PHYSICS

Physics- It is scientific study of matter and energy and the effect that they have on each other.

MECHANICS

Physical Quantity – Quantities expressed in terms of laws of physics are called Physical Quantities.

There are two types of Physical quantities. They are:

(i) Scalars – The physical quantities which has only magnitude and does not depend on direction is called Scalar quantities. For e.g. length, volume, speed, mass, density, temperature etc.

(ii) Vectors – Vector quantities has both magnitude and direction. For e.g. Displacement, velocity, Acceleration, Momentum etc.

NOTE: A physical quantity which has both magnitude and direction but doesn't obey vector law of addition or subtraction is not a vector quantity. For e.g. Electric current, pressure, work etc.

Unit of measurement – A quantity which is used as a standard of measurement is called Unit of measurement.

There are usually two types of units –

(i) Fundamental unit – All those units which are independent of any other unit are called Fundamental units.

There are seven fundamental units. They are:

Fundamental Unit	S I Unit	Symbol
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	k
Amount of substance	Mole	mol
Electric Current	Ampere	A
Luminuous Intensity	Candela	Cd

(ii) Derived Units – All those units which are expressed in terms of two or more fundamental units is called Derived Units. For e.g. velocity (m/s), Acceleration, Force etc.

Dimensions of Physical Quantities – The dimensions of a physical quantity are expressed in terms of powers of Fundamental quantities. For e.g. Velocity = L/T = [LT-1] = [M0LT-1].

KINEMATICS

Kinematics: -

Kinematics is branch of mechanics which deals with the study of motion of the objects without taking into account the cause of their motion.

Rest and Motion: -

An object is said to be at rest if it does not change its position which respect to its surroundings with time and said to be in motion if it changes its position with respect to its surrounding with time.

- **Rectilinear motion** moving car on horizontal road, motion under gravity etc.
- **Angular motion** such as particle going on a circle, projectile motion, rotation of machine shaft etc.
- **Rotational motion** such as motion of a fan.
- If an object travels equal distances in equal intervals of time, then it is said to be in **uniform motion.**
- If an object travels unequal distances in equal intervals of time, then it is said to be in **non-uniform motion.**

Speed

The distance covered by a moving body in a unit time interval is called its speed.

Speed = Distance travelled / Time taken

When a body travels equal distances with **speed $v1$ and$v2$**, then **average speed** is the **harmonic mean** of the two speeds.

$2/v = 1/v1 + 1/v2$

$v = (2v1v2) / (v1+v2)$

When a body travels for equal times with **speeds $v1$ and $v2$**, then **average speed** is the **arithmetic mean** of the two speeds.

$v = (v1+v2) / 2$

Acceleration

The time rate of change of velocity of a body is called its acceleration.

Acceleration = Change in velocity / Time taken

It is a vector quantity and its SI unit is $ms-2$.

Acceleration at an instant of time is known as **instantaneous acceleration**.

When the velocity of a body increases with time, then its acceleration is positive and if velocity decreases with time, then its acceleration is negative called **deceleration or retardation.**

If acceleration does not change with time, it is said to be constant acceleration.

Equations of Uniformly Accelerated Motion (Along straight line)

If a body started its motion with **initial velocity 'u'** and attains **final velocity 'v'** in the **interval 't'**. The **acceleration** assumed to be uniform in motion is **'a'** and the **distance** travelled is 's', then equations of motion:

$v = u + at$

$s = ut + 1/2 (at2)$

$v2 = u2 + 2as$

- If a body is falling freely under gravity, then **'a'** is replaced by **'g'** in above equations.
- If an object is thrown vertically upward, then in above equations of motion a is replaced by (–g).
- For a body with zero acceleration or constant speed, graph between velocity and time will be a line parallel to time axis.
- Velocity–Time Graph For accelerating or decelerating body the graph will be a straight line inclined to time axis and velocity axis.
- Graph between positions (distance) - time for an accelerating or decelerating body is always a parabola.
- Acceleration-time graph for uniformly accelerating body is a line parallel to time axis.

- In case of uniform accelerated, the graph between position and velocity is always parabola.
- In case of uniformly accelerated motion, the graph between velocity and time is always a straight line.
- Slope of displacement-time graph gives velocity and slope of velocity-time graph gives acceleration.

Projectile Motion

- When a body is thrown from horizontal making an angle (θ) except 90°, then its motion under gravity is a curved parabolic path, called trajectory and its motion is called projectile motion.
- Examples:
- The motion of a bullet shot from the gun
- The motion of a rocket after burn-out
- The motion of a bomb dropped from an aero plane etc.

Properties of Projectile Motion

If we drop a ball from a height and at the same time thrown another ball in a horizontal direction, then both the balls would strike the earth simultaneously at different places.

Circular Motion

The motion of an object along a circular path is called circular motion.

Circular motion with a constant speed is called **uniform circular motion**.

The direction of motion at any point in circular motion is given by the tangent to the circle at that point.

In uniform circular motion, the velocity and acceleration both changes.

In case of non-uniform circular motion, the speed changes from point to point on the circular track.

Angular Displacement – Angular displacement of a body is the angle in radians through which body revolves. It is represented by θ. its S.I. unit is radian.

Angular Velocity – If a body describes an angular displacement in a particular time period, than rate of velocity s known as Angular velocity. It is represented by ω. $\omega = \theta/t$.

Projectile Motion – If a body is projected upward with a certain velocity, then the body describes a path called trajectory path which is parabolic and the motion is known as Projectile motion. A projectile motion is influenced by downward force of gravity.

Centripetal Acceleration

During circular motion an acceleration acts on the body towards the center, called centripetal acceleration.

The direction of centripetal acceleration is always towards the center of the circular path.

Force

It is an external push or pull with can change or tries to change the state of rest or of uniform motion. SI unit is newton (N) and CGS unit is dyne. 1 N = 105 dyne.

If sum of all the forces acting on a body is zero, then body is said to be in equilibrium.

Centripetal Force

During circular motion a force always acts on the body towards the centre of the circular path, called centripetal force.

$F=mv2/r=m\omega 2r.$

Centrifugal Force

In circular motion we experience that a force is acting on us in opposite to the direction of centripetal force called centrifugal force. This is an apparent force or imaginary force and also called a pseudo force.

Applications of centripetal and centrifugal forces

Cyclist inclined itself from vertical to obtain required centripetal force. To take a safe turn cyclist slower down his speed and moves on a path of larger radius.

Roads are banked at turns to provide required centripetal force for taking a turn.

For taking turn on a curved road, the **frictional force** is acting between the tyres of the vehicle and the road acts as centripetal force.

If a bucket containing water is revolved fast in a vertical plane, the water may not fall even when bucket is completely inverted because a centrifugal force equal or greater than the weight of water pushes the water to the bottom of the bucket.

For orbital motion of electrons around the nucleus **electrostatic force** of attraction is acting between the electrons and the nucleus as centripetal force.

Cream is separated from milk when it is rotated in a vessel about the same axis. During rotation lighter particles of cream experience a lesser force than the heavier particles of milk.

