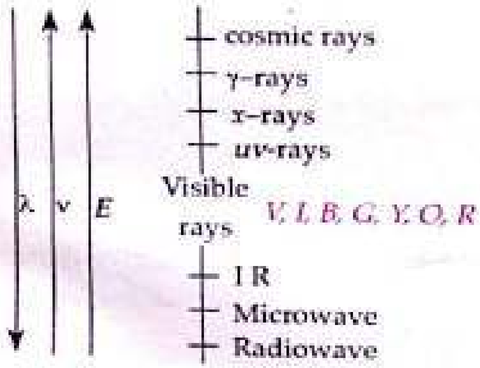
Radius of an atom = 10^5 times of the radius of the nucleons.

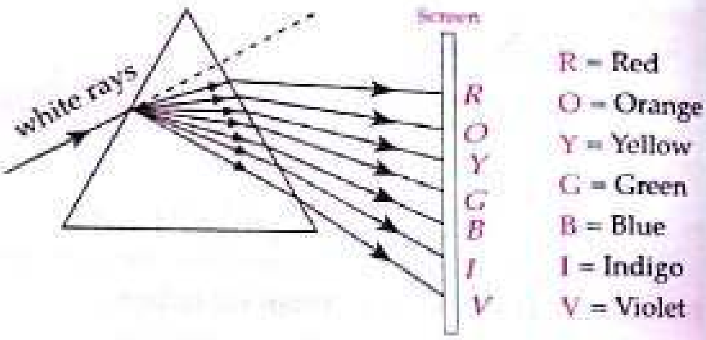
(iii) $$\frac{\text{volume of atom}}{\text{volume of a nucleus}} = \frac{\frac{4}{3}\pi(10^{-8})^3}{\frac{4}{3}\pi(10^{-13})^3} = \frac{10^{-24}}{10^{-39}} = 10^{15}$$

So, volume of an atom is 10^{15} times heavier than volume of a nucleus.

(iv) Electrons revolve around the nucleus in closed orbits with high speed. This model is similar to the solar system, the nucleus representing the sun and revolving electrons as planets. The electrons are therefore, generally referred as planetary electrons.

Spectrum : When white light is allowed to pass through a prism, it splits into several colours. These seven coloured band is called spectrum.





Zeeman's effect : When spectral lines obtained from atomic spectra is placed in a magnetic field, they are splitted into number of fine lines, this is called Zeeman's effect.

Stark's effect : When spectral lines obtained from atomic spectra is placed in electric field, they are splitted into number of fine lines this is called Stark's effect.

Thomson's model	Plum pudding model (watermelon model)
Rutherford's model	Nuclear theory
Bohr's model	Concept of Quantization of energy.
Planck's Quantum theory	Photon & quanta.
Sommerfeld's model	Orbital : elliptical & spherical
de-Broglie's equation	Dual nature of electron
Heisenberg's Uncertainty principle	Exact position & momentum can not be determined simultaneously
Schrodinger's wave equation	wave nature of electron.

3. Periodic classification of Elements

Father of periodic table—Mendeleev.

The arrangement of the known elements in certain groups in such a way so that the elements with similar properties are grouped together is known as classification of elements.

Genesis of periodic classification :

1. Lavoisier classified the elements into metals and non-metals.

2. Dobereinier's Triads : In 1829, Dobereiner, a German chemist 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 same as the average atomic masses of the first and third elements.

Triad	Lithium	Sodium	Potassium
Atomic mass	7	23	39

$$\text{atomic mass of sodium} = \frac{39+7}{2} = \frac{46}{2} = 23$$

But only few elements could be covered under triads.

3. Newland's law of octaves : In 1866, John Newlands, An English Chemist proposed the law of octaves by stating that, *When elements are arranged in order to increasing atomic masses, every eighth element has properties similar to the first, just like musical notes.*

But this generalization was also rejected because it could not be extended to the elements with atomic mass more than 40.

4. Lother's–Mayer's atomic volume curve : In 1869 Lother mayer plotted a graph betweeen atomic volume of the elements and their atomic mass and he pointed that the elements with similar properties occupy similar position in the curve.

5. Mendeleev's periodic law : The physical and chemical properties of the elements are the periodic function of their atomic masses.

Mendeleev's arranged the elements known at that time in increasing order of atomic masses and this arrangement was periodic table.

In periodic table :

Horizontal line is called periods.
Vertical line is called group.

In Mendeleev's periodic table :

Period— 7
Group— 9 (I, II, III, IV, V, VI, VII, VIII, Zero)

6. Modern Periodic law : Modern periodic law was given by Moseley.

According to Moseley : "The physical and chemical properties of the elements are the periodic function of their atomic numbers."

In modern periodic table :

Period— 7 Group— 18

Modern periodic table are classified as :

(i) s–block (ii) *p*–block
(iii) *d*–block (iv) *f*–block

s–block : Alkali & Alkaline earth metals.

p–block : Chalcogen, Picogens, Halogens and inert gases.

d–block : Transition elements.

f–block : Inner transition elements.

Periodic properties :

(i) Atomic radii : The distance from the centre of the nucleus to the outermost shell containing electrons called atomic radius.

It is not possible to measure the absolute value of atomic radius of an element. However, it may be expressed in three different form covalent radii, metallic radii, Van der wall radii.

Van der wall radii > metallic radii > covalent radii.

(ii) Ionic radii : The effective distance from the centre of nucleus of the ion upto which it exerts its influence on the electron cloud is called ionic radii.

Anionic radii > atomic radii > cationic radii

(iii) Ionization Potential (I.P.) : The amount of energy required to remove an electron from isolated gaseous atom is called Ionization Potential (I.P.) or Ionization Energy (I.E.)

$$A\,(g) - e + \text{Energy required (I.P.)} \longrightarrow A^{+}\,(g)$$

(iv) Electron affinity (E_a) : The energy released during addition of an extra electron in isolated gaseous atom is called electron Affinity.

$$A\,(g) + e \longrightarrow A^{-}(g) + \text{Energy released}$$

Chlorine (Cl) has highest E_a value.

(v) Electronegativity (E_n) : The relative electron attracting tendency of its atom for a shared pair of electrons in a chemical bond is called electronegativity.

F is the most electronegative atom

$$E_n = \frac{\text{IP} + E_a}{5.6}$$

E_n value > 1.7 (ionic compound)

E_n value < 1.7 (polar covalent compound)

E_n value = 0 (nonpolar compound)

(vi) Lattice Energy : The amount of energy released during formation of one mole of ionic compound from its constituent ions is called Lattice energy.

(vii) Hydration Energy : The amount of energy released during dissolution of one mole of compound into water, is called hydration energy.

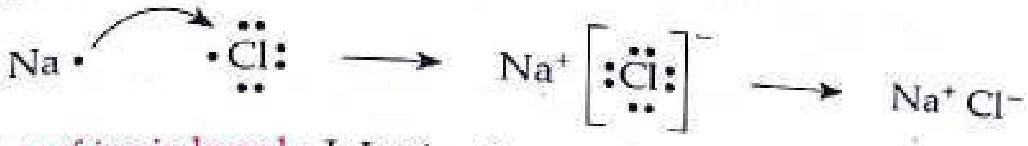
If hydration energy > Lattice energy, then compound is soluble in water and if hydration energy < Lattice energy, then compound is insoluble in water.

4. Chemical Bonding

The force that holds together the different atoms in a molecule is called chemical bond. There are many types of chemical bond.

1. Ionic bond or (Electrovalent bond) : A bond formed by the complete transfer of one or more electrons from one atom to other atom is called ionic bond. *Example—*

(a) Formation of NaCl :



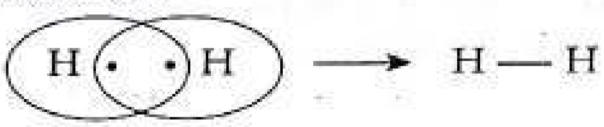
Condition of ionic bond : I. Ionization energy of metal should be low.
II. Electron affinity of non-metal should be high.

Properties of ionic compounds :

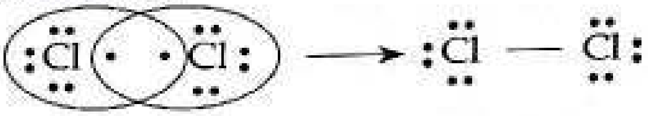
(a) Ionic compounds have high melting point & boiling point.
(b) Ionic compounds are good conductor of electricity in molten state or in water.
(c) Ionic compounds are bad conductor of electricity in solid state.
(d) Ionic compounds are soluble in water.
(e) Ionic compounds are insoluble in non-polar covalent like Benzene, Carbon tetrachloride etc.

