Matter:

Matter is anything that has mass and occupies space. It can be changed from one form to another or into energy but can never be completely destroyed.

Elements:

A pure substance which contains only one kind of atom, e.g. Fe (Iron), Na (Sodium)

Compounds:

A compound is a pure substance which contains more than one kind of element or atom in fixed proportion by weight e.g. NaCl (Sodium chloride), SO2 (Sulphur dioxide) etc.

Mixtures:

A material containing two or more elements or compounds in any proportion is a mixture.

Types of Mixtures

a) Homogeneous
b) Heterogeneous
c) Homogeneous if its composition is uniform throughout.
d) heterogeneous if its composition is not uniform
e) A mixture with definite boiling point is known as azeotropic mixture.

Separation of Mixtures:

a) **Sublimation** : A solid substance passes directly into its vapours.
b) **Sedimentation and decantation:** when one component is liquid and the other is insoluble solid.
c) **Crystallization:** Based on the difference in solubility of the various compounds in a solvent, e.g. mixture of KNO_3 and NaCl can be separated by this process
d) **Filtration:** Removal of solid suspended particles from a liquid.
e) **Evaporation:** the solution is heated so that the solvent vaporizes to give the solute (solid substance)
f) **Distillation:** A mixture of two substances, only one of which is volatile.
g) **Fractional distillation:** Both the components of a mixture are volatile.
h) **Steam distillation:** Used to separate a liquid (should be immiscible with water) from a mixture by heating with steam.
i) **Mechanical separation:** Two immiscible liquids can be separated by using a separatory funnel.
j) **Atmolysis:** A mixture of gases can be separated based on their rates of diffusion.
h) **Chromatography:** most versatile separation method which can be applied to solid, liquid or gas.

ATOM

- Smallest particle of an element which does not always exist independently molecule of hydrogen which exists independently.

Atomicity:

It is the number of atoms present in a molecule of an element.

Molecule:

It is the smallest part of an element or compound that can normally exist separately.

Atomic weight or Atomic mass

The number of times its atom is heavier the ½ th of the mass of carbon atom. Unit atomic mass of hydrogen is 1 amu.

Mole:

- (Or Mol) One mole is equal to the number of atoms present in 12 gram C_{12} i.e., 1 mole = 6.022×10^{23}amu
- Avagadro's number

Equivalent weight

The number of the parts of a substance by weight.

PHYSICAL AND CHEMICAL CHANGES

a) Physical Change:A change of state only and is not accompanied by an alteration in the chemical composition, weight or chemical properties of any substance e.g. melting of ice, magnetizing a needle etc.

b) Chemical Change:A chemical change gives rise to a new substance having composition and properties altogether different from those of the original substances. e.g. radioactive decay, rusting of iron, photosynthesis etc. Energy is absorbed or released during a chemical change.

PHYSICAL AND CHEMICAL PROPERTIES

a) **Physical Properties:** The properties which do not depend on reaction with any other substance. e.g. colour, melting point, boiling point, density etc
b) **Chemical Properties:** The chemical properties of a substance are those that describe its reactions with other substances.

EMPIRICAL FORMULA

Simple whole number ratio between the number of atoms of the different elements forming the compound. e.g. H_2O

MOLECULAR FORMULA

The number of atoms in a molecule of a molecular substance.

COLLOIDS

May be crystalline or non-crystalline. When these are dispersed in a liquid, solid or gas they result in formation of a colloidal system e.g. top soil of earth, protoplasm etc.

a) **Sol:**When a solid is dispersed in a liquid.
b) **Gel:** The liquid contains a colloidal solid.
c) **Aerosol:** When the dispersed colloidal particle is solid.

Smoke: When it is liquid, the result if fog.

d) **Emulsion:** When one liquid is dispersed into another in which it is not soluble e.g., milk, paint etc.

Properties of Colloids

- When the beam of light is passed through a true solution the path of the beam is not visible but when it is passed through a sol its path is visible. This effect is known as Tyndall Effect.

METALLURGY

The production of metal from the ore which generally contains a large percentage of rocky material, called gangue or matrise.

RUSTING

It is caused in iron due to presence of moisture, oxygen, CO_2 in the air. Rusting is prevented by surface coating with film of oil, paint or metal coating such as chromium coating, nickel plating, tin plating and copper plating.

ALLOY

It is a mixture of two or more metals and small amount of non-metals also.

ORES

These are minerals from which metals are produced.

MINERALS

The natural materials extracted from the earth that are formed through geological processes.

ATOMIC STRUCTURE

In 1809, Dalton suggested that atom is the smallest particle of the element and it is indivisible. But in the beginning of 20th century Rutherford. J.J. Thomson etc. suggested that atom is divisible and made up of electrically charged particles.

CHARGE AND MASS OF FUNDAMENTAL SUBATOMIC PARTICLES

Particle	Charge	Mass		Symbol	Discovered by
		Kg	Amu.		
Electron	-1	$9.1093 9x 10^{-31}$	0.000548	e, $-le^0$	J.J. Thomson
Proton	+1	1.672×10^{-27}	1.007276	p, $_1H^1$	Rutherford/Goldstein
Neutron	0	1.674793×10^{-27}	1.008665	n,$_0n^1$	Chadwick

Electron- negative charge – J.J. Thomson.
Proton – positive charge - Rutherford and Goldstein.
Neutron- no charge – Chadwick 1932

Properties of Cathode Rays (-ve)

a) Mechanical motion
b) Are deflected when magnetic field is applied on them
c) cause ionization of gas
d) Produce green fluopresence on the glass, tube
e) Have penetrating power.

Properties of Anode Rays (+ve)

a) Deflect in electric and magnetic field.

Properties of Nucleus (P +ve)

a) The forces that bind the electrons to the nucleus are electrical or coulombic in nature.
b) Density of nucleus is enormous and is of order of 10^{14} g/cm3
c) Instability of the nucleus is due to high neuron proton ratio.
d) The radius of the nucleus is around 5×10^{-13} cm (4 Fermi)

Atomic Number (Z)

Atomic number of an element
= Total no. of protons present in the nucleus no. of protons/electrons.
= Total no. of electrons present outside the nucleus
Or Z = p = e.

Mass Number (A)

- Mass number = number of protons + number of neutrons.
  A = p + n

Representation

Mass Number→ A
Atomic Number→ Z X

Isotopes

Atoms having same atomic number but different atomic masses.

Isobars

Atoms having same atomic mass but different atomic number.

Isomers

Atoms of radioactive elements having same atomic number and same mass number but different radioactive properties.

Isotones

Having same number of neutrons.

$^{14}_{6}C$, $^{15}_{7}N$, $^{16}_{8}O$, etc. No. of neutrons = 8

Isosters

Molecules of different substances which contain the same number of atoms and the same total number of electrons.

Properties of Isotopes

i) Same chemical properties
ii) Different physical properties
iii) Radio active properties can be different
iv) Kept at the same place in the periodic table.

Properties of Isobars

i) Atomic masses are nearly equal
ii) Different chemical and physical properties
iii) Take different places in the periodic table
iv) Different radioactive properties.

Nuclear Stability

- Stability of nucleus depend upon neutron-proton ratio.
- The nuclei of the atoms having atomic number 84 or more than 84 are unstable.

Binding Energy of the Nucleus

- The energy which lessens the effect of repulsive forces of protons in the nucleus is called the binding energy of the nucleus.

DIFFERENCE BETWEEN ORBIT AND ORBITAL

Orbit	Orbital
An orbit is a well definedcircular path around the nucleus in which the electrons move.	An orbital is a three-dimensional space around the nucleus within which the probability of finding an electron is maximum (upto 90%)
All orbits are circular in shape	Different orbitals have different shapes i.e., s-orbitals are spherical, p-orbitals are dumbell shaped etc.
Orbits do not have any directional characteristics	Orbitals except s-orbitals have directional characteristics
The maximum number of electrons present in any orbit is $2n^2$. where n is the number of the orbit.	The maximum number of electrons present in any orbital is two
The concept of an orbit is not in accordance with the wave character of electrons and uncertainty principle.	The concept of an orbital is in accordance with the wave character of electrons and uncertainty principle.

QUANTUM NUMBER

The set of four numbers which give complete information about the electron.

Types of Quantum Numbers

a) Principal Quantum Number (n)
- Gives the major energy level

b) Azimuthal Or Subsidiary Or Angular Momentum Quantum Number (I)
- Gives the energy level of subshells.
- n = 4 (N), l = 0, 1, 2, 3 i.e., four subshells (s,p,d, f)
- Order of energies : s < p < d < f
- It was proposed by Sommerfeld.

c) Magnetic Quantum Number (m)
- Tells the number of orditals present within the same subshell. (2l + 1) values.
- It was given by Lande

d) **Spin Quantum Number (s)**
- Arises due to the spinning of the electron about its own axis. It was introduced by Uhlenbeck and Goudsmet

PAULI'S EXCLUSION PRINCIPLE

- 'No two electrons in an atom can have the same set of four quantum numbers.' 'An orbital can have a maximum two electrons and these must have opposite signs.'

AUFBAU PRINCIPLE

- 'Orbital of lowest energy is filled first, before the filling of orbitals having a higher energy starts.'

Exceptions of Aufbau Principle

The electronic configurations having half-filled or completely filled orbitals are more stable.

HUND'S RULE OF MAXIMUM MULTIPLICITY

'Electron pairing in any orbital (s,p,d,f) cannot take place until each orbital of the same sublevel contains one electron.