For revolution of the earth around the sun, gravitational force of attraction between the earth and the sun acts as centripetal force.

Newton's Laws of Motion:

Newton's First Law

A body continues in its state of rest or of uniform motion in a straight line unless an external force acts on it. It is based on **law of inertia**.

Inertia is the property of a body by virtue of which is opposes any change in its state of rest or of uniform motion in a straight line.

Inertia of Rest

- When a bus or train at rest starts, to move suddenly, the passengers sitting in it jerk in backward direction due to their inertia of rest.
- The dust particles come out from a carpet when it is beaten with a stick due to their inertia of rest.
- A passenger jumping out from a rapidly moving bus or train is advised to jump in forward direction and run forward for a short mile due to inertia of rest.

Inertia of Motion

When a running bus or train stops suddenly, the passengers sitting in it jerk in forward direction due to inertia of motion

Momentum

The momentum of a moving body is equal to the product of its mass and its velocity.

Conservation of Linear Momentum

The linear momentum of a system of particles remains conserved if the external force acting on the system is zero.

- Rocket propulsion and engine of jet aero plane works on principle of conservation of linear momentum. In rocket, ejecting gas exerts a forward force which helps in accelerating the rocket upward.

Newton's Second Law

The rate of change of momentum of a body is directly proportional to the force applied on it and change in momentum takes place in the direction of applied force.

$F = \Delta p / \Delta t = m\Delta v / \Delta t = ma$

Newton's Third Law

For every action, there is an equal and opposite reaction and both act on two interacting objects.

Rocket is propelled by the principle of Newton's third law of motion.

Impulse

- A large force which acts on a body for a very short interval of time and produces a large change in its momentum is called an impulsive force.
- Its unit is newton-second.
- A fielder lowers its hand when catching a cricket ball because by lowering his hands, he increases the time of contact for stopping the ball and therefore fielder has to apply lesser force to stop the ball. The ball will also exert lesser force on the hands of the fielder and the fielder will not get hurt.
- Wagons of a train are provided with the buffers to increase the time of impact during jerks and therefore, decreases the damage. The vehicles like scooter, car, bus, truck etc. are provided with shockers.

Friction

Friction is a force which opposes the relative motion of the two bodies when one body actually moves or tries to move over the surface of another body.

The cause of friction is the strong atomic or molecular forces of attraction acting on the two surfaces at the point of actual contact.

Uses of Friction

- A ball bearing is a type of rolling-element that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and to support loads (weight).
- Friction is necessary for walking, to apply brakes in vehicles, for holding nuts and bolts in a machinery etc.
- Friction can be decreases by polishing the surfaces by using lubricants or by using ball bearings.
- Tyres are made of synthetic rubber because its coefficient or friction with road is larger and therefore, large force of friction acts on it, which stops sliding at turns.
- The tyres are threading which also increases the friction between the tyres and the road.
- When pedal is applied to a bicycle, the force of friction on rear wheel is in forward direction and on front wheel is in the backward direction.

Loses due to Friction

Too much Loss of Energy in machines and then ultimately the machines are damaged.

Machine

- **Lever** - It is a simple machine in which a straight or inclined rod is made to turn or rotate at a point freely or independently. There are three points related to lever namely load, effort and fulcrum.
- **Load** - The weight carried by the lever is called load.
- **Effort** - To operate lever, the force applied externally is called effort.
- **Fulcrum** - The fixed point about which the rod of lever moves independently is called fulcrum.

OSCILLATIONS AND WAVES

Periodic Motion

- A motion which repeats itself identically after a fixed interval of time, is called a periodic motion. For example –
    - Motion of arms of a clock, orbital motion of the earth around the sun, motion of a simple pendulum etc.

Oscillatory Motion

- A periodic motion taking place to and fro or back and forth about a fixed point is called oscillatory motion. For example –
    - Motion of a simple pendulum.
    - Motion of a loaded spring etc.
- If a particle oscillates with its own natural frequency without help of any external periodic force. The oscillation is then called damped oscillation.
- When a body oscillates with the help of an external periodic force with a frequency different from natural frequency of the body, then oscillation is called forced oscillation.

Simple Harmonic Motion (SHM)

- An oscillatory motion of constant amplitude and of single frequency under a restoring force whose magnitude is proportional to the displacement and always acts towards mean position, is called Simple Harmonic Motion.

Characteristics of SHM

When a particle executing SHM passes through the mean position:

1. No force acts on the particle.
2. Acceleration of the particle is zero.
3. Velocity is maximum.
4. Kinetic energy is maximum.
5. Potential energy is zero.

When a particle executing SHM is at the extreme end, then:

1. Acceleration of the particle is maximum.

2. Restoring force acting on particle is maximum.
3. Velocity of particle is zero.
4. Kinetic energy of particle is zero.
5. Potential energy is maximum.

Simple Pendulum

- A heavy point mass suspended from a rigid support by means of an elastic inextensible string, is called a simple pendulum.
- Time period of a simple pendulum is given by $T = 2\pi(\sqrt{l/g})$
- The time period of a simple pendulum of infinite length is 84.6 min. The time period of a second's pendulum is 2 s. Its length on the earth is nearly 100 cm.
- Acceleration due to gravity decreases with altitude (height) and therefore time period of a pendulum clock will increase and clock becomes slow.
- If the bob of a simple pendulum is suspended from a metallic wire, then the length of the pendulum increases with increase in temperature and therefore its time period also increases.
- A girl is swinging over a swing. If she stands up over the swing, then the effective length of the swing decreases and therefore, the time period of oscillations decreases.
- A pendulum clock cannot be used in a space- ship.
- Damped Harmonic Motion
- When there is friction or any other force acting within an oscillating system, the amplitudes of the oscillation decreases over time to this damping force. This is called damped harmonic motion.

Resonant Oscillations

When a body oscillates with its own natural frequency (V0) with the help of an external periodic force also called forced harmonic motion. And if the frequency (v) provided by the external agent is equal to the natural frequency of the body, the oscillations of the body are called resonant oscillations.

Wave

A wave is a disturbance which propagates energy from one place to the other without the transport of matter.

Waves are broadly of two types:

1. Mechanical Wave
2. Non-mechanical wave

Mechanical Wave: The waves which required material medium (solid, liquid or gas) for their propagation are called mechanical wave or elastic wave. Mechanical waves are of two types.

- Longitudinal wave: If the particles of the medium vibrate in the direction of propagation of wave, the wave is called longitudinal wave.

- Transverse Wave: If the particles of the medium vibrate perpendicular to the direction of propagation of wave, the wave is called transverse wave.

Waves on strings under tension, waves on the surface of water are examples of transverse waves.

Non-mechanical waves or electromagnetic waves: The waves which do not require medium for their propagation i.e. which can propagate even through the vacuum are called non mechanical wave.

Light, heat is the examples of non-mechanical wave. In fact all the electromagnetic waves are non- mechanical.

All the electromagnetic wave consists of photon.

The wavelength range of electromagnetic wave is 10−14m to 104 m.