Covalent bond : A bond formed between two same or different atoms by mutual contribution and sharing of electrons is called covalent bond. Example—

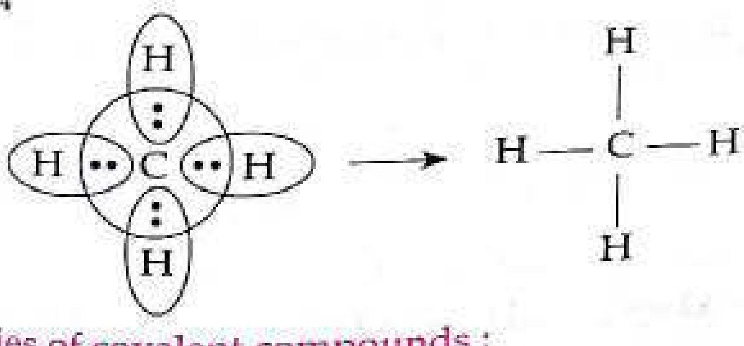
(a) H_2 molecule :



(b) Cl_2 molecule :



(c) CH_4 molecule :



Properties of covalent compounds :

(a) Covalent compounds have high m.p. & b.p.
(b) They are generally bad conductor of electricity (exception graphite)
(c) They are generally insoluble in water.
(d) They are generally soluble in organic solvent like benzene, acetone, chloroform etc.
(e) Covalent bonds are directional.

Co-ordinate bond (or Dative bond) : Co-ordinate bond is a special type of covalent bond in which one atom donates electrons to other atom. The bonding between donor to acceptor atom is called co-ordinate bond. It is denoted by ⟶. *Example*—

SO_2 

Sigma bond (σ–bond) : A bond formed by the linear overlapping of atomic orbitals is called sigma bond. Since, the extent of overlapping of atomic orbitals in σ-bond in large. Hence σ-bond is a strong bond.

Pi-bond (π-bond) : A bond formed by the sidewise (or lateral overlapping of atomic orbitals is called pi-bond. since, in this case, extent of overlapping of atomic orbitals is lesser than σ-bond. So, π-bond is a weak bond.

$$H \underset{\sigma}{—} H \; ; \quad O \overset{\pi}{\underset{\sigma}{=}} O \; ; \quad N \overset{\pi}{\underset{\sigma,\ \pi}{\equiv}} N$$

Bond energy : The amount of energy required to break one mole bonds of a particular type between the atoms in the gaseous state of a substance is called bond energy. The bond energy depends upon the following factors.

I. Size of atom II. Multiplicity of bonds.

Greater the size of atoms, Lesser will be bond energy.

Greater the bond multiplicity more will be bond energy.

Bond energy : Single bond < double bond < triple bond

Bond length : The average equilibrium distance between the centres of the two bonded atoms is called bond length. The bond length is influenced by the following factors—

(i) Size of atoms (ii) Multiplicity of bonds

Greater the size of atoms, greater will be bond length.

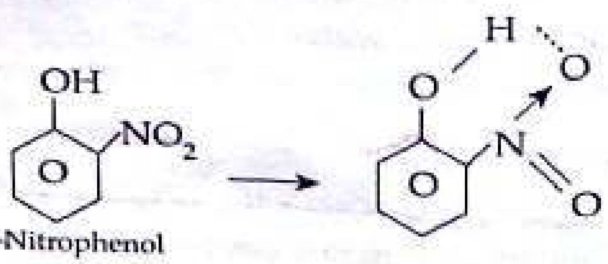
Greater the multiplicity of bonds, lesser will be bond length.

Hydrogen bond : When hydrogen atom is present between two most electronegative atoms (N, O, F) then it is bonded to one by a covalent bond and to other by a weak force of attraction which is called hydrogen bond. etc. It is denoted by .... *Example*—

(i) $(HF)_n$

H — F ..... H — F ..... H — F ..... H — F

(ii) $(H_2O)_n$

(iii) 

O—Nitrophenol

There are two type of hydrogen bonding

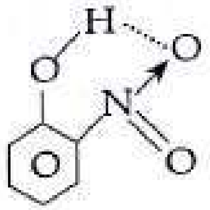
(i) Intermolecular hydrogen bond.

(ii) Intramolecular hydrogen bond.

Intermolecular hydrogen bond arises when hydrogen bonding occurs between two or more molecules. In this case m.p. & b.p. of compound increases due to molecular association.

$$\cdots\cdots H - F \cdots\cdots \quad H - F \cdots\cdots \quad H - F \cdots\cdots$$

When hydrogen bonding occurs within a molecule then it is called intramolecular hydrogen bonding. Due to cyclisation m.p. & b.p. of the compound decreases in this case.



Due to intermolecular hydrogen bonding between alcohol and water. alcohol is soluble in water.

$$\underset{\text{Methyl alcohol}}{CH_3 - O} - H \cdots\cdots \underset{\text{Water}}{O\begin{matrix} \diagup H \\ \diagdown H \end{matrix}}$$

5. Oxidation & Reduction

Oxidation (old concept) : Oxidation is a process which involves either of the following—

(i) addition of oxygen (ii) removal of hydrogen

(iii) addition of electro negative element or group

(iv) removal of electro positive element or group.

$2Mg + O_2 \longrightarrow 2MgO$ (oxidation of Mg)

$H_2S + Cl_2 \longrightarrow 2HCl + S$ (oxidation of H_2S)

$Fe + S \longrightarrow FeS$ (oxidation of Fe)

$2KI + H_2O_2 \longrightarrow 2KOH + I_2$ (oxidation of KI)

Reduction (old concept) : Reduction is a process which involves either of the following—

(i) addition of hydrogen (ii) removal of oxygen

(iii) addition of electro positive element or group.

(iv) removal of electronegative element or group.

$H_2 + Cl_2 \longrightarrow 2HCl$ (reduction of Cl_2)

$CuO + C \longrightarrow Cu + CO$ (reduction of CuO)

$HgCl_2 + Hg \longrightarrow Hg_2Cl_2$ (reduction of $HgCl_2$)

$2FeCl_3 + H_2 \longrightarrow 2FeCl_2 + 2HCl$ (reduction of $FeCl_3$)

Modern concept of oxidation and Reduction : According to modern concept, loss of electrons is called oxidation whereas gain of electrons is called reduction. *Example :*

$$Na \longrightarrow Na^+ + e \quad \text{(oxidation of Na)}$$
$$Zn \longrightarrow Zn^{2+} + 2e \quad \text{(oxidation of Zn)}$$
$$Cl_2 + 2e \longrightarrow 2Cl^- \quad \text{(reduction of } Cl_2\text{)}$$
$$S + 2e \longrightarrow S^{2-} \quad \text{(reduction of S)}$$

Oxidising agent (O.A.) : A substance which undergoes reduction is called oxidising agent

$$CuO + C \longrightarrow Cu + CO$$

Oxidation – C, Reduction– CuO, Oxidising agent – CuO

Examples—O_2, O_3, H_2O_2, $KMnO_4$, $K_2Cr_2O_7$ etc.

Reducing agent (R.A.) : A substance which undergoes oxidation is called reducing agent.

$$H_2O + C \longrightarrow CO + H_2$$

Oxidation— C, Reduction— H_2O, Reducing agent— C

Examples— H_2, CO, H_2S, SO_2, C, $SnCl_2$ etc.

Redox Reaction : A reaction in which both oxidation and reduction takes place simaltaneously is called redox reaction.

Example—

$$CuO + C \longrightarrow Cu + CO$$

Oxidation – C, Reduction – CuO

Oxidation number (O.N.) : The charge present on atom in molecule or ion is called oxidation number. It may be zero, positive or negative.

Rules for determination of oxidation number :

(i) Oxidation number of an atom in free state is zero.

(ii) Oxidation number of alkali metals (Li, Na, K, Rb, Cs) in molecule is always +1.

(iii) Oxidation number of alkaline earth metals (Be, Mg, Ca, Sr, Ba) in a molecule is always + 2

(iv) Oxidation number of hydrogen —
- (+ 1) hydrogen ion
- (– 1) hydride ion

(v) Oxidation number of Oxygen —
- (– 2) oxide
- (– 1) peroxide
- $-\frac{1}{2}$ superoxide

(vi) Sum of Oxidation number of atoms in a molecule is equal to zero.

(vii) Sum of oxidation number of atoms in a ion is equal to magnitude of charge with sign.