HEISENBERG'S UNCERTAINITY PRINCIPLE (1926)

'It is impossible to specify at any given moment both the position and momentum of an electron.' If Δx and Δ p be the uncertainities w.r.t the position and the momentum, then uncertainity principle can be expressed as:

$$\Delta x \,.\Delta p \geq \frac{h}{4\pi}$$

BOHR'S PRINCIPLE

- 'An electron can resolve only in those orbits whose angular momentum (mvr) is an integral multiple of the factor $h/2\pi$'

Bohr-Burry Scheme

- Max. no. of electrons in each shell is $2n^2$.
- Max. no. of electrons in outermost orbit can be 8 and its penultimate orbit can be 18.
- Outermost shell can contain not more than 2 electrons.

PERIODIC TABLE (SEE PAGE NO.18)

Mandeleev's Periodic Law (1869)

The elements are arranged in order of their increasing atomic weights.

Modern Periodic Law by Mosseley - Atomic numbers.

Main features of Modern Periodic Table

a) It has 7 horizontal rows called periods and 16 vertical columns
b) The first period is the shortest period consisting of 2 elements.
c) The second and third periods contain 8 elements, fourth and fifth periods contains 18 elements, sixth period contains 32 elements and seventh period is incomplete with 27 known elements.
d) The elements of second period are known as bridge elements.
e) The elements of I, II, XIII, XIV, XV, XVI, XVII and XVIII groups are collectively known as normal or representative elements.
f) XVIII group are known as inert gases or noble gases.
g) III group to XIII group are known as transition elements.
h) Z = 58 to Z = 71 which occur in periodic table after lanthanum are called lanthanides or lanthanoids. The series of elements with Z = 90 to Z = 103 which occur in the periodic table after actinium are called actinides or actinoids.

s-Block Elements

- I and II groups are s-block elements

Properties:

i) Soft metals
ii) Low ionization
iii) Metallic character
iv) good conductors of heat and electricity.

p-Block Elements

- The XIII to XVIII groups (excluding He have p-blcok elements. The elements of XVII group are known as halogens (salt producers) and that fo XVI group are known as chalcogens (ore-forming)

Properties

- Metallic character

d-Block Elements

- groups III to XII belong to this category.

Properties

- hard , malleable and ductile metals.
- good conductors of heat and electricity
- coloured and paramagnetic
- Most of the transition elements form alloys.

f-Block Elements

- Innter-transition elements.

Properties

- Heavy metals with high m.p and b.p
- Compounds are generally coloured.
- Most of the elements of the actinide series are radioactive.

IMPORTANT TERMS

a) **Metals :**Metals comprise 75% of all known elements and appear on the left hand side of the periodic table.Metals are solids at room temperature except mercury gallium and francium.
b) **Non-metals:** These can be gases, liquids or even solids with low m.p and b.p.
c) **Metalloids:**Show the properties of both metals and non-metals are known as metalloids or semi-metals.
d) **Valency:** Equal to number of valence electrons. The electrons present in outer-most orbit are called valence electrons.'

Which give outermost electrons acquires positive charge and other which take electrons acquire negative charge.
e) **Atomic radius:** The distance between the centre of nucleus and the outer most shell of electrons.
f) **Van der Waal's radius:**Half of the distance between the nuclei of two adjacent atoms belonging to two neighbouring molecules of an element.
g) **Ionisation energy (Ionization potential or Ionization ehtalpy):**The minimum amount of energy required to remove an electron from an atom.

CHEMICAL BONDING – Three types

I. Electrovalent or Ionic Bond

- Transferring of electrons between two atoms.
- Mainly formed between metals and non-metals.

NACL → Na Cl
2,8,1 2,8,7

MgCl2 → Cl Mg Cl
2,8,7 2, 8, 2 2,8,7

Properties of Ionic Compounds

- Compound exist in solid form

II. Covalent Bond

- Equal sharing of electrons between two atoms. This type of bond is mainly formed between non-metals.

III. Co-ordinate or Dative Bond

- Unequal sharing of electrons between two atoms.
- Semipolar bond

Properties of co-ordinate compounds

- insoluble in H2O
- do not conduct electricity

Note: With respect to B.P., M.P., solubility, thermal stability

OXIDATION AND REDUCTION

1. Removal of hydrogen atom – oxidation
   addition of hydrogen atom – reduction
2. addition of oxygen atom – oxidation
   removal of oxygen atom – reduction
3. Increase in valency of an element is oxidation
   decrease in valency of an element is reduction.
4. Addition of an electronegative element is oxidation.
   Removal is reduction.
5. Removal or electropositive element is oxidation and addition is reduction.
6. Loss of electrons is oxidation and gain of electrons is reduction.
7. Increase in oxidation number is oxidation while decrease in oxidation number

Rules for finding oxidation number

1. Oxidation number of element in free state is zero i.e. P_4
2. Oxidation number of hydrogen is +1
3. Oxidation number of oxygen atom is always equal to -2 except.
   a) F_2O(in this compound the oxidation number of oxygen is +2)
   b) The oxidation number of oxygen atom in all peroxides is equal to -1.

Oxidising and Reducing Agents

- Compounds having higher oxidation number will be more acidic and act as oxidizing agent.
- Lower oxidation number will be less acidic and act as reducing agent.
- Compounds with oxygen atom are called oxidizing agent and compounds with hydrogen atom are called reducing agent.

DIFFERENT FORMS OF CARBON ALLOTROPY

Allotropy

- A phenomenon in which an element is found in different forms having different physical properties but similar chemical properties.
- Phosphorus, sulphur, carbon etc. are elements which occur in different allotropic forms.

Carbon

- Classified into crystalline form (diamond, graphite) and amorphous

Crystalline forms of Carbon

1. Diamond: Diamond is the purest form of carbon. It is found very deep inside the earth, in South Africa, Congo, Angola.

Properties

- hardest
- insoluble
- non-conductor of heat and electricity
- occurs as octahedral crystals

Uses

- making jewellery
- cutting hand tools

2. Graphite: Also called as black lead. As compared to diamond, it is widely available in nature in countries like India, Sri Lanka, Canada, Russia etc. It can also be produced artificially by heating anthracite coal with little iron oxide of silica in electric furnace.

Properties

- soft
- good conductor of heat and electricity
- insoluble
- hexagonal crystals

Uses

- writing pencils and lead
- lubricant for high temperature

- electro-typing and manufacturing of gramophone

Amorphous forms of Carbon

3. Coal: Its common variety is bituminous which is like hard stone and burns tiwh smoky flame. The superior quality coal burns without smoke and is called anthracite. It is formed out of carbonization of organic and fossil matter buried deep into the earth, under high pressure and high temperature with very-very limited supply of air, during centuries. Anthracite, Bituminous, Lignite and Peat are the types of coal with decreasing C%

Uses:

- fuel
- coal gas.
- Coal-tar is a source for making dyes, explosiyes, chemicals etc.

4. **Coke:**It is a coal deprived of volatile constituents such as coal gas , ammonia, benzene, phenol, tar etc. It is manufactured from coal by destructive distillation.

Uses:

- making graphite and water gas.
- reducing agent in iron and steel industry.

5. **Wood charcoal:**

Uses:

- a fuel
- constituent of gun-powder.
- purification of water
- deodorant and

6.**Bone black or Animal charcoal:** bones

7.**Lampblack:** when tar or vegetable oil

Uses:

- making Indian ink
- Making printer ink
- ladies for eyelids decoration.

8. **Carbon Black:** obtained by burning natural gas in the presence of limited supply of air

Uses:

- In the rubber for making automobile tyres.

9. **Gas carbon and Petroleum coke:**

- Petroleum mainly contains – automatic hydrocarbon.

Uses:

- Indane gas – Butane + Propane

10. **Sugar charcoal:** The poorest form of carbon.

- it can be converted into a solid state, known as dry ice which is used as a mobile refrigerant.

11. **Carbon-14**

- usefulradio active isotope for tracer studies in organic and bio chemical system, including the determination of the age of materials that were once alive.

Important Elements and Compounds

Hydrogen

- lightest known substance (gas). found in water (H_2O) and all living things.
- Can be produced in the laboratory by Bosch process and by electrolysis.

Oxygen

- It is colourless, tasteless, odourless, combustible slightly heavier than air, some what soluble in water. Atmospheric air contains oxygen by about 21% by weight.

Nitrogen

- non-combustible in active non poisonous gas forming about 80% of the atmospheric air by volume and 75% by weight.

Ozone O3

- It is an allotropic form of oxygen containing three atoms in the molecule and is formed when oxygen or air is subjected to silent electric charge.very active chemically and a powerful oxidizing agent.
- In the upper atmosphere some 25 to 30 km from the earth's surface, called ozonosphere layer. absorbs a large proportion of the sun's ultraviolet radiation.

Carbon

- It is universal constituent of living matter. Two forms: Allotropic form and amorphous form.
- Atoms are capable of uniting with each other

Diamond

- very costly stone and hardest. It is transparent to x-rays only.

Graphite

- It is soft, easily powdered and gives a greasy feeling. It is good conductor of heat and electricity. Also used as a moderator in nuclear reactors.

Coal

- carbonization

Hydrocarbons

- compounds of hydrogen and carbon viz. found abundantly in nature viz., petroleum, natural gas and coal etc. From these natural

hydrocarbons or parent organic compounds many other.

Petroleum
- Hydrocarbon compound

Noble gases
- gaseous elements and are also known as rare gases.
- Helium, neon, argon, krypton, xenon and radon.
- Radon of course, is not present in the atmosphere. It is produced in the radioactive decay of radium.

Halogens:
- Halogens are the four elements fluorine, chlorine , bromine and iodine. Fluorine and chlorine are gases,l bromine is violatile liquid and iodine is a volatile solid. Halogens are highly reactive.

Chlorine
- Used in drinking water supply as germicide.
- Manufacturing bleaching powder, disinfectants, hydrochloric acid

Sulphur
- Non metallic element.
- Vulcanising rubber, manufacturing of dyes and chemicals

Phosphorus
- It is necessary for life. White phosphorus is very inflammable and poisonous solid. Its compounds are employed as fertilizers and detergents.