Properties of electromagnetic waves

1. They are neutral (uncharged).
2. They propagate as transverse wave.
3. They propagate with the velocity of light.
4. They contain energy and momentum.
5. Their concept was introduced by Maxwell.

Following waves are not electromagnetic

- Cathode rays
- Canal rays
- α rays
- β rays
- Sound wave
- Ultrasonic wave

Some Important Electromagnetic Waves & their discoverer

- γ-Rays - Henry Becqueral
- X-Rays - W. Rontgen
- Ultra-violet rays - Ritter
- Visible radiation - Newton
- Infra-red rays - Hershel
- Short radio waves or Hertzian Waves - Heinrich Hertz
- Long Radio Waves - Marconi

Note: Electromagnetic waves of wavelength range 10^{-3} m to 10^{-2} m are called microwaves.

Amplitude: Amplitude is defined as the maximum displacement of the vibrating particle on either side from the equilibrium position.

Wavelength: Wavelength is the distance between any two nearest particle of the medium, vibrating in the same phase. It is denoted by the Greek letter lambda. (λ)

In transverse wave distance between two consecutive crests or troughs and in longitudinal wave, distance between two consecutive compressions or rarefactions is equal to wavelength.

Velocity of wave = frequency × wavelength.

Time period – The time taken by the vibration of the particles of the medium in completing one oscillation is called Time period.

Frequency – The number of oscillations executed by the particles of the medium in one second is called frequency of wave. Its SI unit is Hertz.

Sound

Sound waves are mechanical longitudinal waves and require medium for their propagation. It cannot propagate through vacuum.

When propagated speed and wavelength changes but frequency remains constant. It is of three types:

- Infrasonic waves – (0 to 20,000 Hz)
- Audible waves – (20 to 20,000 Hz)
- Ultrasonic waves – (>20,000 Hz)

Properties of Sound Wave Reflection

- The bouncing back of sound when it strikes a hard surface, is called reflection of sound.
- The laws of reflection of light are also obeyed during reflection of sound.
- The working of megaphone, sound boards and ear trumpet is based on reflection of sound.
- The repetition of sound due to reflection of sound waves, is called an **echo**.
- The persistence of hearing on human ear is 1/10 of a second.
- The minimum distance from a sound reflecting surface to hear an echo is nearly is nearly 17 m.
- Sound proof rooms are made of two layers of walls having vacuum between them.
- Reverberation arises due to multiple reflection of sound.
- While designing an auditorium for speech or musical concerts, one has to take proper care for the absorption and reflection of sound.
- Time taken by reverberant sound to decrease its intensity by a factor of 106 is called reverberation time.

Refraction

When a sound wave moves from one mechanical medium to another mechanical medium, it shows deviation from the original path of the incident wave. The phenomenon is called refraction. It is due to difference is speed of sound in media.

Diffraction

- When sound waves originated by a vibrating source, they spread in the medium and if the medium is homogeneous, this leads to bending of sound waves around the edges. Which is known as diffraction.
- The sound waves diffracted broadly and one can easily hears the voice of the another person.

Musical Scale

In theory of music, a musical scale is a set of musical notes by the frequencies of which are in simple ratios to one another. Sa, re, ga, ma, pa, dha, ni is one such scale called the diatonic scale.

The frequencies of these notes are: sa (256), re (288), go (320), ma (341.3), pa (384), dha(426.7) and ni (480). The next note denoted by sa has a frequency 512, twice that of sa. The interval sa-sa is called an octave (8).

Noise Reduction in Recording Media

Five types of noise reduction system exists in recording media as discussed below

- Dolby A noise reduction system, intended for use in professional recording studios. It provided about 10 dB of broadband noise reduction.
- Dolby B was developed to achieve about 9 dB noise reduction primarily for cassettes. It was much simpler than Dolby A and therefore less expensive to implement in consumer products.
- Dolby C provides about 15 dB noise reduction.
- Dolby SR (Spectral Recording) system is much more aggressive noise reduction approach than Dolby A. Dolby SR is much more expensive to implement than Dolby B or C, but it is capable of providing upto 25 dB noise reduction in the high frequency range.
- Dolby S is found on some Hi-Fi and semi- professional recording equipment. It is capable of 10 dB of noise reduction at low frequencies and upto 24 dB of noise reduction at high frequencies.

Doppler's Effect

The apparent change in the frequency of source due to relative motion between the source and observer is called Doppler's effect.

Applications of Doppler's Effect

The measurement of Doppler shift (based on Doppler's effect) has been used:

- By police to check over speeding of vehicles.
- At airports to guide the aircraft.
- To study heart and blood flow in different parts of the body.
- By astrophysicist to measure the velocities of planets and stars.

SONAR

SONAR stands for Sound Navigation and Ranging.

It is used to measure the depth of a sea, to locate the enemy submarines and shipwrecks.

- The transmitter of sonar produces pulses of ultrasonic sound waves of frequency of about 50000 Hz. The reflected sound waves are received by the receiver.

Human Ear

- We are able to hear with the help of an extremely sensitive organ of our body called the ear. There are three parts of human ear
  - The outer ear is called pinna. It collects the sound from the surroundings. The middle ear transmits the amplified pressure variations received from the sound wave to the inner ear.
- In the inner ear, the pressure variations are turned into electrical signals by the cochlea. These electrical signals are sent to the brain via the auditory nerve and the brain interprets them as sound.

HEAT

Heat

- Heat is the form of energy which produces the sensation of warmth. Its SI unit is joule and other unit calorie (1 cal = 4.2 Joule) .
- The transfer of heat is always from hotter to colder body.

Temperature

- Temperature is measure of hotness or coldness of a body.
- The heat flows from one body to another due to the difference in their body temperature.

Scale of Temperature

- To measure the temperature of a body following temperature scales are used.
  - Celsius scale of temperature freezing point is 0°C Boiling point of water is 100°C
  - Fahrenheit scale of temperature
    - Ice point or freezing of water = 32° F
    - Boiling point of water = 212° F
  - Kelvin or absolute scale of temperature

- Ice point of water = 273° K
- Boiling point of water = 373° K

- Reaumur scale of temperature
  - Ice point of water is 0° R,
  - Boiling point of water = 80°R
- Rankine scale of temperature
  Ice point /freezing point of water = 491.67°R
  Boiling point of water = 671.641° R

Relation between Different Scales of Temperature

Different scales of temperature are related as follows:

➔ C/100 = (F – 32)/180 = R/80 = (K – 273)/100
➔ K =273+ °C

- At temperature – 40°C = – 40°F, Clesius scale is equal to Fahrenheit
- The temperature at which the three phases of water remains at equilibrium is called triple point of water (273.16 K)

Thermometers

The instruments used to measure temperature of a body is called thermometer.

Thermometers are of following three types: -

1. **Clinical thermometer** – It is used to measure human body temperatures and ranges from 96° F to 110°F or 35°C to 43°C.
2. **Electronic thermometer** Basic components of an electronic thermometer are **thermistors or thermo resistors**. Range of electronic thermometer is – 40° to 450°F.
3. **Other thermometers** these include constant volume gas thermometer, platinum resistance thermometer etc.