Oxidation Number of Mn in $KMnO_4$:

Let O.N. of Mn = x

$$1 + x + (-2) \times 4 = 0$$
$$1 + x - 8 = 0$$
$$x = +7$$

Oxidation Number of Cr in $K_2Cr_2O_7$:

Let O.N. of Cr = x

$$1 \times 2 + x \times 2 + (-2) \times 7 = 0$$
$$2 + 2x - 14 = 0$$
$$x = +6$$

Oxidation Number of C in $C_{12}H_{22}O_{11}$:

Let O.N. of C = x

$$x \times 12 + 1 \times 22 + (-2) \times 11 = 0$$
$$12x + 22 - 22 = 0$$
$$x = 0$$

Types of Reactions :

1. Decomposition reactions : In these reactions, compound either of its own or upon heating decomposes to give two or more components out of which at least one is in the elemental state.

$$2NaH\ (s) \xrightarrow{\Delta} Na\ (s) + H_2\ (g)$$
$$2H_2O\ (l) \xrightarrow{\Delta} 2H_2\ (g) + O_2\ (g)$$

2. Combination reactions: In combination reactions, compounds are formed as a result of the chemical combination of two or more elements.

$$H_2\ (g) + \frac{1}{2}O_2\ (g) \longrightarrow H_2O_2(l)$$
$$C\ (s) + O_2\ (g) \longrightarrow CO_2\ (g)$$
$$3Mg\ (s) + N_2\ (g) \longrightarrow Mg_3N_2\ (s)$$

3. Displacement reactions : In these reactions, an atom / ion present in a compound gets replaced by an atom / ion of another element.

$$FeSO_4\ (aq) + Zn\ (s) \longrightarrow Zn\ SO_4\ (aq) + Fe\ (s)$$
$$MgO\ (aq) + 2\ Na\ (s) \longrightarrow Na_2O\ (aq) + Mg\ (s)$$

4. Disproportionation reactions : The chemical reaction in which only one substance is oxidised as well as reduced simultaneously is called disproportionation reaction.

$$Cl_2 + 2NaOH \longrightarrow NaCl + NaOCl + H_2O$$
$$P_4 + NaOH + 2H_2O \longrightarrow 2NaH_2PO_2 + 2PH_3$$

5. Substitution reaction : In these reactions, one or more atoms or groups present in organic molecule get substituted or replaced by suitable atoms or groups.

$$\underset{\text{Ethyl chloride}}{C_2H_5Cl} + KOH\ (aq) \longrightarrow \underset{\text{Ethyl alcohol}}{C_2H_5OH} + KCl$$

6. Neutralisation reaction : When an acid reacts with a base, salt and water is formed. This reaction is called neutralisation reaction.

$$\text{acid} + \text{base} \longrightarrow \text{salt} + \text{water}$$
$$HCl + NaOH \longrightarrow NaCl + H_2O$$

7. **Reversible reaction :** A reaction in which reactants combine to form products and again products recombine to reactants is called reversible reaction.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

8. **Irreversible reaction :** A reaction which proceeds in only one direction is called irreversible reaction.

$$CaCO_3\,(s) \xrightarrow{\Delta} CaO\,(s) + CO_2\,(g)$$

6. Acids, Bases & Salts

Acid :

An acid is a substance which

(i) is sour in taste
(ii) turns blue litmus paper into red
(iii) contains replaceable hydrogen
(iv) gives hydrogen ion (H^+) in aqueous solution (Arrhenius theorem)
(v) can donote a proton (Bronsted & Lowry concept)
(vi) can accept electron (Lewis theorem)

Uses of acid :

1. As food :
   (a) Citric acid — Lemons or oranges (Citrus fruits)
   (b) Lactic acid — sour milk
   (c) Butyric acid — Rancid butter
   (d) Tarteric acid — Grapes
   (e) Acetic acid — Vinegar
   (f) Maleic acid — Apples
   (g) Carbonic acid— Soda water aerated drinks
   (h) Stearic acid — Fats
   (i) Oxalic and — Tomato, wood sorrel.
2. Hydrochloric acid (HCl) is used in digestion
3. Nitric acid (HNO_3) is used in the purification of gold & silver.
4. Conc. H_2SO_4 and HNO_3 is used to wash iron for its galvanization.
5. Oxalic acid is used to remove rust spot.
6. Boric acid is a constituent of eye wash.
7. Formic acid is present in red ants.
8. Uric acid is present in urine of mammals

Strength of acids

↓

strong acid
(completely ionised in water)
HCl, HNO_3, H_2SO_4

weak acid
(partially ionised in water
CH_3COOH, H_2CO_3, HCOOH

Classification of acids

↓

Hydra acids
NH_3, H_2S, HCl, HBr, HF

Oxy acids
HNO_3, H_2SO_4, $HClO_4$, HIO_4

Basicity of an acid : The number of removable hydrogen ions from an acid is called basicity of that acid.

Mono basic acid (one removable H^+ ion) — HCl, HNO_3

Dibasic acid (two removable H^+ ion) — H_2SO_4, H_2CO_3, H_3PO_3

Tribasic acid (three removable H^+ ion) — H_3PO_4

Acidic strength (i) $HF < HCl < HBr < HI$

(ii) $CH_3COOH < H_2SO_4 < HNO_3 < HCl$

Uses of HCl :

(i) HCl present in gastric juices are responsible for the digestion.
(ii) Used as bathroom cleaner.
(iii) As a pickling agent before galvanization.
(iv) In the tanning of leather.
(v) In the dying and textile industry.
(vi) In the manufacture of gelatine from bones.

Uses of HNO_3

(i) In the manufacture of fertilizers like ammonium nitrate.
(ii) In the manufacture of explosives like TNT (Trinitro toluene), TNB (Trinitro benzene), Picric acid (Trinitro phenol) etc.
(iii) Nitro Glycerine (Dynamite)
(iv) Found in rain water (first shower)
(v) It forms nitrates in the soil.
(vi) In the manufacture of rayon.
(vii) In the manufacture of dyes & drugs.

Uses of Sulphuric acid (H_2SO_4)

(i) In lead storage battery.
(ii) In the manufacture of HCl.
(iii) In the manufacture of Alum.
(iv) In the manufacture of fertilizers, drugs, detergents & explosives.

Use of Boric acids : As an antiseptic.

Uses of Phosphoric acid :

(i) Its calcium salt makes our bones.
(ii) It forms phosphatic fertilizers.
(iii) PO_4^{-3} is involved in providing energy for chemical reactions in our body.

Uses of Ascorbic acid : Source of Vitamin C

Uses of Citric acid : Flavouring agent & food preservative.

Uses of Acetic acid : Flavouring agent & food preservative.

Uses of Tartaric acid : (i) Souring agent for pickles (ii) A component of baking powder (sodium bicarbonate + tartaric acid)

Indicator properties of an acid

Indicator	Colour changes
Blue litmus paper	turns red
Methyl orange	Form orange to pink
Phenolphthalein	Remains colourless

Bases :

A. Base is a substance which
   (i) bitter in taste
   (ii) turns red litmus paper into blue
   (iii) gives hydroxyl ions (OH^-) in aqueous solution.
   (iv) can accept proton (Bronsted & lowry concept)
   (v) can donate electrons (Lewis theory)

Indicator properties of bases

Indicator	Change of colour
Red litmus paper	turns blue
Methyl orange	from orange to yellow
Phenolphthalein	from colourless to pink

- Oxides & hydroxides of metals are bases
- Water soluble bases are called alkali e.g. NaOH, KOH, etc.
- All alkalies are bases but all bases are not alkalies because all bases are not soluble in water.

Strength of bases

- Strong bases: NaOH, KOH
- Weak bases: NH_4OH, $Fe(OH)_3$

Acidity of a base : The number of removable hydroxyl (OH^-) ions from a base is called acidity of a base.

Acidity of NaOH = 1
Acidity of KOH = 1
Acidity of $Ca(OH)_2$ = 2

The pH scale : pH of a solution is the negative logarithm of the concentration of hydrogen ions in mole per litre.

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

If $pH < 7$ then solution is acidic
If $pH > 7$ then solution is basic
If $pH = 7$ then solution is neutral

Salt : When an acid reacts with a base, salt and water are formed.

$$\text{Acid} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$
$$HCl + NaOH \longrightarrow NaCl + H_2O$$

The pH value of some common liquids

Liquid	pH
Lemon Juice	2.5
Wine	2.8
Apple Juice	3.0
Vinegar	3.0
Urine	4.8
Coffee	5.0
Saliva	6.5
Milk	6.5
Blood	7.4
Pure water	7.0
Sea water	8.5
Toothpaste	9.0
Milk of magnesia	10.5

Uses of some important salts :

1. **Sodium Chloride :** As a flavouring agent in food. In saline water for a patient of dehydration (0.9% NaCl), In the manufacture of HCl etc.
2. **Sodium iodate :** Iodised salt to prevent Goitre disease.
3. **Sodium Carbonate :** As washing soda, manufacturing of glass etc.
4. **Sodium Benzoate :** As a food preservative for pickles.
5. **Potassium nitrate :** As a fertilizer giving both K & N to the solid, In gun powder ($C + S + KNO_3$), In match sticks etc.