Silicon
- non-metal, found abundantly in earth's crust and sand.

Alkalies
- Bases soluble in water are called alkalies viz. Turn red litmus blue and yellow turmeric powder

Uranium
- Its main ore is pitchblende. It is a radioactive metal, occurring in nature, comprising of 99.28% ($^{238}_{92}U$) and 71% ($^{238}_{92}U$)has the capacity of substaining a nuclear chain reaction and is used in nuclear reactors and nuclear weapons.

Thorium
- dark grey radio active metal used in alloys and as a source of nuclear energy. Its compounds occur in monazite and thorite.

Plutonium
- It is a transuranic element (element having atomic number more than 92) which do not occur in nature but may be obtained by nuclear reaction. It is radio active.

Iron
- It is extracted from its ores by the blast furnace process. Iron obtained from blast furnace is called pig iron or cast iron containing about 5% carbon. Pure iron is called wrought iron which does not contain carbon more than 0.2%, or any other impurities or constituents.

Copper
- It is a metal element, malleable, ductile and best conductor of electricity after silver.

Zinc
- It is a metal element, bluish white in colour. It occurs as calamine, zincite and zince blende.

Aluminium
- It is metal element, light white in colour, occurring widely in nature in clays, extracted mainly from ore: bauxite.

Silver
- It is a metal element, soft, white malleable, best conductor of electricity.

Gold
- It is a metal element, bright yellow, soft, malleable, non-corrodible by air and unaffected by most acids, but dissolves in aqua regia. It is alloyed with silver and copper. It is the best conductor of electricity.

Potassium
- It is a metal used extensively in the form of various salts which are further used as fertilizers. It is a necessary for life and is found in all living matter.

Calcium
- It occurs in nature in the form of calcium sulphate (gypsum) and calcium carbonate (lime stone, marble and chalk). Calcium is an essential constituent of bones and teeth.

Magnesium

- It occurs as magnesite, dolomite, carnallite as well as in many compounds.

Mercury

- It is a silver white, liquid form metal, widely used in thermometers. It is a very heavy metal.

WATER

- Of the total global water, the oceans and inland saline water bodies hold 97.3% and the fresh water amounts to only 2.7%
- 65% our our body

Note:

- Water has maximum density (1g) at 4° C
- M.P. is 273.2 K and B.P. is 373.2 K

HEAVY WATER

- deuterium oxide (D_2O)
- discovered by Urey
- use in nuclear reactors as a moderator because it slows the fast moving neutrons.

Properties of water

- The freezing point, boiling point, heat of fusion and heat of vaporization of water are higher as compared to the hydrides of the other memebers of same group of oxygen.

HARD AND SOFT WATER

- Water which produces lather with soap solution readily is called soft water e.g. Rain-water, demineralized water.
- Water which does not produce lather with soap solution readily is called hard water e.g. Sea-water, river water, well water, tap-water.

Cause of hardness of water

- Due to presence of the bicarbonates, chlorides and sulphates of calcium and magnesium.

TYPES OF HARDNESS OF WATER

A) **Temporary hardness**

- presence of bicarbonates of calcium and magnesium. It can be removed by boiling.

B) **Permanent hardness**

- Presence of bicarbonates of calcium and magnesium.

SOFTENING OF WATER

- The process of removal of hardness from water is called softening of water
- Water is treated with calculated amount of washing soda ($Na_2 CO_2$)

Iron exchange method:

A) **Inorganic cation exchanges:** Permutit method. These complex salts are known as 'Zeolites'.

B) **Organic ion exchanges:** ion exchange.

Note: Mass of 1 mole of D2O and T2O are 20 gm and 22gm respectively.

CEMENT

PORTLAND CEMENT

The approximate composition of Portland cement is:

1. Cal. oxide → 62%
2. Silica → 22%
3. Alumina → 7.5%
4. Magnesia → 2.5%
5. Ferric oxide → 2.5%

The above compounds are provided by the two raw materials:

1. lime stone CaCo3 2. Clay

GLASS

- solid mixture of silica (SiO2), sodium silicate (Na2 SiO3) and calcium silicate (CaSiO3)
- no definite crystal structure and melting point.
- Na2O.Cao.6 SiO2 – a mixture not a compound.

Annealing of Glass

- process of slowly cooling of glass in annealing kiln.

TYPES O GLASS

1. **Soft-glass** – Na2O.Cao.6SiO2
2. **Hard –glass** – K2O.CaO. 6SiO2
3. **Flint-glass** – K2O. PbO.6SiO2
4. **Crookes-glass** –Containing circum oxide which cut off ultra violet rays harmful to eyes and used in manufacturing of lens of spectales.
5. **Pyrex-glass** –mixture of sodium aluminum borosilicates. It has high percentage of silica, about 80%. It does not melt at very high temperature.
6. **Quartz-glass** – It is obtained from pure silica.
7. **Ground glass**–It is prepared by grinding ordinary sand (soft) glass by emery and turpentine oil.
8. **Reinforced glass** – It has network of wires embedded in and does not shatter easily.
9. **Safety –glass**–It is also known as shatter proof glass. It is prepared by placing a layer of transparent plastic glass (usually a sheet of vinyl acetate resin) between two layers of glass by means of a suitable adhesive.

DYES

- used for colouring textiles, foodstuffs, silk, wool, etc. are called dyes. But all coloured substances are not dyes.
- It should absorb light in the visible region.

Nitro dyes: These are polynitro derivatives of phenol.

ORES OF METALS

Aluminium (Al) a) Bauxite – $Al_2O_3 . 2H_2O$
b) Corundum – Al_2O_3
c) Kryolite – Na_3AlF_6

Iron (Fe) a) Haematite - Fe_2O_3
b) Magnetite - Fe_3O_4
c) Iron Pyrite - FeS_2
d) Siderite - $FeCO_3$

Zinc (Zn) a) Zinc Blende - ZnS
b) Calamine - $ZnCO_3$

Lead (Pb) a) Galena PbS

Manganese (Mn) a) Pyrolesite
Rock salt Nacl
Mohr's salt $FeSO_4(NH_4)_2 SO_4 . 6H_2O$
Basic Salt $NaHCo_3$ / PbCoH NO_3
Complex salt $K_4 Fe (CN)_6$ [coordination salt]
Epsom salt $MgSO_4 . 7H_2O$

Mercury(Hg) a) Cinnabar HgS
Magnesium(Mg) a) Dolomite $MgCO_3 . CaCO_3$

COMMON AND CHEMICALS NAMES OF SOME COMPOUNDS

Common Name	Chemical Name	Chemical Formula
Dry Ice	Solid Carbon di oxoide	CO_2
Bleaching Powder	Calcium Oxychloride	$CaOCl_2$
Caustic Soda	Sodium Hydroxide	NaOH
Rock Salt	Sodium Chloride	NaCl
Caustic Potash	Potassium Hydroxide	KOH
Epsom salt	Magnesium Sulphate	$MgSO_4. 7H_2O$
Quick Lime	Calcium Oxide	CaO
Mohr's salt	Ammonium Ferrous Sulphate	$FeSO_4 (NH_4)_2 SO_4.6H_2O$
Blue Vitriol	Copper Sulphate	$CuSO_4. 5 H_2O$
White Vitriol	Zinc Sulphte	$ZnSO_4. 7H_2O$
Vinegar	Acetic Acid	$CH_3 COOH$
Baking Powder	Sodium Bicarbonate	$NaH CO_3$
Washing Soda	Sodium carbonate	$Na_2CO_3. 10H_2O$
Chalk (Marble)	Calcium Carbonate	$CaCO_3$
Lunar Caustic	Silver Nitrate	$AgNO_3$
Laughing Gas	Nitrous Oxide	N_2O
Chloroform	Tricholoro Methane	$CHCl_3$
Tartaremetic	Potassium antimonyl tartrate	
Phenol	Carbolic Acid	
Alcohol	Ethyl Alcohol	C_2H_5OH

EXTRA DOSE

IMPORTANT CHEMICAL PROCESSES

1. Bessemer process: converting pig iron to steel by blowing.

2. Clemmensenreduction :to convert aldehydes and ketones to the corresponding hydrocarbons.

3. Gatterman reaction: convert an aromatic amine into the corresponding halogen.

4. Haber process: Producing ammonia

5. Kolbe reaction: preparation of saturated or unsaturated hydrocarbons by the electrolysis.

6. Solvay process:process of shaking sodium carbonate from calcium carbonate and sodium chloride.

7. Bayer process: Used to extract aluminium oxide $Al_2 O_3$ or aluminium by treating powdered bauxite with hot caustic soda solution.

8. Bergius process:making lubricants and synthetic fuel.

9. Bosch process:used to make industrial hydrogen by passing steam over white-hot coke to produce water gas.

10. Down process: making sodium metal by electrolysis of molten sodium chloride.

11. Frasch process: It is used to extract sulphur from subterranean deposits in which superheated water.

12. Hall-Heroult process (Hall-Heroult): Prepare aluminium by electrolysis.

13.Parkesprocess:extraction of silver traces fom lead are galena Molten zinc.

IMPORTANT GENERAL CHEMICAL TEST

1. Brown-ring testfor chemical analysis of nitrates.

2. Flame testto identify certain elements in which a clean platinum. Using a busen flame.detected by the change in the colour of flame.

3. Beilstein's testis used for the detection of halogen in an organic compound.

4. Fehling's testused to detect sugars and aldehydes in a solution.

5. Kjedahlmethodis used to measure nitrogen in an organic compound.
6. Molish's testis used to detect carbohydrates in a solution.
7. Rast's method: Used to determine molecular weight.
8. Schiff's test: Used to distinguish between aldehydes and ketones.

REACTIONS AND THEIR RESULTS
Reactions –Phosphorous kept in water
Result – with air it catches fire and in water it is insoluble.