- **Clinical thermometer** measures temperature in degree **Fahrenheit (°F)**.
- In thermometer, mercury is commonly used through a wide range from –30°C to 300°C.
- Thermometer was developed by Galileo who found that the gases expand on heating.

Thermal Expansion

The expansion of a body caused by heat is known as thermal expansion.

Anomalous Expansion of Water

When temperature of water is increased from 0°C, then its volume decreases up to 4°C, becomes minimum at 4° C and then increases. This behavior of water expansion around 4°C is called, anomalous expansion of water.

Latent Heat

- The heat energy absorbed or released at constant temperature per unit mass for change of state, is called latent heat.

- It is denoted by L and its SI unit is cal/g or kcal/kg.
- Heat energy absorbed or released during change of state is given by

$$Q = mL$$

Where, m = mass of the substance.

- Latent heat of fusion of ice is 80 cal/g.
- Latent heat of vaporization of steam is 536 cal/g.

Thermodynamics

- The branch of physics which deals with the study of relation of heat energy with different types of energy is called thermodynamics.
- Entropy measures the molecular disorder of a system and is a thermodynamic function depending only on the temperature of the system.
- Evaporation is a process in which molecules escape slowly from the surface of a liquid.
- For a given liquid the rate of evaporation demands on the temperature and area of evaporating surface.
- Refrigerator is a device used for cooling things by the evaporation and compression of a volatile liquid inside a copper coil.

Humidity

- The presence of moisture in the atmosphere is called humidity.
  - The amount of water vapour present in the unit volume of atmosphere is called absolute humidity.
  - The relative humidity of air at a given temperature is the ratio of mass of water vapour present in a certain volume of air to the mass of water vapour required to saturate the same volume of air at the same temperature, multiplied by 100.
- Relative humidity is measured by hygrometer.
- Relative humidity of about 50% is considered comfortable at temperature 22° – 25° C.
- If the relative humidity is very low in air, then lips become dry and cracks appear in them.
- If relative humidity is very high in air then the sweat from our body does not evaporate readily and therefore we feel uncomfortable.
- Air conditioning provides comfortable conditions by regulating temperature and humidity.

Transmission of Heat

- Heat can be transferred from one place to another by process of transmission.
- There are three methods of transmission of heat.

Conduction

- The mode of transmission of heat in solids from higher temperature part to lower temperature part without actual movement of the particles, is called conduction.
- Transmission of heat in solids takes place mainly through conduction.
- Metals are good conductors of heat.

- Wood, cotton, wool, glass are bad conductors of heat, dry air is also a bad conductor of heat.
- Woolen clothes do not allow the heat of our body to escape and therefore we feel warm.
- On a cold night two thin blankets give more warmth than a single thick blanket because the layer of air between the two blankets works as a better insulator.
- Refrigerators and ice-boxes have double walls having thermocol between them which minimize heat gain by conduction.

Convection

- The mode of transmission of heat in fluids (liquids and gases) due to actual movement of the particles, is called convection.
- In liquids and gases, heat is transmitted by convection.
- When a liquid in a vessel is heated at the bottom, the liquid at bottom gets heated and expands.
- Due to its lower density, hot liquid rises and its place is taken by cold liquid from above. Convection currents are set up in the liquid until the temperature of the whole liquid becomes same.
- The cooling unit in a refrigerator is fitted near the top as cold air move downward and keeps cool the whole interior.
- Radiator in a motor car works on the principle of convection.

Radiation

- The process of heat transmission in the form of electromagnetic waves is called radiation.
- Radiation does not require any medium for propagation and it propagates without heating the intervening medium.

Black Body

- A body that absorbs the entire radiation incident on it is called perfectly black body.

LIGHT

REFLECTION OF LIGHT (Law of Reflection)

i. The angle of incidence is equal to the angle of reflection
ii. The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane

Spherical Mirrors & their Uses

Uses of concave mirrors

Concave mirrors are commonly used in torches, search-lights and vehicles headlights to get powerful parallel beams of light.

They are often used as shaving mirrors to see a larger image of the face. The dentists use concave mirrors to see large images of the teeth of patients.

Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

Uses of convex mirrors

Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles, enabling the driver to see traffic behind him/her to facilitate safe driving. They always give an erect, though diminished, image. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to view much larger area than would be possible with a plane mirror.

REFRACTION OF LIGHT

when a thick glass slab is placed over some printed matter, the letters appear raised when viewed through the glass slab the bottom of a tank or a pond containing water appears to be raised seen a pencil partly immersed in water in a glass tumbler. It appears to be displaced at the interface of air and water

A lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides.

The following are the laws of refraction of light.

i. The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
ii. The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.

If "I" is the angle of incidence and r is the angle of refraction, then,

Sin I / Sin r = constant

The one with the larger refractive index is optically denser medium than the other. The other medium of lower refractive index is optically rarer. The speed of light is higher in a rarer medium than a denser medium

The light from the Sun constitutes parallel rays of light. These rays were converged by the lens at the sharp bright spot formed on the paper. In fact, the bright spot you got on the paper is a real image of the Sun. The concentration of the sunlight at a point generated heat. This caused the paper to burn.

REFRACTION OF LIGHT THROUGH A PRISM DISPERSION OF WHITE LIGHT BY A GLASS PRISM

The prism has probably split the incident white light into a band of colours. The sequence of colours VIBGYOR. The splitting of light into its component colours is called dispersion.

Different colours of light bend through different angles with respect to the incident ray, as they pass through a prism. The red light bends the least while the violet the most. Thus the rays of each colour emerge along different paths and thus become distinct.It is the band of distinct colours that we see in a spectrum.

A rainbow is a natural spectrum appearing in the sky after a rain shower. It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere. A rainbow is always formed in a direction opposite to that of the Sun. The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colours reach the observer's eye.

ATMOSPHERIC REFRACTION

The air just above the fire becomes hotter than the air further up. The hotter air is lighter (less dense) than the cooler air above it, and has a refractive index slightly less than that of the cooler air.Since the physical conditions of the refracting medium (air) are not stationary, the apparent position of the object, as seen through the hot air, fluctuate. This wavering is thus an effect of atmospheric refraction (refraction of light by the earth's atmosphere).

Twinkling of stars

The twinkling of a star is due to atmospheric refraction of starlight.

The starlight, on entering the earth's atmosphere, undergoes refraction continuously before it reaches the earth. The atmospheric refraction occurs in a medium of gradually changing refractive index. Since the atmosphere bends starlight towards the normal, the apparent position of the star is slightly different from its actual position. As the path of rays of light coming from the star goes on varying slightly, thestarlight entering the eye flickers – the star sometimes appears brighter, and at some other time, fainter, which is the twinkling effect.

Advance sunrise and delayed sunset

The Sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after the actual sunset because of atmospheric refraction. The time difference between actual sunset and the apparent sunset is about 2 minutes.