6. Calcium Chloride : Dehydrating agent used for removing moisture from gases.
7. Calcium carbonate (lime stone) : In the construction of building, In the cement industry., In the extraction of metals etc.
8. Calcium sulphate : (i) Plaster of Paris ($2\ CaSO_4 \cdot H_2O$) – For moulds & statues, in the cement industry in the form of Gypsum ($CaSO_4 \cdot 2H_2O$).
9. Calcium Phosphate : As a fertilizer (Superphosphate of lime)
10. Bleaching powder : (i) As a disinfectant (ii) As a bleaching agent (removing colours)
11. Alum (Potassium aluminium sulphate) : (i) In the purification of water. (ii) In the dyeing industry (iii) As antiseptic after shave.

The acidic and basic nature of some household substances

Acidic	Basic (Alkaline)
1. Bathroom acid	1. Milk of magnesia (Anta acids)
2. Vitamin C tablets (Ascorbic acid)	2. Toothpaste
3. Lemon juice	3. Soap solution or detergent soln.
4. Orange juice	4. Solution of washing soda.
5. Tomato juice	5. Slaked lime & white wash
6. Vinegar	
7. Fizzy drinks (Colas & Sodawater)	

7. Behaviour of Gases

1. Boyle's law : At constant temperature, the volume of a definite mass of a gas is inversely proportional to pressure.

$$V \propto \frac{1}{p} \quad \text{(at constant } T) \quad \text{or,} \quad V = K \cdot \frac{1}{p}$$

$$pV = K \quad \text{(where } K \text{ is a constant)}$$

$$p_1 V_1 = p_2 V_2$$

2. Charle's law : At constant pressure, the volume of a definite mass of a gas is directly proportional to absolute temperature.

i.e. $V \propto T$ (at constant p) or, $V = K \cdot T$ or, $\frac{V}{T} = k$

$$\therefore \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

3. Gay-Lussac's law : At constant volume, the pressure of given mass of a gas is directly proportional to the temp in Kelvin.

$$p \propto T \quad \text{(at constant } V) \quad \text{or,} \quad p = K \cdot T$$

or, $\frac{p}{T} = K$ $\quad \therefore \quad \frac{p_1}{T_1} = \frac{p_2}{T_2}$

4. Avogardo's gas law : At constant temperature and pressure the volume of a gas is directly proportional to the number of molecules.

$$V \propto n \quad \text{(at constant } T \text{ \& } p)$$

5. Ideal gas equation : $pV = nRT$ is called ideal gas equation. Where

p = Pressure, V = volume

n = number of mole T = temperature in Kelvin.

R = gas constant

$= 0.0821$ lit atm K^{-1} mol^{-1}

$= 8.314$ J K^{-1} mol^{-1}

$= 1.987$ cal K^{-1} mol^{-1}

6. S.T.P. & N.T.P. :

S.T.P. — Standard temperature and pressure.

N.T.P. — Normal temperature and pressure.

At S.T.P., for 1 mole gas

$V = 22.4$ litre $= 22400$ ml

$p = 1$ atm $= 76$ cm of Hg $= 760$ mm of Hg

$T = 273$ K

Diffusion of gases : The process of intermixing of gases irrespective of the density relationship and without the effect of external agency is called diffusion of gases.

In a gas, the molecules are far separated and the empty space among the molecules are very large. Therefore the molecules of one gas can move into the empty spaces or voids of the other gas and vice-versa. This leads to diffusion.

Graham's law of diffusion : Under the similar conditions of temperature and pressure, the rates of diffusion of gases are inversely proportional to the square roots of their densities.

Let r_1 and r_2 be the rates of diffusion of two gases A and B, d_1 and d_2 be their respective densities, then according to Graham's law of diffusion.

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$$

Since molecular mass = 2 × vapour density.

$$M = 2 \times d$$

Dalton's law of partial pressure : It states that– If two or more gases which do not react chemically are enclosed in a vessel, the total pressure of the gaseous mixture is equal to the sum of the partial pressure that each gases which exert pressure when enclosed separately in the same vessel at constant temperature.

Let p_1, p_2 and p_3 be the pressure of three non-reactive gases when enclosed separately. Let total pressure be p

then $p = p_1 + p_2 + p_3$

8. Electrolysis

1. Electrolytes : These are the substances which allow the electricity to pass through them in their molten states or in the form of their aqueous solution and undergo chemical decomposition. Examples— acids, bases & salts.

2. Strong electrolytes : The electrolytes which are almost completely dissociated into ions in solution are called strong electrolytes. Example—NaCl, KCl, HCl, NaOH etc.

3. Weak electrolytes : The electrolytes which do not ionise completely in solution are called weak electrolytes. *Example*—CH_3COOH, H_2CO_3, HCN, $ZnCl_2$, NH_4OH etc.

4. Electrolysis : The process of chemical decomposition of an electrolyte by passage of electric current through its molten state or its solution is called electrolysis.

5. Electrodes : In order to pass the current through an electrolytes in molten state or in aqueous solution, two rods or plates are needed to connect with the terminal of a battery. These rods or plates are called electrodes.

Anode : The electrode which is attached to positive terminal of battery is called anode. Oxidation occurs at anode.

Cathode : The electrode which is attached to negative terminal of batteries is called, Reduction occurs at cathode.

Examples— Electrolysis of molten NaCl

At anode : $Cl^- - e \longrightarrow Cl$

$Cl + Cl \longrightarrow Cl_2$

At cathode : $Na^+ + e \longrightarrow Na$

So, Cl_2 gas occurs at anode while Na at cathode.

9. Carbon and its Compounds

Carbon is non-metal having atomic number 6 and mass number 12. It is placed in group (IV) A or group 14 in periodic table

Allotropy.

The substances which have same chemical properties, but different physical properties are called allotropes and this property is called allotropy. *Example*—Allotropies of Carbon—Diamond, graphite, charcoal.

Diamond.

(i) It is the purest form of carbon.
(ii) It is the hardest natural known substance.
(iii) It is transparent, and specific gravity 3.52.
(iv) It is bad conductor of electricity and heat.
(v) It has very high refractive index 2.415.
(vi) It is chemically inert and on heating above 1500° c, transferred into graphic.
(vii) It form tetrahedral crystals and hybridisation of C–atom is sp^3.
(viii) It has high mp & density.
(ix) Black diamonds called carbonado contains traces of graphite.

Graphite (Plumbago or black lead)

(i) It is soft, greasy, dark greyish colored crystalline solid.
(ii) It is good conductor of heat and electric
(iii) Its specific gravity is 2.3
(iv) The hybridization of carbon in graphite is sp^2 and it has hexagonal layer structure

(v) It is chemically more reactive than diamond

(vi) Its layer structure is held by weak van der waal's force.

(vii) Graphite is used in making for lining and making electrodes of electric furnances, in making refractory crucibles, in making lead pencils, as a moderator in nuclear reactor as lubricant in machinery, as a reducing agent in steel manufacturing.

Forms of Amorphous carbon obtained by destructive distillation.

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

Hydrocarbons

Compounds made of carbon and hydrogen atoms only are celled hydrocarbons. The natural source of hydrocarbons is petroleum.

Hydrocarbons are classified as :

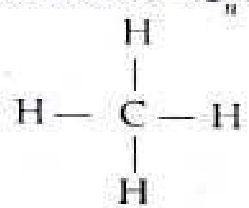
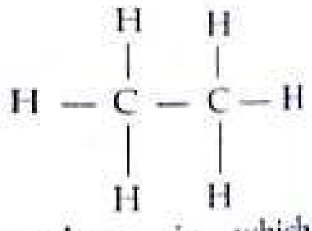
(i) saturated hydrocarbons

(ii) unsaturated hydrocarbon

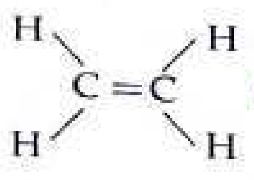
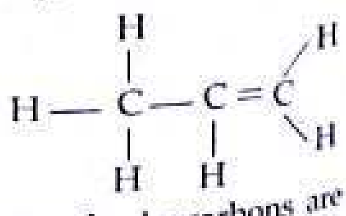
(iii) aromatic hydrocarbons.

1. Saturated hydrocarbons: The hydrocarbons in which carbon atoms and singly bonded are called saturated hydrocarbons. Saturated hydrocarbons are also called alkanes or paraffins. Alkanes are relatively unreactive under ordinary laboratory conditions. So, alkanes are also called paraffins because paraffins means little reactive.

general formula of alkane—$C_n H_{2n+2}$

Methane (CH_4):  Ethane (C_2H_6): 

(ii) Unsaturated hydrocarbons : The hydrocarbons in which carbon atoms are either doubly or triply bonded are called unsaturated hydrocarbons. Doubly bonded (carbon carbon atoms) hydrocarbons are called alkenes. The general formula of alkene is $C_n H_{2n}$.

Ethane (C_2H_4):  Propane (C_3H_6): 

Triply bonded carbon : Carbon atoms containing hydrocarbons are called alkynes. The general formula of alkynes are $C_n H_{2n-2}$

(iii) Aromatic hydrocarbons : These are homocyclic compounds which contain atleast one benzene ring in which carbon atoms are linked to one another by alternate single and double bonds.