Reactions – milk curdle
Result – Lactose (milk sugar) content of milk undergoes fermentation and changes into lactic acid which on reacting with lactose forms curd.

SOME CHEMICAL CHANGES
Hydrolysis :double decomposition reaction in which water reacts with a second substance.
Neutralisation reactions: The interaction of an acid with an equivalent quantity of a base.

Electrolysis
- The process of decomposition of an electrolyte (a compound formed by electrovalent bonds) by the passage of an electric current through its molten state or its aqueous solution.

Application of Electrolysis
i) Electroplating: is a process of depositing one metal over another metal for preservation of decoration.
ii) Electrorefining: Metals can be refined (purified)
iii) Electroprinting : Is made on wax of plaster of Paris.
iv) Electrometallurgy: process of extraction of metal from its ore.
v) Industrial Preparations:A large number of chemicals used in industry and medicine are prepared electrolytically.

RADIOACTIVITY
- Naturally occurring heavy elements like radium, actinium, uranium, thorium etc, with the emission of alpha, beta and gamma rays.

Discovery of Radioactivity
- Discovered in 1896 by French physicist Henry de Becquerel.

Radioactive Emissions
i) Sub-atomic Particles (Radiation)
a) Alpha (α) particles : very little penetrating power.
b) Beta (β) particles: penetrating power is greater than that of alpha-ray.
ii) Penetrating Particles (Radiation)
Also called Gamma(γ) emission. These are electromagnetic radiations of low wavelength, high frequency and high energy.

NUCLEAR REACTION AND ATOMIC ENERGY
Nuclear Reaction
- first nuclear reaction – Rutherford
- nuclear fission – Otto Hahn and F steersman
- Nuclear model of atom – Rutherford
- Empirical atomic model – J.J. Thomson
- Elliptical orbits of electrons is an atom – Sommerfield.
- Hydrogen atom model – Bohr.

Radioactivity
- It was discovered by Henry Becquerel but term radio activity wasgivenMadam Curie. It is the process of spontaneous process of spontaneous disintegration of nucleus and is measured by Geiger counter.
- It is a nuclear phenomenon, thus remains unaffected by external factors like temperature, pressure etc.
- It involves emission of α, β and γ rays/ particles and has units Curie, Becquerel, Rutherford.

Alpha (α)-particles
- These are positively charged helium nuclei $(_2He^4)^{2+}$. They have +2 unit charge and 4u mass.
- They have low penetrating power but very high ionizing power and kinetic energy.
- Anα-emission reduces the atomic mass by 4 and atomic number by 2, thus, the new nuclei formed occupy a position two places left to the parent nuclei in the Periodic Table. (Soddy Fajans group displacement law)

Beta (β)-particle
- These are negatively charged electrons (-1e0) and have -1 unit charge and 0 mass.
- These are more dangerous than α-rays.
- These have high penetrating power as compared to α-rays.
- A β-emission the atomic number by one with no change in atomic mass, occupy a position one place right to the partent nuclei in the Periodic Table (Soddy Fajans group displacement law).

Gamma (γ)- rays

- These are electromagnetic radiation and have very high penetrating power.
- These have low, ionizing power and kinetic energy.
- Their emission does not affect the position of nuclei in the Periodic Table.

Nuclear Fission

- It is a process in which a heavy nucleus is broken down into two or more medium heavy fragments.
- It is usually accompanied with the emission of neutrons and large amount of energy. It is used innuclear reactor and atom bomb.

Nuclear reactor

- It is a device that is used to produce electricity and permits a controlled chain nuclear fission.
- It contains fules e.g., $_{92}U^{235}$, moderator (e.g. graphite and heavy water, D_2O)to slow down neutrons and control rods (made up of boron steel or cadmium) to absorb neutrons.
- It may also contain liquid sodium as coolant.

Half-life Period

- It is the time in which a radioactive substance remains half of its original amount.

Atom Bomb

- It is based on uncontrolled nuclear fission. It contains ^{235}U or ^{239}Pu as fuel.

Nuclear Fusion

- It is a process which involves fusion of two or more lighter nuclei to give a heavier nuclei.
- It occurs only at extremely high temperature ($> 10^6$ K), so also called thermonuclear reactions.
- It is used in hydrogen bomb. Energy of Sun is also a result of a series of nuclear fusion reactions.

Hydrogen Bomb

- It containsa mixture of deuterium oxide (D_2O) and tritium oxide (T_2O) in a space surrounding an ordinary atom bomb.

Uses of Radioisotopes

- Iodine-131 is employed to study the structure and activity of thyroid gland. It is also used in internal radiation therapy for the treatment of thyroid disease.
- Iodine-123 is used in brain imaging.
- Cobalt-60 is used in external radiation therapy for the treatment of cancer.
- Sodium-24 is injected along with salt solution to trace the flow of blood.
- Phosphorus-32 is used for leukemia therapy.
- Carbon-14 is used to study the kinetics of photosynthesis.

Radiocarbon Dating

- It is used in determining the age of carbon bearing materials such as wood, animal fossils etc.
- It is based on the concentration of C^{12} and C^{14} isotopes.

Uranium Dating

- It is used to determine the age of earth, minerals and rocks.

Types of Chemical Reactions

- Chemical reactions are of following types.

1. Addition reactions

- In such reactions, two or more substances combine to give a single substance, e.g.,

$$CaO + H_2O \rightarrow Ca(OH)_2$$

Calcium Oxide + water → calcium hydroxide

2. Substitution reactions

In such reactions, an atom or a group of atoms of a molecule is replaced by another atom or group of atoms e.g.,

$$CuSO_4 + Fe \rightarrow FeSO_4 + Cu$$

Copper sulphate + Fe → Ferrous Sulphate + Cu

3. Decomposition reactions

- These are those irreversible reactions in which, a molecule decompose into two or more simpler molecules e.g.,

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

Potassium Chlorate → potassium chloride + oxygen

4. Dissociation reactions

- These are those reversible reactions in which a molecule dissociates into two or more simple molecules e.g.,

$$2HI \rightarrow H2 + I2$$

Hydrogen iodide → Hydrogen + iodine

Reversible reactionsare those which occurs in forward as well as in Backward direction but never go to completion.

Irreversible reactionsoccur only in forward direction and go to completion.

5. Double decomposition reactions

- These involve exchange of ions between two compounds.e.g. ,
  $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
- Reactions occurring between the ions or ionic compounds are very fast.

6. Exothermic reactions

- These are those reactions in which energy is released, e.g. burning of natural gas, respiration, decomposition of vegetable matter into compost, combustion reactions etc.

7. Endothermic reactions

- These are those in which energy is consumed, e.g., digestion.

Catalysis

- It was discovered by Berzelius.
- It is a term, used for the reactions/ processes which occur in the presence of certain substances that increase the rate of the reaction without being consumed. Such substances are called catalysts.
- Catalysis is called homogeneous when reactants and catalyst are in same phase e.g., for the manufacture of sulphuric acid.
  $SO_2(g) + O_2(g) \xrightarrow{NO(g)} SO_3(g)$
- Catalysis is called heterogeneous when reactants and catalyst are in different phase e.g., Haber process for the synthesis of ammonia.
  $N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$
- Catalysis is called autocatalysis, when one of the product increases the rate of the reaction i.e., acts as catalyst e.g.,
  $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$

Acid, Bases and Salts

- These are the substance, which have sour taste and turn blue litmus red.
- These are the substance which gives H+ ions in their aqueous solution (Arrhenius concept) e.g., HCl or which gives proton (Bronsted Lowry concepts) e.g., CH_3COOH or which accepts electrons (Lewis concepts) e.g. BF_3, $AlCl_3$, Na^+, K^+, PF_3, SF_4, PF_5 etc.
- Acids give hydrogen with more reactive metals, e.g.,
  $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
  Metal acid salthydrogen
- Acids give carbon dioxide gas (CO_2) with carbonates e.g.,
  $CaCO_3 + H_2SO_4 \rightarrow CaSO_4$
  Marble or calcium sulphuric
  Carbonate acid $+ H_2O + CO_2\uparrow$
- These in aqueous solution are conductor of electricity.

Sources of Some Important Acids

Acid	Source
Citric acid	Lemon, organge, grapes
Maleic acid	Unripe apple
Tartaric acid	Tamarind
Acetic acid	Vinegar
Lactic acid	Milk
Hydrochloric acid	Stomach
Oxalic acid	Tomato

- Acid – $H^+ \rightarrow$ conjugate base
- Base + $H^+ \rightarrow$ conjugate acid
- Generally most of the acids contain hydrogen.
- Pickles are always kept in glass jar because acid present in them reacts with the metal of metallic point.
- Basicity represents the number of replaceable H-atoms.e.g., it is 1 for HCl, 2 for H_2SO_4.

Uses of Some Acids

1. **Hydrochloric acid (HCl)**It is present in gastric juices and is responsible for the digestion. It is used as bathroom cleaner, as pickling agent, tanning of leather, in dying and in the manufacture of gelatin from bones.

2. Nitric Acid (HNO_3) It is used for the manufacture of fertilizers like NH_4NO_3; explosive like TNT, picric acid, dynamite etc. rayon, dyes and drugs.

3. Sulphuric acid (H_2SO_4)It is also known as oil of vitriol and is used in manufacture of fertilizers, drugs, detergents and explosives.

4. Acetic acid (CH_3COOH) is used in vinegar, medicines and as a solvent.

Bases

- These are the substances, which have bitter taste and turn red litmus blue.
- Bases give OH^- ion in their aqueous solution (Arrhenius concept) e.g., NaOH, KOH, CsOH; Mg(OH)2 etc., or accept proton (Bronsted-Lowry concept) e.g., NH_3, H_2O etc., or donate electrons (Lewis concept) e.g., simple anions like Cl^-, F^-, OH^-, molecules with unshared (lone) pairs of electrons like NH_3, ROH, R_2O, pyridine etc.