SCATTERING OF LIGHT

The blue colour of the sky, colour of water in deep sea, the reddening of the sun at sunrise and the sunset.

Why is the colour of the clear Sky Blue?

The red light has a wavelength about 1.8 times greater than blue light. Thus, when sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter

wavelengths) more strongly than red. The scattered blue light enters our eyes. If the earth had no atmosphere, there would not have been any scattering. Then, the sky would have looked dark. The sky appears dark to passengers flying at very high altitudes, as scattering is not prominent at such heights.

Total Internal Reflection

a) mirage – Desert e.g.

Hotter air is less dense, and has smaller refractive index than the cooler air. On hot summer days, the air near the ground becomes hotter than the air at higher levels noticed that while moving in a bus or a car during a hot summer day, a distant patch of road, especially on a highway, appears to be wet. This is also due to mirage.

b) Diamonds - Their brilliance is mainly due to the total internal reflection of light inside them.

c) Optical fibres too make use of the phenomenon of total internal reflection.Light undergoes repeated total internal reflections along the length of the fibre there is no appreciable loss in the intensity of the light signal.

MAGNETISM AND ELECTRICITY

Electricity — Flow of Electrons is called Electricity

- The electricity produced by friction between two appropriate bodies, is called static electricity, it is also called frictional electricity.

Coulomb's law:-

- The electrostatic force of interaction acting between two stationary point charges is directly proportional to the product of magnitude of charges and inversely proportional to the square of the distance between them.

F= (Kqa-qb) / r2

Electric Field

- The space in the surrounding of any charge in which its influence can be experience by other charge, is called electric field.
- Electric field intensity (E) at any point is defined as the electrostatic force (F) acting per unit positive test charge (q) at the point.
- $\boldsymbol{E} = \mathrm{F}/q$
- Its unit is newton/coulomb.
- Therefore, electric field intensity is inversely proportional to the square of the distance r from the point charge.

Electric Field Lines

- An electric field line is an imaginary line, so that its tangent at any point is in the direction of the electric field vector at that point.
- Two lines can never intersect. Electric field lines always begin on a positive charge and end on a negative charge and do not start or stop in mid- space.

Type of Materials

- **Conductors** are those type of materials which have number of free electrons to conduct the electricity. The metals are good conductors of electricity.
- **Insulators** are that type of materials which do not have the free electrons in its volume and hence, it does not conduct the electricity at all.
- **Semiconductor** is that type of materials which do not have free electrons at the normal temperature, but has the free electrons at the increased temperature and hence, behaves like a conductor. The materials such as silicon, germanium etc., are the semiconductor.

Electric Current

- An electric current whose magnitude and direction do not change with time is called direct current, and whose magnitude changes continuously and direction changes periodically is called alternating current.
- Inverter is a device which converts DC to AC.
- In solid conductors, electric current flows due to flow of electrons, in liquids due to flow of ions as well as electrons and in semiconductors due to flow of electrons and holes.
- Its S.I. unit is Ampere

Resistance

- Resistance is the opposition that a substance offers to the flow of electric current.
- It is represented by R.
- Its S.I. unit is ohm.

Combination of Resistances

- It resistance $R1$, $R2$ and $R3$ are connected in series,

Then their equivalent resistance is given by

$$R = R1 + R2 + R3$$

In series combination, equal current flows through each resistors but Voltage varies

- If resistances $R1$, $R2$, $R3$ are connected in parallel, then their equivalent resistance is given by

$$1/R = 1/R1 + 1/R2 + 1/R3$$

In parallel combination, potential difference across each resistor remains same but current varies.

Electric Cell

- An electric cell is a device which converts chemical energy into electrical energy.
- Electric cell are of two types
    - — Primary cell cannot be charged. Voltaic, Daniell and Leclanche cells are primary cells.
    - — Secondary cell can be charged again and again. Acid and alkali accumulators are secondary cells.
- Working of electric cells is based on chemical effect of electric current

Electric power

- The electrical energy produced or consumed per unit time is called electric power.
- Electric power, P = IV = I ^ 2 * R = (V ^ 2)/R

$$P = IV = I^2R = \frac{V^2}{R}$$

- 1 kWh = 3.6 × 10^6 J

Magnetism

Magnet

- A magnet is a material which can attract iron objects.
- A natural magnet is an ore of iron ($Fe3O4$) called magnetite or lodestone.
- A magnet which is prepared artificially is called an artificial magnet.
- A freely suspended magnet always aligns itself into North-South direction. Like magnetic poles repel and unlike magnetic poles attract each other.
- A current - carrying coil containing a soft iron core is called an electromagnet.
- An electromagnet is utilised in electric bell, telegraph receiver, telephone diaphragm, transformer, dynamo etc.
- Permanent magnets are made of steel and temporary magnet or electromagnets are made of soft iron because steel cannot magnetised easily but when it is magnetised one time, cannot be demagnetised easily. The soft iron can be magnetised or demagnetised easily.

Ammeter and Voltmeter

- An **ammeter** is an instrument used to measure electric current. It is **always connected in series**. The **resistance** of **an ideal ammeter is zero**.
- A galvanometer can be converted into an ammeter by connecting a low resistance in parallel.

- A **voltmeter** is a device used to measure potential difference between two points in an electric circuit.
- The **resistance** of an **ideal voltmeter is infinity**. It is **always connected in parallel**.
- A galvanometer can be converted into a voltmeter by connecting a high resistance in series.
- A small resistance connected in parallel with the load resistance to reduce amount of electric current through resistor is called shunt.

Magnetic Substances

- There are three types of magnetic substances Paramagnetic, Diamagnetic and Ferromagnetic.
- Paramagnetic Substances
- Those substances which are feebly magnetised in the direction of magnetic field when placed in strong magnetic field are called paramagnetic substances.
- For examples—Aluminium, platinum, chromium, manganese, solutions of salts of iron, nickel, oxygen etc.
- These substances are attracted towards strong magnetic field in a non-uniform magnetic field.
- The magnetism of these substances decreases with increase in temperature.

Diamagnetic Substances

- Those substances which are feebly magnetised in the opposite direction of magnetic field when placed in strong magnetic field are called diamagnetic substances.
- For examples— Gold, silver, zinc, copper, mercury, water, alcohol, air, hydrogen etc.
- These substances are attracted towards weak magnetic field in a non-uniform magnetic field.
- The magnetism produced in these substances does not change with increase or decrease in temperature.

Ferromagnetic Substances

- Those substances which are strongly magnetised in the direction of magnetic field when placed in it, are called ferromagnetic substances.
- For examples —Iron, nickel, cobalt etc.
- The magnetism produced in these substances decreases with increase in temperature and at a particular temperature, called Curie temperature.
- At the Curie temperature, a paramagnetic substance becomes diamagnetic.

NUCLEAR REACTOR

- A nuclear reactor is a device that contains and controls sustained nuclear chain reactions. In nuclear reactors, the nuclear fission is controlled by controlling the number of neutrons released during the fission. The energy liberated in a controlled manner is used to produce steam, which can run turbines and produce electricity.