In Greek, aroma stands for sweet smell. Compounds in these classification have pleasant smell. Hence, they are called aromatic compounds.

Example : 

Benzene Naphthalene Anthracene

Isomerism : Two or more compounds having same molecular formula but different physical and chemical properties are called isomers and this phenomenon is called isomerism

Polymerisation : The simple molecules which combine to form a macro molecule is called polymer. The process by which the simple molecules (monomers) are converted polymer is called polymerisation.

$$\underset{\text{ethene}}{nCH_2=CH_2} \xrightarrow{\text{polymerisation}} \underset{\text{Polyethene}}{(-CH_2-CH_2-)_n}$$

Natural occurring polymers are protein, nucleic acid, cellulose, starch etc.

Plastics : Plastics are cross linked polymers and are very tough. Lac is a natural plastic chemically plastic can be of two types.

(i) Thermoplastic (ii) Thermosetting plastics.

(i) Thermoplastic : These are the polymers which can be easily softened repeatedly when heated and hardened when cooled with little change in their properties.

Examples : Polyethylene, polystyrene, polyvinyl chloride, teflon. etc.

(ii) Thermoplastic : These are the polymers which undergo permanent change on heating. On heating they undergo extensive cross linking in moulds and become hard and infusible therefore, they can not be reused.

Examples : Bakelite, glyptal, terrylene etc.

Bakelite (Phenol-formaldehyde resins) : It is a condensation polymer and is obtained from phenol and formaldehyde in presence of either an acid or a base catalyst. It is used for making combs, fountain pens, photographs records, electrical goods etc.

Rubber : It is a polymer which is capable of returning to its original length, shape or size after being stretched or deformed. The rubber obtained from natural sources are called natural rubber and polymer prepared in laboratory which are similar to natural rubber are known as synthesize rubber.

Natural rubber

Synthetic rubber

(i) Neoprene

(ii) Thiokol : Thiokol is made by polymerisation of ethylene chloride and sodium polysulphide

$$Cl\,CH_2-CH_2\,Cl + Na-S-S-Na + Cl\,CH_2-CH_2\,Cl$$

$$\downarrow \text{Polymerisation}$$

$$\underset{\text{Thiokol rubber}}{-CH_2-CH_2-S-S-CH_2-CH_2-}$$

repeating unit is $-CH_2-S-S-CH_2-$

Thiokol is chemically resistant polymer. It is used in the manufacture of hoses and tank linings, engine gaskets and rocket fuel.

Vulcanization of rubber : Natural rubber is soft and sticky and therefore, in order to give strength and elasticity Natural rubber is vulcanized. Vulcanization is a process of treating the natural rubber with sulphur or some compound of sulphur (SF_6) under heat. Vulcanized rubber is used for manufacturing rubber bands, gloves, car, tyres etc.

Fibres : Fibres are the polymers which have quite strong intermolecular forces such as hydrogen bonding. Nylon–6,6, dacron, orlon etc are the examples of this type.

Rayon : Synthetic fibre obtained from cellulose is known as Rayon.

10. Fuels

A substance that can supply energy either alone or by reacting with another substance is known as fuel. Heat produced by fuel is measured in Calories. An ideal fuel should

(i) have high calorific value

(ii) be cheap and easily available

(iii) be easily stored & transport

(iv) be regulated and controlled

(v) have low ignition temperature

The quantity of fuel is expressed in the form of calorific value.

Calorific value is the total quantity of heat liberated by complete combustion of a unit mass of fuel in air or oxygen.

Calorific value of fuels are expressed in kcal / m^3 or British Thermal unit (B.T.U) per cubic foot.

$$1\ \text{kcal}/m^3 = 0.107\ \text{B.T.U}/ft^3$$

Fuel may be sold (e.g wood, coal etc.)

Liquid (e.g kerosene oil, petroleum, alcohol etc.) or gas (e.g water gas, producer gas, coal gas, oil gas, natural gas, gobar gas, LPG etc.) However, gaseous fuel are considered to be the best fuels.

1. Water gas (syn gas) : It is a mixture of carbon monoxide and hydrogen. It is obtained by the action of steam on a red hot coke at 1000° C.

$$C + H_2O \longrightarrow \underset{\text{Water gas}}{CO + H_2} - 28\ \text{kcal}$$

It has a high calorific value (2700 kcal / m^3)

Producer gas : It is a mixture of CO and N_2. It is prepared by burning coke in limited supply of air. It is the cheapest gaseous fuel, however its calorific value is not very high because it has a large proportion of nitrogen.

Coal gas : It is a mixture of H_2, CH_4, CO and other gases like N_2, C_2H_4, O_2 etc. It is obtained by destructive distillation of coal at about 1000°C

Oil gas : It is a mixture of H_2, CH_4, C_2H_4, CO and other gases like CO_2. It is obtaineal by thermal cracking of kerosene oil. It is used in laboratories.

Gobar gas : It contains CH_4, CO and H_2. It is produced by fermentation of gobar in absence of air. It is used as a domestic fuel in villages.

Natural gas : It is a mixture of gaseous hydrocarbons viz methane 85% , ethane, propane butane etc. Liquefied petroleum mainly butane and isobutane.

Coal : On the basis of carbon % and calorific value there are four types of coal.

S.N	Nature	% of carbon	Calorific value
1.	Peat : Low grade coal produces less heat & more smoke & ash.	50 – 60%	2500 – 3500
2.	Lignite : High moisture content burns easily, low calorific value.	60 – 70%	3500 – 4500
3.	Bituminous : Black, hard, smoky, flame, domestic fuel.	75 – 80%	7500 – 8000
4.	Anthracite : Superior quality, hardest form, high calorific value.	90 – 95%	6700 – 7500

11. Metallurgy

The process of extracting metal in pure form from its ore is known as metallurgy.

Minerals : The compound of a metal found in nature is called a mineral. A mineral may be a single compound or a complex mixture.

Ores : Those minerals from which metal can be economically and easily extracted are called ores.

All ores are mineral but all minerals are not ores.

Gangue (or matrix) : The ore is generally associated with earthy impurities like sand, rocks and limestone known as gangue or matrix.

Flux : A substance added to ore to remove impurities is called flux. There are two types of flux— (i) acidic flux. (ii) basic flux.

Acidic flux is added to remove basic impurity

$$\underset{\text{acidic flux}}{SiO_2} + \underset{\text{basic impurity}}{FeO} \longrightarrow \underset{\text{Ferrous silicate}}{FeSiO_3}$$

Basic flux is added to remove acidic impurity.

$$\underset{\text{basic flux}}{CaCO_3} + \underset{\text{acidic impurity}}{SiO_2} \longrightarrow \underset{\text{Calcium silicate}}{CaSiO_3} + CO_2$$

Slag : Combination of gangue with flux in ores forms a fusible material which is called slag.

$$\text{Gangue} + \text{flux} \longrightarrow \text{slag}$$

$$SiO_2 + CaO \longrightarrow CaSiO_3$$

Concentration : The process of removal of gangue from the ore is known as concentration of ore. Concentration of ore can be carried out in the following ways depending upon the nature of the ore.

(i) Gravity separation (ii) Magnetic concentration

(ii) Froth flotation process (iv) Chemical methods

Calcination : Calcination is a process in which ore is heated, generally in the absence of air, to expel water from hydrated oxide or carbon dioxide from a carbonate at temperature below their melting point example :

$$Al_2O_3 \cdot 2H_2O \xrightarrow{\Delta} Al_2O_3 + 2H_2O$$

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

Roasting : Roasting is a process in which ore is heated usually in the presence of air, at temperatures below its melting points.

$$ZnS + 2O_2 \longrightarrow ZnSO_4; \qquad CuS + 2O_2 \longrightarrow CuSO_4$$

Smelting : The reduction of oxide ore with carbon at high temperature is known as smelting.

$$Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO; \qquad PbO + C \longrightarrow Pb + CO$$

Important metals and their ores

Metal	Ores	Chemical Formula
Sodium (Na)	Chile saltpeter	$NaNO_3$
	Trona	$Na_2CO_3, 2NaHCO_3 \cdot 3H_2O$
	Borax	$Na_2B_4O_7 \cdot 10H_2O$
	Common salt	$NaCl$
Aluminium (Al)	Bauxite	$Al_2O_3 \cdot 2H_2O$
	Corundum	Al_2O_3
	Felspar	$K\,Al\,Si_3\,O_8$
	Cryolite	$Na_3Al\,F_6$
	Alunite	$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 4\,Al(OH)_3$
	Kaolin	$3\,Al_2O_3 \cdot 6\,SiO_2 \cdot 2H_2O$
Potassium (K)	Nitre (salt peter)	KNO_3
	Carnalite	$KCl \cdot MgCl_2 \cdot 6\,H_2O$
Magnesium (Mg)	Magnesite	$MgCO_3$
	Dolomite	$MgCO_3 \cdot CaCO_3$
	Epsom salt	$MgSO_4 \cdot 7\,H_2O$
	Kieserite	$MgSO_4 \cdot H_2O$
	Carnalite	$KCl \cdot MgCl_2 \cdot 6\,H_2O$