Indicators

- These are the substances which give different colours in acid and base solutions.

- Some indicators and their colours in acid and base medium are
- Water soluble bases are called alkali e.g., NaOH, KOH.
- Basicity is the number of replacable OH-, ions. E.g., It is 1 for NaOH, 2 for $Ca(OH)_2$

pH Value

- It is a measure of acidity or basicity of a solution.
- It is defined as the negative logarithm of the concentration in (mol/L) of hydrogen ions which it contains, i.e.,
  $pH = -\log [H^+] = \log\frac{1}{[H^+]}$
  or $[H^+] = 1 \times 10^{-pH}$
- It is 7 for neutral solution, greater than 7 for basic solution and less than 7 for acidic solution.
- pH of some common substances are

Substance	pH	Substance	pH
Gastric juice	1.0 – 3.0	Rain water	6.0
Soft drinks	2.0 – 4.0	Tears	7.4
Lemon	2.2 – 2.4	Sea water	8.5
Vinegar	2.4 – 3.4	Milk of magnesia	10.5
Urine (human)	4.8 – 8.4	Milk (cow)	6.3-6.6
Saliva(human)	6.5 – 7.5	Blood plasma (human)	7.39 – 7.42

Salts

These are the product of neutralization reaction between an acid and a base e.g.,

$HNO_3 (aq) + KOH (aq) \rightarrow KNO_3(aq) + H_2O(l)$
Acid base salt water
These are of the following types:

1. Mixed Salt

- These are obtained by neutralization of an acid by two baseor a base by two acids. E.g., bleaching powder (CaOCl2)

2. Double Salt

- It is obtained by mixing two or more salt, e.g.,
  Alum ($K_2SO_4\ Al_2\ (SO_4)_3\ 24H_2O$),
  Mohr salt
  ($FeSO_4(NH_4)_2SO_46H_2O$)

Washing Soda

It is chemically sodium carbonate decahydrate ($Na_2CO_3.10H_2O$),and is used in glass, soap and paper industries and for removing permanent hardness of water.

Baking Soda

- It is sodium hydrogen carbonate ($NaHCO_3$). It is a mild non-corrosive base.
- When mixed with a mild edible acid such as tartaric acid it is called baking powder and is used to make bread or cake soft and spongy.
- It is used as mild antiseptic for skin infections, in soda-acids and as fire extinguishers.

Bleaching Powder

- It is chemically Ca(OCl) Cl or $CaoCl_2$.
- It is used for bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories.
- It is used for disinfecting drinking water.

Plaster of Paris

- It is chemically calcium sulphate hemihydrates $\left(CaSO_4\frac{1}{2}H_2O\right)$ and obtained by heatinggypsum$(CaSO_42H_2O)$. It contains half molecule of water of crystallization.

Periodic properties

- Periodic properties are those which show a regular trend along a period and a group.

1. Atomic size

- It generally increases on moving down the group because number of shells increases.
- It decreases along a period from left to right. Thus, size of alkali metal is largest and that of halogens is smallest in a period.

2. Valency

- It is the combining capacity of an element.
- It increases from 1 to 7 along a period with respect to hydrogen whereas with respect ot oxygen, it first increases from 1 to 4 and then decreases to 0.
- It remains the same in a group.

3. Metallic character

- It is the tendency of an element to form cationby the loss of electrons.
- It decreases along a period from left to right and increases in a group on moving downwards.

4. Ionisation energy

- It is the energy required to remove an electron from the outermost shell of an isolated gases atom.
- It generally increases along a period from left to right but ionization energy of Be, Mg, Ca, Sr is larger than the ionization energy of

N, P, is larger than ionization energy of O, S, Se respectively.
- It generally decreases along a group on moving downwards.

5. Electron affinity (EA)
- It is defined as the energy liberated when an extra electron is added to an atom.
- It increases across a period from left to right, but EA of II(2), 15 group and 0 group is 0 or positive.
- It decrease on moving down a group. It is highest for chlorine.

6. Electronegativity
- It is the tendency of an atom in a molecule to attract the shared electrons towardsitself. It increases regularly along a period from left to right and decreases on moving down a group.
- It is highest for fluorine.

Metals, Non-Metals and Metallurgy

Metals
- These are the elements which are hard, lustrous, ductile, malleable, sonorous and conductor of heat and electricity in their solid as well as molten state.
- These form oxide with air. These oxides are generally basic, but oxides of zinc and aluminiumare amphoteric, i.e., have acidic as well as basic properties.
- These evolve hydrogen gas when reacts with water and acids.
- Metals which are highly reactive displace the less reactive metals from their salts. The order of reactivity is, potassium (K)> sodium (Na) >calcium (Ca) > magnesium (Mg) >aluminium (Al) > zinc (Zn) > iron (Fe) > lead (Pb) > hydrogen (H)> copper (Cu)> mercury (Hg) > silver (Ag)> gold (Au) (Thus, gold is less reactive metal)

Non-metals
- These may be solid, liquidor gas (bromine is the only liquid non-metal)
- These are soft, non-lustrous, brittle, non-sonorous and non-conductor of heat and electricity.
- These have low melting and boiling points.
- These form oxides with oxygen which are generally acidic.
- Their examples include noble gases (i.e., helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and some other p-block elements.

1. Helium
- It is a noble gas (discovered by Lockyear and Janssen)
- It is used for filling balloons and other lighter aircraft.
- He, when mixed with O_2, is used by deep-sea divers for breathing and for respiratory patients.
- It is used as a heat transfer agent in gas cooled nuclear reactors.

2. Neon
- It was discovered by Ramsay and Travers. It is used in neon signs.

3. Argon
- It was discovered by Rayleigh and Ramsay.
- It is used to generate inert atmosphere for welding and to fill incandescent light bulbs.

4. Xenon
- It is called stranger gas.
- Xe, when mixed with Kr, used in high intensity, short exposure photographic flash tubes.

Metalloids

These have properties of metals as well as non-metals. They are present only in p-block e.g., arsenic, antimony, germanium etc.

Metallurgy
- It is the process of extraction of metal from its ores.

It involves the following sequence of steps:

1. Minerals
- These are the substances in the form of which metal is found in nature.
- The main constituent of pearl is calcium carbonate ($CaCO_3$)
- Ruby and sapphire are chemically aluminium oxide Al_2O_3.
- In haemoglobin and myoglobin, iron is present as Fe^{2+}

2. Ores
- These are the minerals from which metal can be obtained conveniently and beneficially.
- All ores are minerals but all minerals are not ores.

3. Gangue or Matrix
- These are the impurities associated with the ore.

4. Calcination
- It is the process of heating the concentrated ore in absence or in limited supply of air,

below its melting point. It is done for hydroxide or carbonate ore.
- It is done in reverberatory furnace.

5. Roasting
- It is the process of heating the concentrated ore in excess of air.
- It is used for sulphideores.
- It is done in reverberatory furnace.

6. Flux
- These are the substances which converts infusible impurities into fusible substances, called slag. These are of two types: Acidic flux such as SiO_2(used to remove basic impurities) and basic flux such as CaO, MgO (used to remove acidic impurities)
- In electrolytic refining, anode is made up of impure metal and cathode is made by, thin strip of pure metal.

7. Smelting
- It is the process of heating the oxides of elements with cock and flux above their melting point.

Corrosion
- It is the process of oxidative deterioration of a metal surface by the action of environment to form unwanted corrosion products.
- e.g., conversion of iron into rust [$Fe_2O_3.x H_2O$, tarnishing of silver](due to the formation of Ag_2S), development of green coating [of $Cu(OH)_2CuCO_3$ basic copper carbonate)] on copper and bronze. It is basically an electrochemical process.
- Corrosion of iron is called rusting. It is accelerated by the present of impurities, H^+, electrolytes such as NaCl, gases such as CO_2, SO_2, NO, NO_2 etc.

Formation of a layerof aluminium oxide over aluminiumsurface protects the metal from further corrosion.

A sliced apple turns brown if kept open for some time due to the oxidation of iron present in the apple.

It is prevented by the following methods,
- By electroplating
- By surface coating (i.e., coating of surface with oil, grease, paint and varnish).
- By alloying
- By galvanization of iron (process of deposition of a thin layer of zinc over iron surface)

Alloys
- These are mixture of two metals or a metal and a non-metal. They have properties different from the main metal.
- Alloys of mercury are called amalgam.

Aqua-regia
- It is a mixture of concentrated hydrochloric acid HCl and concentrated nitric acid (HNO_3) in the ratio of 3 : 1. It is used to dissolve noble metals like gold and platinum.

Uses of some important metals and non-metals

1. Ferrous oxide (FeO)is used to prepare ferrous salts and green glass.
2. Ferric oxide (Fe_2O_3) is used in jeweler rough.
3. Silver nitrate ($AgNO_3$) is called lunar caustic and is used to prepare the ink used during noting.
4. Silver iodide (AgI)is used for artificial rain.
5. Mercuric chloride ($HgCl_2$) is used to prepare calomel and as a poision.
6. Hydrogen peroxide (H_2O_2)is used as a oxidizing agent, bleaching agent, as a insecticide, and for washing old oil paintings.

Coal and Petroleum

Natural resources
- These are given by nature like air, water, mineral, sunlight etc.

There are of two types:

1. Renewable natural resources
- These are available in excess amount i.e., never end. E.g., air, sunlight etc.

2. Non-renewable natural resources
- These are available in limited quantity e.g., minerals, coal, petroleum, natural gas, etc.

Coal
- It is believed to have been formed by the slow carbonization of vegetable matter buried underneath the earth centuries ago, in limited supply of air under high temperature and pressure prevailing there.
- It is available in different varities: Peat (60% C), lignite or brown coal (70% C), bituminous coal (80% C), anthracite coal (90% C).
- Bituminous is the most common variety of coal
- Coal is used for the synthesis of water gas and producer gas.