- Fuel - (uranium 235, Plutonium-239)
- The fissionable material is used in the reactor along with a small neutron source. The solid fuel is made into rods and is called fuel rods.

WORK, POWER AND ENERGY

Work – The work done by the force is defined as the product of magnitude of force and distance through which particles moves.

Work is a scalar quantity.

Its SI unit is joule and CGS unit is erg. 1 joule = 107 erg.

Work done by a force is zero when

- Body is not displace actually, i.e. s = 0
- Body is displaced perpendicular to the direction of force i.e. θ = 90°.

Work done by a variable force

If we throw a ball upward, work done against gravity is given by, W = mgh

Where, m = mass of the body, g = acceleration due to gravity and h = height through which the ball is raised.

The **centripetal force** acts on a body perpendicular to the direction of motion. Therefore, work done by or against centripetal force in circular motion is zero.

If a coolie is carrying a load on his head and moving on a horizontal platform, then work done by force of gravity is zero as displacement is perpendicular to the direction of force of gravity.

Power – The rate at which work is done is called Power.

Power (P) = Work done/ time interval = W/t.

The SI unit of Power is Watt.

The Power of machines is expressed in Horse power (HP).

Energy – Energy of a body is its capacity of doing work.

It is a scalar quantity and its SI unit is joule.

Energy can be transformed into work and vice-versa with the help of some mechanical device.

There are two types of Mechanical Energy, which are as follows

Kinetic Energy

The energy possessed by a body by virtue of its motion is called its kinetic energy.

Kinetic energy of the body of mass m moving with velocity v is given by K = 1/2 $mv2$.

Potential Energy

The energy possessed by any object by virtue of its position or configuration is called its potential-energy. Gravitational potential energy, U = mgh

Conservative and Non-conservative forces

Conservative forces are non-dissipative forces like gravitational force, electrostatic force etc.

For the conservative forces, work done during a round trip is always zero.

Non-conservative forces are dissipative in nature like frictional force, viscous force etc.

Some Equipments used to Transform Energy		
S.	**Equipment**	**Energy Transformed**
1.	Dynamo	Mechanical energy into electrical energy
2.	Candle	Chemical energy into light and heat energy.
3.	Microphone	Sound energy into electrical energy.
4.	Loud Speaker	Electrical energy into sound energy.
5.	Solar Cell	Solar energy into electrical energy.
7.	Electric Bulb	Electrical energy into light and heat energy.
8.	Battery	Chemical energy into electrical energy.
9.	Electric motor	Electrical energy into mechanical energy.
10.	Sitar	Mechanical energy into sound energy.

Mass and Weight

The **mass** of a body is the quantity of matter contained in it.

It is a scalar quantity and its SI unit is kg.

Mass is measured by an ordinary equal arm balance. Mass of a body does not change from place to place and remains constant.

The **weight** of a body is the force with which it is attracted towards the centre of the earth. Weight of a body (w) = mg

The centre of gravity of a body is that point at which the whole weight of the body appears to act.

The centre of gravity of a body can be inside the material of the body or outside it.

It is a vector quantity and its SI unit is newton (N). It is measured by a spring balance.

Weight of a body is not constant; it changes from place to place.

Weight of a Body in a Lift

- When lift is rest or in uniform motion The weight recorded in spring balance (i.e. apparent weight) is equal to the real weight of the body w = mg.
- When lift is accelerating upward The weight recorded in spring balance is greater than then real weight of the body w' = m(g + a)
- When lift is accelerating downward The weight recorded in spring balance is smaller than the real weight of the body w' = m(g – a).
- When lift is falling freely under gravity The apparent weight of the body

$$w' = m (g – g) (\because a = g)$$

$$w' = 0$$

Therefore, bodies will experiences weightlessness.

Weight of a Body at the Moon

As mass and radius of moon is lesser than the earth, so the force of gravity at the moon is also less than that of the earth. Its value at the moon's surface is $g/6$

Satellite

A heavenly body revolving around a planet in an orbit is called a satellite. **Moon** is a **natural satellite** of the earth. The satellite may be artificial.

Artificial satellites are of two types.

Geostationary Satellites

It revolves around the earth in equatorial orbits which is also called Geostationary or Geosynchronous orbit. The **time period** of these satellites is **24 hour**.

Polar Satellites

These satellites revolve around the earth in polar orbits at a height of approximately **800 km.**

Weather monitoring which is predicted on the basis of information about moisture present in air, atmospheric pressure etc, obtained through a polar satellite.

We are able to see a live telecast of cricket world cup match or other programme with the help of a **communication satellite** which is a **geostationary satellite**.

Launching vehicles – PSLV & GSLV

CHEMISTRY

CHEMISTRY – Chemistry is the study of the structure of substances and of the way that they react with other substances.

MATTER AND ITS NATURE

On the basis of Chemical composition, matter is divided into:

- **Element** – An element is a substance which is formed by two or more identical molecules. For e.g. Hydrogen, Copper etc.
- They can be classified into – Metal, Non-metal and Metalloids.
- **Compound** – A compound is a substance composed of the atoms of two or more elements combined in a definite proportion by weight. For e.g. Water, Sugar etc.
- **Mixture** – A mixture is a substance composed of two or more compounds or elements in any proportion by weight. For e.g. Milk, Cement etc.

Types of mixture:

- **Homogenous Mixture** – When a mixture has same composition throughout than it is known as Homogenous Mixture. For e.g. Alloys and Solutions.
- **Hetrogenous Mixture** – A mixture which does not have uniform properties and composition. It can be clearly separated by boundaries. For e.g. Colloids, Emulsions or Suspensions.

Separation of mixture: Various methods used for separation of components of mixture are as follows:

1. Crystallization
2. Sublimation
3. Distillation

Matter can exist in three states-

1. Solid
2. Liquid
3. Gas.

- The forces of attraction between the particles (inter-molecular force) are maximum in solids, intermediate in liquids and minimum in gases. The spaces in between the constituent particles and kinetic energy of the particles are minimum in the case of solids, in liquids and maximum in gases.
- The states of matter are inter-convertible. The state of matter can be changed by changing temperature or pressure.
- The process of melting, that is, change of solid state into liquid state is also known as fusion.
- Evaporation is a surface phenomenon. Particles from the surface gain enough energy to overcome the forces of attraction present in the liquid and change into the vapour state. The rate of evaporation depends upon the surface area exposed to the

atmosphere, the temperature, the humidity and the wind speed. Evaporation causes cooling.

- Burning of coal, wood or leaves is a chemical change. Explosion of a firework is a chemical change. If you leave a piece of iron in the open for some time, it acquires a film of brownish substance. This substance is called rust and the process is called rusting. The process of rusting can be represented by the following equation: Iron (Fe) + Oxygen (O2, from the air) water (H2O) rust (iron oxide-Fe2O3) for rusting, the presence of both oxygen and water (or water vapour) is essential. It is a chemical change.
- Prevent iron articles from coming in contact with oxygen, or water, or both. One simple way is to apply a coat of paint or grease. Another way is to deposit a layer of a metal like chromium or zinc on iron. This process of depositing a layer of zinc on iron is called galvanization.
- Stainless steel is made by mixing iron with carbon and metals like chromium, nickel and manganese. It does not rust.