Metal	Ores	Chemical Formula
Calcium (Ca)	Dolomite	$CaCO_3 \cdot MgCO_3$
	Calcite	$CaCO_3$
	Gypsum	$CaSO_4 \cdot 2H_2O$
	Fluorspar	CaF_2
	Asbestus	$CaSiO_3 \cdot MgSiO_3$
Strontium (Sr)	Strontianite	$SrCO_3$
	Silestine	$SrSO_4$
Copper (Cu)	Cuprite	Cu_2O
	Copper glance	Cu_2S
	Copper pyrites	$CuFeS_2$
Silver (Ag)	Ruby Silver	$3Ag_2S \cdot Sb_2S_3$
	Horn Silver	$AgCl$
Gold (Au)	Calaverite	$AuTe_2$
	Silvenites	$[(Ag, Au)Te_2]$
Barium (Ba)	Barytes	$BaSO_4$
Zinc (Zn)	Zinc blende	ZnS
	Zincite	ZnO
	Calamine	$ZnCO_3$
Mercury (Hg)	Cinnabar	HgS
Tin (Sn)	Casseterite	SnO_2
Lead (Pb)	Galena	PbS
Antimony (Sb)	Stibenite	Sb_2S_3
Cadmium (Cd)	Greenocite	CdS
Bismuth (Bi)	Bismuthite	Bi_2S_3
Iron (Fe)	Haemetite	Fe_2O_3
	Lemonite	$2Fe_2O_3 \cdot 3H_2O$
	Magnetite	Fe_3O_4
	Siderite	$FeCO_3$
	Iron Pyrite	FeS_2
	Copper Pyrites	$CuFeS_2$
Cobalt (Co)	Smelite	$CoAsS_2$
Nickel (Ni)	Milarite	NiS
Magnese (Mn)	Pyrolusite	MnO_2
	Magnite	$Mn_2O_3 \cdot 2H_2O$
Uranium (U)	Carnetite	$K(UO)_2 \cdot VO_4 \cdot 3H_2O$
	Pitch blende	U_3O_8

Alloys : An alloy is a metallic intimately mixed solid mixture of two or more different elements, at least one of which is metal.

Alloys are homogeneous in molten state but they may be homogeneous or heterogeneous in solid state.

Important alloys & their uses

Alloys	Compositions	Uses
Brass	Cu (70%) + Zn (30%)	In making utensils
Bronze	Cu (90%) + Sn (10%)	In making coins, bell and utensils
German Silver	Cu + Zn + Ni (60% + 20% + 20%)	In making utensils
Rolled gold	Cu (90%) + Al (10%)	In making cheap ornaments
Gun metal	Cu + Sn + Zn + Pb (88% 10% 1% 1%)	In making gun, barrels, gears & bearings
Delta metal	Cu + Zn + Fe (60% 38% 2%)	In making blades of aeroplane
Munz metal	Cu (60%) + Zn (40%)	In making coins
Dutch metal	Cu (80%) + Zn (20%)	In making Artificial ornaments
Monel metal	Cu (70%) + Ni (30%)	For base containing container
Rose metal	Bi + Pb + Sn (50% 28% 22%)	For making automatic fuse
Solder	Pb (50%) + Sn (50%)	For soldering
Magnalium	Al (95%) + Mg (5%)	For frame of Aeroplane
Duralumin	Al + Cu + Mg+ Mn (94% 3% 2% 1%)	For making utensils
Type metal	Sn + Pb + Sb (5% 80% 15%)	In printing industry
Bell metal	Cu (80%) + Sn (20%)	For casting bells, statues
Stainless steel	Fe + Cr + Ni + C (75%,15%,10%,.05%)	For making utensils and surgical cutlery
Nickel steel	Fe (95%) + Ni (5%)	For making electrical wire, automobile parts

Amalgum : An alloy in which one of the component metals is mercury, is called amalgam.

In alloys, the chemical properties of the component elements are retained but certain physical properties are improved.

Compounds of metal and non-metal and their uses :

1. **Ferrous oxide** (FeO) : In green glass, Ferrous salt.
2. **Ferric oxide** (Fe_3O_4) : In electroplating of ornaments and formation of ferric slat
3. **Ferrous sulphate** ($FeSO_4 \cdot 7H_2O$) : In dye industry, and Mohr's salt
4. **Ferric hydroxide** [($Fe(OH)_3$)] : In laboratory reagent and in making medicines.
5. **Iodine** (I_2) : (i) As antiseptic, (ii) In making tincture of iodine.
6. **Bromine** (Br_2) : (i) In dye industry (ii) As laboratory reagent
7. **Chlorine** (Cl_2) : In the formation of (i) Mustard gas (ii) Bleaching powder

8. Hydrochloric acid (HCl): In the formation of aquaregia (3 HCl : 1 HNO_3) and dyes
9. Sulphuric acid (H_2SO_4): (i) As a reagent (ii) In purification of petroleum (iii) In lead storage battery.
10. Sulphur dioxide (SO_2) : (i) As oxidants & reductants (ii) As bleaching agent
11. Hydrogen Sulphides (H_2S) : In qualitative analysis of basic radical (group separation)
12. Sulphur (S) : Antiseptics, vulcanization of rubber, gun powder, medicine.
13. Ammonia (NH_3) : As reagent in ice factory.
14. Phosphorous : (i) Red (P_4) refrigerent, in match industry etc.
    (ii) White (P_4) – Rat killing Medicine.
15. Producer gas ($CO + N_2$) : (i) In heating furnace (ii) Cheap fuel (iii) In Extraction of metal
16. Water gas ($CO + H_2$) : (i) As fuel (ii) Welding work
17. Coal gas : (i) As fuel (ii) Inert atmosphere
18. Nitrous oxide (N_2O) : Laughing gas, Surgery.
19. Carbondioxide (CO_2) : Sodawater, Fire extinguisher.
20. Carbon monoxide (CO) : In phosgene gas ($COCl_2$).
21. Graphite : As electrodes.
22. Diamond : Ornaments, Glass cutting, Rock drilling.
23. Alum [K_2SO_4 $Al_2(SO_4)_3 \cdot 24H_2O$] : (i) Purification of water (ii) Leather industry.
24. Aluminium sulphate [$Al_2(SO_4)_3 \cdot 18H_2O$] : In paper industry/fire extinguisher.
25. Anhydrous aluminium chloride ($AlCl_3$) : Cracking of petroleum.
26. Mercuric Chloride ($HgCl_2$) : Calomel, Insecticides (Corrosive sublimate)
27. Mercuric oxide (HgO) : Oientment, poison.
28. Mercury (Hg) : Thermometer vermillion, amalgum.
29. Zinc Sulphide (ZnS) : White pigment.
30. Zinc Sulphate (White vitriol) ($ZnSO_4 \cdot 7H_2O$) : Lithopone, Eye ointment.
31. Zinc Chloride ($ZnCl_2$) : Textile industry.
32. Zinc oxide (ZnO) : Ointment.
33. Zinc (Zn) : In battery.
34. Calcium carbide (CaC_2) : Calcium cyanide & acetylene gas.
35. Bleaching powder [Ca(OCl) Cl] : Insecticides, Bleaching actions.
36. Plaster of paris [$(CaSO_4)_2 \cdot 2H_2O$/$CaSO_4$ ½ H_2O)] : Statue, Surgery.
37. Calcium sulphate ($CaSO_4 \cdot 2H_2O$) : Cement industry.
38. Calcium carbonate ($CaCO_3$) : Lime & toothpaste.

39. Copper sulphate ($CuSO_4 \cdot 5H_2O$) : Insecticides, Electric cells.
40. Cupric oxide (CuO) : Blue & green glass, purification of petroleum
41. Cuprous Oxide (Cu_2O) : Red glass, pesticides.
42. Copper (Cu) : Electrical wire.
43. Sodium nitrate ($NaNO_3$) : Fertilizer.
44. Sodium Sulphate (Glauber salt) ($Na_2SO_4 \cdot 10H_2O$) : Medicine, cheap glass
45. Sodium bicarbonate (Baking soda) ($NaHCO_3$) : Fire extinguisher, bakery, reagent.
46. Sodium Carbonate (Washing soda) : (i) Glass industry (ii) Paper industry (iii) Removal of permanent hardness of water (iv) washing
47. Hydrogen peroxide (H_2O_2) : Oxidants & reductants, Insecticides.
48. Heavy water (D_2O) : Nuclear reactor.
49. Liquid hydrogen : Rocket fuel.