Charcoal
- It can be wood charcoal, animal charcoal, and activated charcoal depending upon the source from which it is obtained. Wood

charcoal absorbs colouringmatter and odoriferous gases, thus used in decolourisingsugar solutions and in gas masks.

Lamp black or carbon black

- It is the most pure amorphous form of carbon (contain about 98-99% carbon)
- It is used for making printer ink, black paint, varnishes and carbon papers.

Petroleum

- It is a dark coloured oily liquid with offensive odour. It is also called rock oil, mineral oil, crude oil or black gold.
- When subjected to fractional distillation, it gives different products at different temperatures.

Liquified Petroleum gas (LPG)

- It is a mixture of n-butane, iso-butane and some propane.
- It is easily compressed under pressure as liquid and stored in iron cylinders.

Compressed natural gas (CNG)

- It consists mainly of methane (95%) which is a relatively unreactive hydrocarbon and makes its nearly complete combustion possible.
- It has octane rating 130

Octane number

- Octanenumber is the percentage of iso-octane in the mixture of iso-octane and n-heptane which has same knocking properties as thefuel sample.
- It is a measure of quality of petrol (gasoline). It is zero for heptanes and 100 for iso-octane. (i.e., 2, 2, 4-trimethyl pantane).
- **Higher the octane number, better is the fuel.**

Antiknock compounds

- These are used to reduce the knocking property. E.g., tetraethyl lead (TEL).

Cetane number

- Centane number is the percentage of cetane in the mixture of centane and
- A-methyl naphthalene which has same knocking properties as the fuel sample.
- It is a measure of quality of diesel. It is 100 for Cetane and 0 for α-methyl naphthalene.

Fuels and Flame

Fuels

- These are the substance which produce heat and light on combustion.
- Some important gaseous fuels and their compositions are as follows.

Fuel	Composition	Sources
Water gas	Carbon monoxide (CO) + hydrogen (H_2)	By passing steam over red hot coke
Producer gas	Carbon monoxide (CO) + nitrogen (N_2)	By passing insufficient air over red hot coke
Oil gas	Methane (CH_4) + ethylene (C_2H_4) + acetylene (C_2H_2)	By destructive distillation of kerosene
Coal gas	Hydrogen (H_2) + methane (CH_4) + ethylene + acetylene + CO	By fractional distillation of wood
Natural gas	Methane(83%) + ethane	From petroleum
LPG	Butane (C_4H_{10}) + propane (C_3H_8)	From oil wells
Biogas or Gobar gas	Methane (CH_4) + carbon dioxide (CO_2) + hydrogen (H_2) + nitrogen (N_2)	From organic wastes

Calorific Value

- It is defined as the heat obtained when 1 g of a fuel is burned in excess of oxygen and is expressed in kcal/g.
- Calorific value of some important fuels are

Fuel	Calorific value (kJ/g)
Coal	25-32
Kerosene oil	48
Petrol	50
Diesel	45
Bio-gas	35-40
LPG	50
Wood	17
Cow dung	6-8
Ethanol	30
Methane	55
Hydrogen	150
Natural gas	35-150

- **Hydrogen**is the fuel of future.
- Alcohol, when mixed with petrol, is called power alcohol. It is an alternative source of energy.
- For the combustion of a substance, its ignition temperature should be low.

Flame

- It is the hot part of fire and has three parts:

1. Innermost region of flame

- It is black because of the presence of unburned carbon particles.
- It has the lowest temperatures.

2. Middle region

- It is yellow luminous due to partial combustion of fuel.

3. Outermost region

- It is blue (non-luminous) due to complete combustion of fuel.
- It is the hottest part of flame and is used by the Goldsmith to heat the gold.
- **Water** is a common fire extinguisher.
- In case of electric fires and oil fires water cannot be used as an extinguisher as it is a conductor of electricity and oil being lighter comes above the water. Such fires are extinguished by carbon di oxide.

Safety match

- Safety match stick contains a mixture of antimony trisulphide and potassium chlorate at its one end. Its box side contains a mixture of powdered glass and red phosphorus.

Electrochemistry

Electrolysis

It is used

i. In production of oxygen for space craft and nuclear submarines.
ii. In layering metals to fortify them
iii. In production of hydrogen for fuel.
iv. In electrolytic etching of metal surfaces like tools or knives with a permanent mark or logo.

Electrometallurgyis the process of reduction of metallic compound into pure metal by electrolysis.

Anodisationis an electrolytic process that makes the surface of metals resistant to corrosion.

- Electrolysis of brine (the water, saturated or nearly saturated with salt, usually sodium chloride) gives hydrogen and chlorine. The products are gaseous

$2NaCl + 2\ H_2O \rightarrow 2\ NaOH + H_2 + Cl_2$

Faraday's Laws of Electrolysis

First law of electrolysis

- It states that the quantity of elements separated by passing an electric current through a molten or dissolved salt is proportional to the quantity of electrich charge passed through the circuit.

  $w \propto Q$

  $w = ZQ = Z\ it$ (charge = current x time)

Second law of electrolysis

- It states that the mass of the resulting separated elements is directly proportional to the atomic masses of the elements when an appropriate integral divisor is applied.

  $w \propto E$ or $\frac{W_1}{W_2} = \frac{E_1}{E_2}$

Electrochemical Cell

- It is a device that produces an electric current from energy released by a spontaneous redox reaction (in short which converts chemical energy into electrical energy). This kind of cell includes the galvanic cell or voltaic cell.
- It has two conductive electrodes, i.e., anode (at which oxidation occurs) and cathode (at which reduction occurs)
- It contains electrolyte in between the electrodes, which contains ions that can move freely.

Battery

- It is an arrangement of one or more cells connected in series.
- It is basically a galvanic cell.
- These are of two types.

i. Primary batteries (non-rechargeable) e.g., dry cell, mercury cell etc.
ii. Secondary batteries (rechargeable) e.g., lead storage battery, nickel cadmium battery.

Lechlanche Cell or Dry Cell

- It consists of a zinc container that acts as anode and carbon (graphite) rod surrounded by powdered manganese di oxide and carbon which acts as cathode.
- It contains a paste of NH_4Cl and $ZnCl_2$ in between the electrodes.
- It is used in transistors and clocks.
- It has a potential of really 1.5 V.

Mercury Cell

- It is suitable for the low current devices like hearing aids and camera etc.
- It consists of zinc-mercury amalgam as anode and a paste of HgOand carbon as cathode. The electrolyte is a paste of KOH and ZnO.
- It has potential 1.35 V. This potential remains constant during its whole life.

Lead Storage Battery

- It is a secondary battery.
- It acts as electrochemical cell during discharging (i.e., during use)and as electrolytic cell during charging.
- It is used in automobiles and invertors.
- It consists of lead anode and a grid of lead packed with lead di oxide (PbO_2) as cathode. A 38% solution of sulphuric acid is used as an electrolyte.
- It consists of a series of six identical cells assembled in series. Each cell may produce a potential of 2 V, hence overall voltage produced is 12 V.
- $PbSo_4$ is formed when lead storage battery is in use and lead di oxideare formed when it is charged.

Fuel cells

- These are galvanic cells which use energy of combustion of fuels like hydrogen (H_2), methane (CH_4), methanol (CH_3OH) etc., as the source to produce electrical energy. E.g., hydrogen-0xygen fuel cell.

Air, Water and their Pollution

Air

- It is a homogeneous mixture of different gases.
- It has the following composition: 78% nitrogen ; 21% oxygen, 0.03-0.05% carbon dioxide (CO_2), argon etc.
- It has different density at different heights from sea level. Thus, several layers are formed. These layers are

1. Troposphere

- It is the lowest layer of atmosphere, extend up to a height of 10 km from sea level.
- It is a turbulent and dusty zone which contains air (N_2, O_2, CO_2)much water vapours and clouds.

2. Stratosphere

It is the layer which contains ozone layer (which protects us from harmful UV rays coming from the Sun), so called ozonosphere.

- **Temperature of mesosphere** decreases with height and reaches to – 100°C. That's why when any meteors enter in mesosphere, it burns up.
- In thermosphere, although the temperature can rise to 1500°C, a person would not feel warm because of the extreme low pressure.
- The international space stations orbit is also in thermosphere.
- It extends up to 10-50 km above sea level.
- Mesosphere , thermosphere and exosphere are the other layers of atmosphere.

Oxygen (O_2)

- It was discovered by K. Scheele.
- It is obtained during photosynthesis .
- It is colourless, odourless, neutral gas which gets absorbed over alkaline pyrogallol.
- It is non-combustible but helps in combustion. It form oxides with metals and non-metals.
- It is used for artificial respiration and in oxy-hydrogen flame, oxygen-ethylene flame and oxygen acetylene flame (used for welding and as a rocket fuel)

Ozone (O_3)

- It is an allotrope of oxygen.
- It is used as insecticide, in purification of water to preserve food, to synthesis artificial silk and camphor and as a bleaching agent.

Nitrogen (N_2)

- It was discovered by Rutherford (in 1771)
- It is a colourless, odourless, non-combustible, non-poisonous gas.
- It is neutral and lighter than air.
- It is filled in sealed packets and bulbs to create inert atmosphere.
- Living being die in an environment of nitrogen.
- Soil Containsseveral pores filled with air. At the time of raining these pores get filled with water. That's why earthworm come at the surface to breath.