PROPERTIES OF GASES

1. Properties of Gases

- Gas has no definite volume or shape.
- The other outstanding characteristic of gases is their low densities, compared with those of liquids and solids.
- All gases expand equally due to equal temperature difference.
- Diffusion of gases: The phenomenon in which a substance mixes with another because of molecular motion, even against gravity- is called diffusion.
- The pressure of a gas: The molecules of a gas, being in continuous motion, frequently strike the inner walls of their container
- Temperature and Temperature Scales: Temperature is defined as the measure of average heat. Temperature is independent of the number of particles or size and shape of the object.
- Compressibility: Particles of a gas have large intermolecular spaces among them. By the application of pressure much of this space can be reduced and the particles be brought closer. Hence the volume of a gas can be greatly reduced. This is called compressing the gas.

STRUCTURE OF ATOM

The atomic theory of matter was first proposed by John Dalton. Fundamental particles of an atom are Electron, Proton and Neutron.

1. **Proton (p)**: Discovered by E. Goldstein.

- Protons are positively charged.
- The absolute charge on the electron to be + 1.6 × 10–19 C.

2. **Electron (e)**: Discovered by J.J. Thomson when he was studying the properties of cathode ray.

- Irish physicist George Johnstone Stoney named this charge 'electron' in 1891.
- **Electrons are negatively charged**.
- The absolute charge on the electron to be – 1.6 × 10–19 C.
- e/me as: = 1.758820 × 1011 C kg–1
- The charge of an electron was measured by R. Millikan in Oil drop experiment.

3. **Neutrons (n)**: J. Chadwick

- It has no charge and a mass nearly equal to that of a proton.
- The mass of a neutron is taken as one unit each.

4. **Atomic nucleus** – Rutherford

- The fast moving alpha (α)-particles (doubly- charged helium ions) were made to fall on a thin gold foil.
- The mass of an atom is the sum of the masses of protons and neutrons present in the nucleus.

5. **Valency**

- The number of electrons gained, lost or shared so as to make the octet of electrons in the outermost shell, is called valency.
- The atoms of elements, having a completely filled outermost shell show little chemical activity,their valency is zero.
- An outermost-shell, which had eight electrons is said to possess an octet. Atoms would thus react, so as to achieve an octet in the outermost shell.
- The chemical behavior of an atom depends upon the number of electrons orbiting around the nucleus.

6. **Atomic Number**

The atomic number is defined as the total number of protons present in the nucleus of an atom. It is denoted by "Z".

7. **Mass number**

The mass number is defined as the sum of the total number of nucleons (protons and neutrons) present in the nucleus of an atom.

8. **Mole and Avagadro number** – According to new definition of Mole given by IUPAC “One mole contains exactly 6.03×1023 elemetary entities. Thus, avagadro number or avagadro constant, is the no. of particles found in one mole of a substance i.e. 6.023×1023 particles per mole.

9. **Isotopes**

- Atoms which have the same atomic number but different mass numbers. The chemical properties of isotopes are similar but their physical properties are different. But some isotopes have special properties which find them useful in various fields. Some of them are :

a. An isotope of uranium is used as a fuel in nuclear reactors.
b. An isotope of cobalt is used in the treatment of cancer.
c. An isotope of iodine is used in the treatment of goiter

Radioactive isotopes

Arsenic–74 → detect tumors

Sodium–24 → Blood clot

Iodine–131 → Activity of thyroid gland

Cobalt–60 → Treat of cancer

10. **ISOBARS** – Atoms of different elements with different atomic numbers, which have the same mass number, are known as isobars.

11. **Isotones** – atoms having same number of neutrons.

12. **Isoelectronic** – atoms/molecules/ions containing sae number of electrons.

13. Mass defect - The mass defect is the difference between the rest mass of a nucleus and the sum of the rest masses of its constituent nucleons.

14. **Binding Energy**

- The binding energy of a nucleus is the energy required to separate a nucleus into its constituent parts.
- For heavier nuclei, energy is released when they break up (fission).
- For lighter nuclei, energy is released when they fuse together (fusion).
- Nuclear particles are held together by a nuclear strong force.A stable nucleus remains forever, but as the ratio of N/Z gets larger, the atoms decay. Elements with Z > 82 are all unstable.
- As the heavier atoms become more unstable, particles and photons are emitted from the nucleus and it is said to be radioactive. All elements with A > 82 are radioactive.

Examples are:

Alpha particles – (2 proton and 2 neutron) least penetrating

Beta – minus particles - (electron) penetrating beta- plus particles - (positron) penetrating

Gamma rays – most penetrating, high electromagnetic radiation.

Half-Life period - The half half-life of an isotope is the time in which 1/2 of its unstable nuclei will decay.

$N = N_o (1/2) n$, Where n is number of half-lives

ACID, BASE AND SALTS

1. **Acid**

- An acid is a compound, produce hydrogen ions, H+ (aq), in solution, which are responsible for their acidic properties.
- According to Bronsted – Lowry theory, an acid is any species that can donate a proton to another species.
- Hydrogen ions cannot exist alone, but they exist after combining with water molecules. So, on dissolving in water yields hydronium ions (H3O+) as the only positive ions.
- The presence of hydrogen ions makes acids strong and good electrolytes.
- Strong Acid:
- Examples of strong acids are: hydrochloric acid, sulphuric acid, nitric acid etc.

Weak Acid:

Examples are: acetic acid, formic acid, carbonic acid etc.

- Acids are generally sour in taste and corrosive.
- Indicators: Test whether a substance is acidic or basic.

Eg: Turmeric, litmus, China rose petals (Gudhal), etc., are some of the naturally occurring indicators.

- Litmus is extracted from lichens a plant belonging to the division Thallophyta. It has a purple colour in distilled water. When added to an acidic solution, it turns red and when added to a basic solution, it turns blue.
- The solutions which do not change the colour of either red or blue litmus are known as neutral solutions. These substances are neither acidic nor basic.
- Olfactory indicators: There are some substances whose odour changes in acidic or basic media.

Uses of Acids

(i) Hydrochloric acid present in our stomach helps in the digestion of food.

(ii) Vitamin C or ascorbic acid gives the needed nutrients for body.

(iii) Carbonic acid is used in making carbonated beverages and fertilizers.

(iv) Vinegar a preservative is a dilute form of acetic acid.

(v) Sulphuric acid is used in the manufacture of fertilizers, paints, synthetic fibres etc.

(vi) Nitric acid is used in the preparation of aqua regia, used in the purification of precious metals like gold and silver.

(vii) Boric acid is used to wash eyes.

(viii) Phosphoric acid is used in making fertilizers and detergents.

- Basicity of an acid is defined as the no of ionizable hydrogen (H+) ions present in one molecule of an acid.