12. Important Facts About Some Metals

- Zinc phosphide is used for killing rats.
- Wood furnitures are coated with zinc chloride to prevent termites.
- Excess of copper in human beings causes disease called Wilson.
- Galvanised iron is coated with zinc.
- Rusting of iron is a chemical change which increases the weight of iron.
- Calcium hydride is called hydrolith.
- Calcium hydride is used to prepare fire proof and waterproof clothes.
- In flash-blub, magnesium wire is kept in atmosphere of nitrogen gas.
- Titanium is called strategic metal because it is lighter than iron.
- Group 1st element are called alkali metals because its hydroxides are alkaline whereas group 2nd elements are called alkaline earth metals.
- Babbitt metal contains 89% Sn (Tin), 9% Sb (Antimony) and 2% Cu (Copper).
- Gun powder contains 75% Potassium nitrate, 10% sulphur and 15% charcoal.
- Chromium trioxide is known as chromic acid.
- Nichrome wire is used in electrical heater [(Ni, Cr, Fe)]
- Potassium carbonate (K_2CO_3) is known as pearl ash.
- Generally transition metals and their compounds are coloured.
- Zeolite is used to remove hardness of water.
- In cytochrome iron (Fe) is present.
- Selenium metal is used in photo electric cell.
- Galium metal is liquid at room temperature.
- Palladium metal is used in aeroplane.
- Radium is extracted from pitchblende.
- World famous Eiffel Tower has steel and cement base.
- Actinides are radio-active elements.

- Cadmium rod is used in nuclear reactor to slow down the speed of neutron.
- Sodium peroxide is used in submarine and also to purify closed air in hospital.
- Co (60) is used in cancer treatment.
- Onion and garlic odour due to potassium.
- Oxides of metals are alkaline.
- Silver and copper are the best conductor of electricity.
- Gold and Silver are the most malleable metal.
- Mercury and iron produces more resistance in comparison to the other during the flow of electricity.
- Lithium is the lightest and the most reductant element.
- In fireworks, crimson red colour is due to presence of strontium (Sr).
- Green colour is due to the presence of Barium in fireworks.
- Barium sulphate is used in X-ray of abdomen as barium meal.
- Barium hydroxide is known as Baryta water.
- Osmium is the heaviest metal and the Platinum is the hardest.
- Zinc oxide is known as flower of zinc. It is also known as chinese white and used as white paint.
- Silver chloride is used in photochromatic glass.
- Silver iodide is used in artificial rain.
- Silver nitrate is used as marker during election. It is kept in coloured bottle to avoid decomposition.
- Silver spoon is not used in egg food because it forms black silver sulphide.
- To harden the gold, copper is mixed. Pure gold is 24 carrat.
- Iron Pyrites (FeS_2) is known as fool's gold.
- Mercury is kept in iron pot because it doesn't form amalgum with iron.
- In tubelight there is the vapour of mercury and argon.
- Tetra-Ethyl lead is used as anti knocking compound.
- Lead-pipe is not used for drinking water because it forms poisonous lead hydroxide.
- Fuse wire is made up of lead and tin.

13. Non metal

In modern periodic table there are 24 non metals. 11 are gases, 1 is liquid (Br_2) and 12 are solid.

Electronegative elements are non metals.

Non metals are bad conductor of heat and electricity except graphite, Si & Ge are semi conductor.

Hydrogen (H_2)

The lightest gas having three isotopes

$_1H^1$, Protium $_1H^2$, Deuterium $_1H^3$, Tritium (Radioactive)

Protium is only one isotope in Periodic Table having zero neutron.

Deuterium oxide is known as heavy water and used in nuclear reactor as moderator.

Liquid hydrogen is used as rocket fuel.

Hydrogen is known as range element because it may kept in group I & group VII A.

Water (H_2O)

Hard water – Less froth with soap

Soft water – more froth with soap.

Hard water – Due to the presence of soluble impurities of bicarbonates, chlorides & sulphates of Ca & Mg.

Temporary hardness – Due to the presence of bicarbonate of calcium and magnesium.

Permanent hardness – Due to the presence of chlorides and sulphates of calcium and magnesium.

Temporary hardness is removed by boiling and by Clark's method while permanent hardness is removed by Soda ash (Na_2CO_3) process.

Permanent hardness is also removed by permutit process.

Oxygen

Important constituent of air, exists in three different isotopes.

$${}_8O^{16},\ {}_8O^{17},\ {}_8O^{18}$$

Ozone (O_3) is the allotrope of Oxygen .

Ozone reduces the effect of ultraviolet rays in the atmosphere.

Nitrogen

78% by volume in atmosphere, liquid nitrogen is used for refrigeration.

Ammonia is an important compound of N_2 which is prepared by Haber's process.

Ammonia

As refrigerent, In the manufacture of HNO_3.

In fertilizer like urea, ammonium sulphate etc.

In the manufacture of Na_2CO_3 & $NaHCO_3$.

In preparation of ammonium salt.

In preparation of explosive.

In preparation of Artificial silk.

Nitrogen fixation in leguminous plants

Phosphorous

An important constituent of animals and plants. It is present in bones & DNA.

Phosphorous shows allotropy – White or yellow phosphorous, Red phosphorous, Black phosphorous etc.

White phosphorous is more reactive than red phosphorous.

Halogens

17th group elements

Uses of fluorine : In the preparation of UF_6 and SF_6 for energy production and as dielectric constant respectively.

By using HF, chloro fluoro carbon compound and polytetra fluoro ethylene can be synthesised.

Chlorofluoro carbon is known as Freon used as refrigerent and aerosol.

Non-stick utensil is made up of teflon.

Chlorine is used to prepare PVC, insecticides herbicides etc.

Bromine is used in ethylene bromide synthesis which is mixed with leaded pertrol. In the preparation of AgBr which is used in photography.

Inert gases

It belongs to 18th group of P.T.

He, Ne, Ar, Kr, Xe, Rn

Except Rn, all inert gases are present in atmosphere.

Argon is used in Arc. welding & electric bulb.

Helium is light & non-inflammable so, used in balloon, weather indicator etc.

Neon is used in discharge tube glow light.

14. Common Facts

	Catalyst	Process
1.	Fe + Mo	Synthesis of NH_3 by Haber's process.
2.	Ni	Synthesis of vanaspati Ghee (hydrogenation)
3.	Pt	Synthesis of H_2SO_4 by Contact process.
4.	NO	In the manufacture of H_2SO_4 by the Lead chamber process.
5.	Hot Al_2O_3	In the preparation of Ether from Alcohol.
6.	$CuCl_2$	Preparation of chlorine gas by Deacon process.

Some Important Explosive

- **Dynamite** : It was discovered Alfred Nobel in 1863. It is prepared by absorption of raw dust with Nitro-glycerine. In modern dynamite Sodium Nitrate is used in place of Nitro-glycerine.
- **Tri Nitro Toluene** (TNT)
- **Tri Nitro Benzene** (TNB)
- **Tri Nitro Phenol** (TNP) : It is also known as picric acid.
- R.D.X is highly explosive known as plastisizer in which Aluminium powder is mixed to increase the temperature and the speed of fire.

Some Important Facts

- Age of fossils and archeological excavation is determined by radioactive carbon (C^{14}).
- Diamond has maximum refractive index and due to total internal reflection. It has lustre.

- Chloroform in sunlight forms poisonous gas 'Phosgene' ($COCl_2$).
- To decrease the basicity of soil gypsum is used.
- In the preparation of Talcom powder theo phestal mineral is used.
- Potassium chloride is most suitable for the removal of permanent hardness of water.
- To avoid melting of ice gelatine is used.
- When dry ice is heated it is directly converted into gas.
- Saccharine is prepared from toluene.
- Cream is a type of milk in which amount of fat is increased while amount of water decrease.
- From one kilogram of honeybee 3500 calorie energy is produces.
- N_2O is known as laughing gas.
- Bones contain about 58% calcium phosphate.
- Phosphine gas is used in voyage as Holmes signal.
- Chlorine gas bleaches the colour of flower.
- Red phosphorus is used in match industry.
- Urea contains 46% nitrogen.
- In the electroplating of vessel NH_4Cl is used.
- Power alcohol is prepared from mixing pure alcohol in benzene which is used as rocket fuel.
- Artificial perfumes are prepared from Ethyl acetate.
- Urea was the first organic compound synthesised in Laboratory.
- Vinegar contains 10% acetic acid.
- Acetylene is used for light production.
- Ferric chloride is used to stop bleeding.
- Barium is responsible for green colour in fireworks.
- Cesium is used in solar cells.
- Yellow phosphorus is kept in water.
- Sea weeds contains iodine.
- During cooking maximum vitamin is lost.
- For the preparation of silver mirror, glucose is used.
- When cream is separated from milk, it's density increases.
- For artificial respiration mixture of oxygen and helium gas cylinder is used.
- In cold places, to decrease the freezing point ethylene glycol is used.
- Hydrogen peroxide is used for oil paintings.
- Sodium is kept in kerosene oil.
- The heaviest element is Osmium (Os).
- The lightest element, least dense and most reductant is lithium (Li).
- Flourine is the most oxidising agent.
- Silver is the best conductor of electricity.
- Radon is the heaviest gas.