Carbon dioxide (CO_2)

- It is used by plants for photosynthesis.
- It is 1.5 times heavier than water.
- It turns the lime water milky which disappears in the excess of CO2 due to conversion of milky calcium carbonate ($CaCO_3$) into soluble calcium bicarbonate.
- It is used to extinguish fire and for artificial respiration when mixed with oxygen (carbogen)
- It is dangerous to have charcoal fire burning in a closed room because it produces carbon monoxide gas, which is suffocating.
- Plants respire at night and give out CO_2 which reduces oxygen content of air required for breathing, so it is dangerous to sleep under trees at night.
- ENO produces effervescence if dissolved in water due to evolution of CO_2 gas.

Water

- It containstwo elements: hydrogen and oxygen (H_2O). It constituteabout 70% part of earth.
- It is a universal solvent and maintains the body temperature due to its high specific heat.
- It has boiling point 100°C and freezing point 0°C . Its density is maximum at 4°C.

Soft Water

Soft water easily lather with soap.

Hard Water

It does not lather with soap.

It is of two types

1. Temporary Hard Water

- It contains bicarbonate of calcium and magnesium.
- It is converted into soft water by boiling or by adding calculated quantity of calcium hydroxide. (Clark's process)

2. Permanent Hard Water

- It contains sulphates and chlorides of calcium and magnesium.
- It is converted into soft water by adding sodium carbonate (Na_2CO_3), or calgon or zeolite

Heavy Water

- It is deuterium oxide, D_2O. (molecular mass 20)
- It is used as a moderator in nuclear reactors, in the study of mechanisms of chemical reactions involving hydrogen and its compounds etc.

Pollutants

These are the substance that contaminate the environment and of two types.

1. Primary Pollutants

- These persist in the environment in the form, they are formed example sulphur dioxide (SO_2), nitrogen di oxide (NO_2) etc.

2. Secondary Pollutants

- These are the products of reaction of primary pollutants e.g., PAN, ozone (O_3), aldehyde etc.
- The order of different pollutants to cause pollution is carbon monoxide (CO), SO_2>hydrocarbon >particulates >nitrogen oxides.

Green House Effect

- It is the heating of earth and its objects because of the trapping of IR radiations by carbon di oxide (CO_2), methane (CH_4), NO, ozone (O_3), chloro-fluorocarbons and water vapours.

Global Warming

- It is a result of of increased concentration of green houses gases.
- It may result in melting of ice caps and glaciers, spreading of several infectious diseases like malaria, sleeping sickness etc.

Acid Rain(By Robert Augus)

- It has pH less than 5. It is due to oxides of nitrogen and sulphur.
- It damages the buildings and other structures made up of limestone as marble, corrodes metal pipes, results in several diseases.
- pH of normal rain water is 5.6

Particulates

- These are minute solid particles and liquid droplets dispersed in air. E.g. mists, dusts, smoke, fumes etc.

Diseases	Cause
Pneumoconiosis	Due to inhalation of coal dust
Silicosis	Due to inhalation of free silica
Black lung disease	Found in workers of coal mines
White lung disease	Found in textile workers
Byssinosis	Due to inhalation of cotton fibre dust

Smog

- It is a consequence of particulate pollution and is of two types.

1. Classical Smog

- It is also called London type smog.
- It is reducing in nature.
- It is formed in cool humid climate when carbon soot particles combine with gaseous oxides of sulphur.

2. Photochemical Smog

- It is also called Los Angeles smog
- It occurs in warm, dry and sunny climate by the action of sunlight on unsaturated hydrocarbons and nitrogen oxide.
- It is oxidizing in nature.
- Troposphere Pollution Presence of undesirdlesolid or gaseous particles in the air. Gaseous air pollutants are S, Nand C, H_2S, hydrocarbons ozone and other oxidants particulate pollutants are dust, mist, furmes smoke, smog etc.

Stratospheric Pollution

- Stratospheric pollution means depletion of ozone layer (ozone hole) by certain compounds like chlorofluorocarbons (CFCs), oxides of nitrogen (which are released into upper atmosphere from engines of supersonic transport planes).
- CCl_4, halons and methyl chloroform also deplet ozone layer.
- Depletion of ozone layer can cause skin cancer, sunburn, ageing of skin, cataract or even blindness and increase in evaporation of surface water.

Water Pollution

- It is due to the presence of foreign substances like sewage, algae, soluble salts etc., in water.
- It can also be due to metals. These causes following diseases

Mercury	Minamata disease
Chromium & arsenic	Cancer
Cadmium	Itai-itai disease
Mercury	Minamatodisease

- For a healthy aquatic life, dissolved oxygen (DO) is 5-6 ppm.
- For clean water BOD (bio chemical oxygen demand) is less than 5 ppm while for highly polluted water, it is 17 ppm or more.

Soil Pollution

It is alteration in soil. It is caused by pesticides like insecticides (e.g. DDT, BHC etc), herbicides (e.g. sodium chlorate and sodium arsenate), fungicides (e.g., organomercurycompounds):

Carbon and Its Compounds

Carbon

It is a member of group 14 in the Periodic Table, with symbol C and atomic number 6.

It has three crystalline allotropes.

1. Graphite

- It is opaque and black.
- It is a very good conductor.
- It is soft enough to form a streak on paper.

Diamond

- It is highly transparent.
- It is the hardest materials known.
- It has a very low electrical conductivity.
- Under normal conditions, it has the highest thermal conductivity of all known materials.

Fullerenes

- It (C_{60}) looks like a soccer ball (or bucky ball)
- It contains 20 six membered and 12 five membered rings of carbon atoms.
- It acts as wonderful lubricant and the alkali metal compounds of C_{60} are used as superconducting substance at the temperature range of 10-40K.

Other Difference between Diamond and Graphite

Diamond	Graphite
Diamond is the ultimate abrasive	Graphite is a very good lubricant, displaying super lubricity
Diamond is an excellent electrical insulator	Graphite is a conductor of electricity.
Diamond is the best known naturally occurring thermal conductor	Some forms of graphite are used for thermal insulation (i.e., firebreaks and heat shields)
Diamond is highly transparent	Graphite is opaque

Graphene

- Graphene is an allotrope of carbon. Its structure isone-atom-thick planar sheets of carbon atoms that are densely packed in a honeycomb crystal lattice. The term grapheme was coined as aa combination of graphite and the suffixene by Hanns-Peter Boehm, who described single-layer carbon foils in 1962.

Carbon Monoxide (CO)

- It is formed by incomplete combustion. It is a colourless, odourless gas.
- It contain a triple bond and are fairly polar, resulting in a tendency to bind permanently to heamoglobinmolecules, displacing oxygen, which has a lower binding affinity.

Organic Compounds

- These are the compounds of mainly carbon and hydrogen or compounds of carbon and hydrogen with other elements like phosphorus, oxygen, nitrogen, sulphur, halogens etc.
- Urea is the first synthesized organic compound (by wholer)
- Acetic acid was the first organic compound synthesized in the laboratory from its elements.

Hydrocarbons

- These are the compounds of only carbon and hydrogen.

These are of three types:

1. Saturated Hydrocarbons

- These compounds contain only single bonds. These are also called alkanes or paraffins and have general formula $C_n H_{2n+2}$ where, n = 1, 2, 3 .....
- Methane is the first member of this group.

2. Unsaturated Hydrocarbons

- These have general formula C_nH_{2n} for alkene and $C_n H_{2n-2}$for alkynes.
- These have at least one double (==) or triple (≡) bond, and are called alkene and alkynes respectively.
- Ethylene (C_2H_4) is the first member of alkene and acetylene (C_2H_2) is the first member of alkyne.

3. Aromatic Hydrocarbons

- These have ring structure with alternate double bonds and (4n + 2) π e- (Huckle's rule)
- **Benzene** is the first member of aromatic hydrocarbons.

Functional Group

- It is an atom or group of atoms in a molecule, which is responsible for the chemical properties of the molecules.
- -OH is alcoholic group, -CHO is aldehyde group, >C=O is keto group, -COOH is carboxylic acid group, -o- ether group.

Homologous Series

- It is a series of compounds in which adjacent members differ by a $-CH_2$ unit (14 unit mass)
- All members of a homologous series have same functional group and same chemical properties.

Isomerism

- Compounds having the same molecular formula but different structure are called isomers and the phenomenon is called isomerism. E.g., C_2H_6O can have the following structure CH_3OCH_3 and C_2H_5OH.

Uses of Some Important Organic Compounds

- **Methane (CH_4)** is used to manufacture printer ink, methyl alcohol and to obtain light and energy.
- **Ethylene (C_2H_4)** is used to prepare mustard gas (war gas) and for ripening of fruits.
- **Glycol ($C_2H_6O_2$)**is used as a antifreeze mixture in car radiator and to prevent the freezing of fuel in space crafts.
- **Acetylene (C_2H_2)** is used to generate light, to weld metals as oxy-acetylene flame and to prepare synthetic rubber (neoprene)
- **Methyl alcohol (CH_3OH)** is used as a fuel with petrol, used to synthesise varnish and polish, used to denature ethanol
- **Chloroform ($CHCl_3$)** is used as an aneasthetic and to preserve substances obtained from plants and animals. It converts into poisonous phosgene ($COCl_2$), when exposed to sunlight. So, it is kept in dark bottles.
- **Glycerene ($C_3H_8O_3$)**is used to synthesis explosive nitroglycerine, stamp ink and boot polish.
- **Formic acid (HCOOH)** is used as a preservative for fruits and juices, in leather industry and in coagulation of rubber.
- **Acetic acid (CH_3COOH)**is used in vinegar, medicines, and as a solvent.
- **Oxalic acid ($C_2H_2O_4$)** is used in printing of clothes, in photography and in the synthesis of coaltar.
- **Glucose ($C_6H_{12}O_6$)**is used for the synthesis of alcohol and as a preservative for fruit juice.
- **Benzene (C_6H_6)** is used as a solvent for oil fat and in dry cleaning. Sodium benzoate is a food preservative.
- **Toluene ($C_6H_5CH_3$)**is used to synthesis explosive TNT, for dry cleaning and for the synthesis of medicines like chloramine.
- **Phenol (C_6H_5OH)**is used to synthesis explosive, 2, 4, 6-trinitrophenol (picric acid) and Bakelite.
- **Ethyl alcohol (C_2H_5OH)**is used for drinking, in medicine to prepare tincture and as insecticide. And as a fuel with petrol.