- Polonium has the maximum number of isotopes.
- Sulphuric acid is known as oil of vitriol.
- Noble metals — Ag, Au, Pt, Ir, Hg, Pd, Rh, Ru, and Os.

15. Man made substances

1. Fertilizers : The substances added to the soil to make up the deficiency of essential elements are known as fertilizers, these are either natural or synthetic (chemical). For a chemical fertilizer, the following requirements should be met :

(i) It must be sufficiently soluble in water

(ii) It should be stable so that the element in it may be available for a longer time.

(iii) It should contain nothing injurious to plants.

Among the chemical fertilizers the two important categories are :

Phosphatic Fertilizers : All naturally occurring phosphates are orthophosphates, the most abundant of these being rock phosphate $[Ca_3(PO_4)_2]$, which is mostly consumed by the fertilizer industry in the manufacture of 'superphosphate of lime', 'triple superphosphate' and 'nitrophos'— a combined phosphatic and nitrogenous fertilizer. Other phosphatic fertilizers are ammoninum dihydrogen orthophosphate and diammonium hydrogen orthophosphate, which also conteract nitrogen dificiency.

Nitrogenous Fertilizers : Plants need nitrogen for rapid growth and increase in their protein content. For this reason, nitrogenous fertilizers become more important. The chief nitrogeneous fertilizers are ammonium sulphate, calcium cyanamide, sodium nitrate, ammonium nitrate, urea, diammo-nium phosphate and ammonium phosphate.

2. Dyes : Coloured substances used for colouring textiles, foodstuffs, silk, wool, etc. are called dyes.

Different classes of dyes are given below.

(i) Nitro dyes : These are polynitro derivatives of phenol where nitro group acts as a chromophore and hydroxyl group as auxochrome. These are less important industrially because the colours are not fast.

(ii) Azo dyes: These are an important class of dyes and are characterised by the presence of azo group (—N=N—) as the chromophore. The groups like NH_2, NR_2 or —OH, etc., present in the molecule containing one or more azo gruops act as the auxochromes.

(iii) Triphenylmethane dyes: These dyes contain the paraquinoid moiety as a chromophore and —OH, —NH_2 or —NR_2 as auxochrome. These dyes are not fast to light and washing and hence are mainly used for colouring paper or typewriter ribbons, e.g. malachite green which is used for dyeing wool and silk directly and cotton after mordanting with tannin.

(iv) Mordant dyes : Those dyes which are fixed on the fibre with the help of a mordant are known as mordant dyes. For acidic dyes, basic mordants (such as hydroxides of iron, aluminium and chromium) are used, while for basic dyes, acidic mordants (like tannic acid) are used. Here the fabric is first dipped into a solution of mordant and then into the dye solution. The colour produced depends on the nature of the mordant used.

(v) Vat dyes : These are water insoluble dyes and are introduced into the fibre in its (soluble) reduced form, also known as *leuco* form (colourless). These are called vat dyes because reducing operation (using sodium hydrosulphite) was formerly carried out in wooden vats. Indigo is a vat dye and is used for dyeing cotton.

Cement : It is a complex material containing the silicates of calcium and aluminium. A paste of it in water sets into a hard rocky mass-called the setting of cement. A paste of sand, cement and water called mortar, is very conveniently used for joining bricks and plastering walls.

A mixture of stone chips (gravel) sand cement and water, known as concrete. Sets harder than ordinary mortar. It is used for flooring and making roads. Concrete with steel bars and wires called reinforced concrete (RC) forms a very strong material. It is used for constructing roofs, bridges and pillars.

Glass : Supercooled liquid is called glass. SiO_2 is it's common constituent.

(a) Soda glass or soda lime glass : It is Sodium calcium silicate (Na_2O CaO 5 SiO_2). It is the cheapest of all glasses and used for making window panes and bottles and easily attacked by chemicals.

(b) Potash glass : It contains potassium in place of sodium. it has higher softening temperature as also a greater resistance to chemicals. So used for chemical apparatus; beakers, flasks, funnels etc.

(c) Optical glass: It is used for making lenses, prisms and optical instruments like telescopes and microscopes. It contains boric oxide (B_2O_3) and silica (SiO_2)

Types : (i) Crown glass : Contains K_2O & BaO as the basic oxide

(ii) Flint glass : Contains PbO as the basic oxide.

(d) Crooks glass: for spectacles : Absorbs ultraviolet rays which are harmful for the eyes.

(e) Lead crystal and crystal glass : Lead glass sparkles used for making decorative items. It contains 24% or more of PbO called lead crystal. If it contains term than 24% lead oxide called crystal glass.

(f) Borosilicate glass : It contains less alkali (K_2O or CaO_3) and more SiO_2 than potash glass and some B_2O

(g) Coloured glass :

Colour	Substance added to the glass melt
Red	Selenium (Se) or copper (I) oxide (Cu_2O)
Green	Chromium III oxide (Cr_2O_3)
Violed	Maganese IV oxide (MnO_2)
Blue	Copper II oxide eno or cobalt II oxide (CoO)
Brown	Er on III oxide (Fe_2O_3)

It is used for making artificial jewellery, crockery and stained glass windows.

(h) Milky glass: Milky glass is prepared by adding tin oxide (SnO_2). Calcium phosphate ($Ca_3(PO_4)_2$) or cryolite (AH_33NaF) to the melt glass. All these substances are white so look milky.

(i) Glass laminates : It is made by fixing polymer sheets between layers of glass. It is used to make windows & Screens of cars, trains and aircraft specially manufactured glass laminates are used bulletproof material.

Some common man-made polymers and their uses.

Polymer	Use
Polythene	Packaging material, carry bags, bottles.
Polypropene	Bottles, Crates.
Polyvinyl chloride (PVC)	Pipes insulation
Nylon (Polyester)	Fibres, ropes
Teflon	Nonstick kitchen ware
Vinyl rubber	Rubber erasers
Polystyrene	Foam Thermocole
Poly (Styrene butadiene)	Rubber bubble gum
Bakelite	Electrical insulation buttons
Lexan	Bullet proof glass
Melamine	Crockery

Paints : Chemical, contains a pigment as a vehicle and a thinner.

White pigment : Zinc oxide, white lead and titanium dioxide. The pigment is mixed with a vehicle, which is an oil like *linseed* or *soyabean oil* or a *polymer*. A thinner is a solvent such as *turpentine oil* or *kerosene*.

Luminous paints : Glow when exposed to light. Paints are applied on a surface to protect it from corrosion and weathering or to give it an attractive look.

Soaps and Detergents : Soaps are the sodium or Potassium salts of fatty acids. They are made by the saponification of fats. Detergents are made from some petroleum products.

Antibiotic : Medicinal compounds produced by moulds and bacteria, capable of destroying or preventing the growth of bacteria in animal systems.

Antibody : Kinds of substances formed in the blood, tending to inhibit or destroy harmful bacteria, etc.

Antidote : Medicine used against a poison, or to prevent a disease from having effect.

Antigen : Substance capable of stimulating formation of antibodies.

Antimony : A brittle, crystalline, silvery white metal.

Antipyretie : A substance used to lower body temperature.

Pesticides : Many living organism destroy crops or eat away grains. They are collectively known as pests. To kill chemical used called pesticides.

Insecticides : D.D.T. aluminium phosphate gammexine.

Fungicide : Thiram, Bordeanx mixture $CaCaSO_45H_2O + (OH)_2$

Rodenticides : Aluminium phosphide.

Herbicides : Benzipram, benzadox.

Medicines : To cure diseases by biological changes in the body.

Analgesics : Painkillers are called analgesics eg, Aspirin, Paracetamol and morphine.

Antimalarial drugs : Used to treat malaria quinine derivatives eg, chlovoquine.

Destroy microorganism : Penicillin, Aminogly considers, oftoxaim, Homophonic.

Sulphadrugs:Alternativesofantibiotics,sulphanilamide,sulphadiazine, Sulpha gunamidine.

Antaoxide :Substances which remove the excess acid and raise the pH to appropriate level in scotch are called antacids. It is caused by excess of HCl in the gastric juice magnesium hydrate, magazines carbonate, magnesium truistical, aluminium phosphene are common antacids.

Epsom salt : Hydrated magnesium sulphate ($MgSO_4 \cdot 7H_2O$), used in medicines to empty bowels.

Chloroform : A sweetish, colourless liquid. It is used as a solvent and anaesthetic.

Saccharin : A white crystalline solid which is 550 times sweeter than sugar, but does not have any food value. It is used by diabetic patients.

DDT : Dichloro diphenyl tricholoro ethane, a white powder used as an insecticide.

★★★