MAN MAN MATERIALS

Soaps

These are sodium and potassium salts of higher fatty acids. E.g., sodium palmitate, sodium stearateetc.

Detergents

- These are sodium or potassium salts of long chain alkyl or aryl sulphonates or sulphates e.g., sodium alkyl sulphonate, sodium alkyl benzene sulphonate, etc.
- These are also called soapless soap.
- Detergents lather with hard water.
- Detergents cause pollution but straight chain alkyl group containing detergents are biodegradable and do not cause pollution.
- The cationic detergents are used as fabric softeners and germicides while non-ionic

detergents are used as liquid dish washing detergents.

Fertilizers

- These substances increase the fertility of soil by providing elements essential for the growth of plants like nitrogen, phosphorus and potassium. E.g., basic calcium nitrate[CaO. $Ca(NO_3)_2$], ammonium sulphate [$(NH_4)_2SO_4$]. These two increases the acidity of soil. Which is removed by adding lime.
- Other examples are calcium cyanamide or nitrolim($CaCN_2$), Urea or carbonate (it does noteffect the pH of soil), calcium super phosphate or super phosphate of lime [$Ca(H_2PO_4)_2 + 2CaSO_4.2H_2O$]

Glass

- It is an amorphous or transparent solid, also called supercooled liquid.
- It contain mainly silica (SiO_2)

Different Substance give Different Colour to Glass

Colour	Substance added
Red	Copper oxide
Green	Chromium oxide
Violet	Manganese oxide
Blue	Cobal oxide
Brown	Iron oxide

It can be of the following types

1. Soda or soft glass is sodium calcium silicate ($Na_2O.CaO.6SiO_2$). It is the ordinary glass and used for making bottles, window panes etc.

2. Potash glass or hard glasscontains potassium (from $K2CO_3$). It has higher softening temperature. It is used for chemical apparatus: beakers, flasks, funnel etc.

3. Crown glasscontains potassium oxide (K_2O), barium oxide (BaO), boric oxide (B_2O_3) and silica (SiO_2). It is used for optical apparatus.

4. Flint glasscontains lead oxide (PbO) and used in optical instruments like lenses, prisms.

5. Crook's glasscontains cesium oxides. It is used for spectacles as it absorbs UV rays.

6. Jena glasscontains B_2O_3 and alumina. It is stronger and more resistant to acids and alkalies, that's why used for making laboratory bottles, for keeping acids and alkalies.

7. Milky glassis prepared by adding tin oxide (SnO_2), calcium phosphate [$(Ca_3 (PO_4)_2$] or cryolite ($Na_3 AlF_6$) to the melt glass

8. Glass laminates is made by fixing polymer sheets between layers of glass. It is used to make windows and screens of cars, trains and aircraft. Specially manufactured glass laminates are used as bulletproof material.

Cement or Portland Cement

- It is a complex material containing the silicates and aluminates of calcium with small amount of gypsum.
- It has the following composition calcium oxide (CaO)= 50-60%, silica (SiO_2) = 20-25%, alumina (Al_2O_3) = 5-10%; magnesium oxide (MgO) = 2-3%
- It is manufactured from limestone and clay.
- Cement if contains excess lime, cracks during setting and if lime is less, cement is of weak strength.
- Gypsum decreases the rate of setting of cement.
- A paste of sand, cement and water is called mortar and is used for joining bricks and plastering walls.
- A mixture of stone chips (gravel), sand, cement and water is known as concrete and is used for flooring and making roads.
- Concrete with steel bars and wires is called reinforced concrete (RC) and is used for constructing roofs, bridges and pillars.

Medicines

- These are the chemicals used for treating diseases and reducing suffering from pain.
- These are classified as

Analgesics are used to reduce pain. E.g., aspirin, paracetamol, morphine etc.

Antipyreticsis used to reduce body temperature during high fever, e.g., paracetamol, aspirin, phenacetin,analgin, novalgin.

Tranquilizers are used to treat stress, mild and severe mental disease. These are also called psychotherapeutic drugs. E.g., equanil, valium, veronal, serotonin, chlorodiazepoxide, meprobamate etc.

Antisepticprevent the growth of microorganisms or kill them but are not harmful to living tissues. E.g., dettolsavlon, iodine tincture, boric acid, hydrogen per oxide etc.

Antibiotics are obtained from microorganisms and used to destroy the other microorganisms e.g.,

penicillin, ampicilin, amoxycilin (all are narrow spectrum), ofloxacin, tetracycline, chloramplinol (all are broad spectrum). Penicillin was discovered A. Fleming in 1929.

- **Antimalarial**are used to treat malaria. E.g. chlorquin
- **Sulpha drugs** are alternatives of antibiotics, e.g., sulphanilamide, sulphadiazine etc.
- **Antacids** are used as a remedy for acidity. E.g., magnesium hydroxide, sodium bicarbonate (baking soda) etc.
- **Pesticides** are used to destroy the organisms that harm the crop.

These are of the following types.

1. Insecticidese.g., DDT, aluminium phosphate, gammexane.

2. Fungicidee.g., bordeux mixture

3. Herbicidese.g., benzipam, benzadox

4. Rodenticidese.g. aluminium phosphide.

Plastics

These are cross-like polymers (a substance having high molecular weight and repeating unit) and are very tough.

- Lac is a natural plastic (polymer)
- Polymers are made up of monomers

There are of two types.

1. Thermoplastics are the polymers which can be easily softens on heating e.g., polythene, polystyrene, polyvinyl chloride, Teflon etc.

2. Thermosetting plasticsare the polymers which undergo permanent change on heating due to excessive cross-linking. These cannot be reused, e.g., Bakelite.

Some important Polymers and their Monomers

Polymer	Monomers
Polyethylene	Ethylene
Polystyrene	styrene
Polyvinyl chloride (PVC)	Vinyl chloride
Polytetrafluoroethylene (PTFE) or Teflon	Tetrafluoroethane
Bakelite	Formaldehyde + phenol
Urea formaldehyde resin	Urea + formaldehyde
Melmac	Melamine + formaldehyde

Fibres

These have strong intermolecular forces like hydrogen bonding e.g., nylon-66, Dacron, orlont etc.

Natural rubber

- It is an elastomer. It is a polymer of cis-isoprene e.g., it is cis-polyisoprene. Synthetic rubber (neoprene) is a polymer of chloropene.
- It is insoluble in water, dilute acids and alkalies, absorbs a large amount of water and has low tensile strength and elasticity.
- It is heated with sulphur compounds at 373K in the presence of ZnO to improve these properties. This process is called vulcanization of rubber.
- If vulcanized with 5% S, it is used for making tyres and if with 30% sulphur, it is used in making battery cases.

Explosives

Some examples of explosives are trinitrotoluene (TNT), nitroglycerine or trinitroglycerine, cyclotrimethylenetrinitroamine (RDX, also called cyclonite).

1 **H** Hydrogen 1.00794																	2 He Helium 4.003
3 **Li** Lithium 6.941	4 **Be**Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 **Na** Sodium 22.989770	12 **Mg** Magnesium 24.3050	Transition Elements							13 **Al** Aluminium 26.981538	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.973761	16 **S** 32.066	17 **Cl**Chlorine 35.4527	18 **Ar**Argon 39.948			
19 **K** Potassium 39.0983	20 **Ca** Calcium 40.078	21**Sc** Scandium 44.955910	22 **Ti** Titanium 47.867	23 **V** 5.9415	24 **Cr** Chromium 51.9961	25 **Mn**Manganese 54.938	26 **Fe** Iron 55.845	27 **Co** Cobalt 58.933200	28 Ni 58.6934	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga**Gallium 69.723	32 **Ge**Germanium 72.61	33 **As** 74.92160	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** Krypton 83.80
37 **Rb**Rabidium 85.4678	38 **Sr**Stromium 87.62	39 **Y** Yitrium 88.90585	40 **Zr** 91.224	41 **Nb**92.90638	42 **Mo** Molybedum 95.94	43 **Tc** (98)	44 **Ru**101.07	45 **Rh** Rhodium 102.90550	46 **Pd**106.42	47 **Ag** Silver 107.8682	48 **Cd** Cadmium 112.411	49 **In** 114.818	50 **Sn** Tin 118.710	51 **Sb** 121.760	52 **Te**127.60	53 **I** Iodine 126.90447	54**Xe**Xenon 131.29
55 **Cs** Cesium 132.90545	56 **Ba** Barium 137.327	57 **La** 138.9055	72 **Hf** 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.84	75 **Re** 186.207	76 **Os**190.23	77**Ir**192.217	78 **Pt**Platinum 195.078	79 **Au** Gold 196.96655	80 **Hg** Mercury 200.59	81 **Tl**Thallium 204.3833	82 **Pb**Lead 207.2	83 **Bi** 208.98038	84 **Po** (209)	85 **At** (210)	86 **Rn**Radon (222)
87 **Fr** Franciu m (223)	88 **Ra** Radium (226)	89 **Ac** Actiniu m (227)	104 **Rf**Rutherfordum (261)	105 **Db**(262)	106 **Sg**(263)	107 **Bh**Borium (262)	108 **Hs**Hassium (265)	109 **Mt** (266)	110 (269)	111 (272)	112 (277)	113	114				

Inner Transition elements	58 **Ce**140.116	59**Pr**140.90765	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	71 **Lu** 174.967
	90 **Th** 232.0381	91 **Pa** 231.03588	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)	101 **Md**(258)	102 **No** (258)	103 **Lr** (262)