Acids	Formulae	Basicity
Hydrochloric acid	HCL	1-Monobasic
Nitric acid	HNO_3	1-Monobasic
Carbonic acid	H_2CO_3	2-Dibasic
Sulphuric acid	H_2SO_4	2-Dibasic
Phosphorous acid	H_3PO_3	2-Dibasic
Phosphoric acid	H_3PO_4	3-Tribasic

For the acid containing the carboxylic acid, we do not count the number of hydrogen atoms but the number of carboxyl group (i.e.) – COOH

ACIDS USED IN DAY-TO-DAY LIFE

Sources of the acid	Name of the acid
Vinegar	acetic acid
Citrus fruits	citric acid
Grapes, tamarind, gooseberries.	tartaric acid
Sour milk	lactic acid
Apples	malic acid
Curd	butyric acid
Tea, tomatoes	oxalic acid
Sting of red ants and bees	formic acid
Proteins	amino acids
Guava, oranges	ascorbic acid

Note: The process of dissolving an acid or a base in water is a highly exothermic one. The acid must always be added slowly to water with constant stirring.

2. **Bases and Alkalis**

- A Base is a substance that gives OH-ions when dissolved in water. Bases are usually metal hydroxides (MOH).
- According to Bronsted-Lowry theory, a base is a proton acceptor.
- Bases are soapy substances with a bitter taste .

- The strength of a base depends on the concentration of the hydroxyl ions when it is dissolved in water.
- Bases soluble in water are called alkalies. All alkalies are bases but all bases are not alkalies.

Strong Base:

Examples: Sodium hydroxide: NaOH (caustic soda), Potassium hydroxide: KOH(caustic potash), Calcium hydroxide: Ca(OH)2.

Weak Base:

Examples: Magnesium hydroxide: Mg(OH)2, Ammonium hydroxide: NH4OH

SALT

Potash alum (potassium aluminum sulfate $KAl(SO_4)_2$)

- It is used in dyeing industries to fix the dye to the fabric.
- It is used for cleaning teeth.

USES OF SALTS IN INDUSTRIES:

- Sodium chloride is used in the manufacture of chlorine, caustic soda, washing soda and baking soda.
- Ammonium salts are used as fertilizers.
- Potassium nitrate is used in the manufacture of gun powder and fireworks.
- Silver bromide is used in photography.
- Potassium chlorate is used in the match industry.
- Aluminum sulphate is used in preparing alums.

3. **pH SCALE**

The p in pH stands for 'potenz' in German, meaning power.

- The scale that measures the strength of an acid or a base is called the pH scale. This value lies between 0 and 14.
- Higher the hydronium ion concentration, lower is the pH value.
- The pH of a neutral solution is 7. Values less than 7 on the pH scale represent an acidic solution. As the pH value increases from 7 to 14, it represents an increase in OH– ion concentration in the solution, that is, increase in the strength of alkali.
- Most food crops grow best at a PH of 7-7.8.If the soil is too acidic then its pH can be raised by adding lime (or slaked lime) which neutralizes the excess acid in the soil.Similarly, if the soil is too alkaline then its pH can be lowered by adding gypsum or some other substance which can neutralize the excess alkali present in the soil.
- The medium in our stomach is highly acidic and has pH around 1.2. Our stomach produces hydrochloric acid which helps in digestion of food. Magnesium hydroxide (Milk of magnesia), a mild base, is an antacid which neutralises the excess acid.
- Tooth decay starts when the pH of the mouth is lower than 5.5.

- Acid Rain- When pH of rain water is less than 5.6, it is called acid rain.
- Gastric juice - 1.2
- Lemon Juice - 2.2
- Pure water - 7.4
- Milk of mgnesia - 10
- Sodium hydroxide solution - 14

Note - The atmosphere of Venus is made up of thick white and yellowish clouds of sulphuric acid.

CLASSIFICATION OF ELEMENTS

Mendeleef's Periodic Table (1869)

States that, "the physical and chemical properties of elements are the periodic function of their atomic masses."

Modern Periodic Law

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

Long Form of Periodic Table

Long form of periodic table or Bohr's table is based on Bohr-Burry concept of electronic configuration. It contains 7 periods (horizontal rows) and 18 groups.

Periodic Properties

The properties which are repeated at regular intervals are known as periodic properties, i.e. periodic properties show a regular order along a group and period. Some important periodic properties are

Ionisation enthalpy

It is the minimum energy required to remove an electron from an isolated gaseous atom of an element to form a positive ion.

Electron gain enthalpy

It is the energy released by an element when an extra electron is added to its neutral gaseous atom.

Electronegativity

It is the ability of an atom to attract the shared pair of electrons towards it.

Metallic character

It is the tendency of an element to form cation by the loss of electrons.

CHEMICAL REACTIONS AND EQUATION

Physical Change

- The changes that only affect physical properties, but the chemical compositions remains unchanged, are called physical change.
- These can be reversed by changing the conditions of temperature and pressure, boiling, cutting of trees, dissolving common salt in water burning of wax.

Chemical Change

- The change which affects the composition as well as chemical properties of matter and result in the formation of a new substance is called a chemical change.
- Chemical changes are generally irreversible. Some examples of chemical changes are burning of candle (gases), photosynthesis, ripening of fruits, electrolysis of water.
- A chemical reaction involves bond breaking or bond formation between any two atoms to produce new substances.

Types of Chemical Reactions:

Exothermic and Endothermic Reactions

Reactions, in which heat is released along with the formation of products, are called exothermic reactions. Burning of fuel is an example of **exothermic reaction**.

Reactions, in which heat is absorbed, are known as **endothermic reactions**.

Oxidation and Reduction

- Oxidation is removal of electrons.
- Reduction is the addition of electrons.
- Oxidation means
  a) addition of oxygen
  b) Removal of hydrogen.
- Reductions means
  a) Removal of oxygen.
  b) Addition of hydrogen.

The substance that causes oxidation is called the oxidizing agent.

The substance that causes reduction is called the reducing agent.

Oxidising agent

1. Acceptors of electrons.
2. It is a substance which removes the electron from an atom.
3. It brings about oxidation.

Reducing agent

1. Donors of electrons.
2. It is a substance which adds electrons to an atom.
3. It brings about reduction.

REDOX REACTION

A reaction which involves oxidation and reduction occurring simultaneously together are called redox reaction. Photosynthesis in plants digestion of food in animals; dry and wet batteries and corrosion of metals are diverse examples of oxidation and reduction reactions.

Electrolysis

- Electrolysis is carried out in an electrolytic cell.
- A simple electrolytic cell consists of two copper strips dipping in an aqueous solution of copper sulphate.
- On applying DC voltage to the two electrodes, copper metal is deposited on cathode and copper is dissolved at anode.
- Used In the purification of impure metals.
- In the extraction of metals
- The blocks used in typing industries are prepared by electrolysis.
- Steel is coated with zinc metal during the process of galvanization.

Batteries

These convert chemical energy into electrical energy. Mainly two types of batteries are used, i.e. primary and secondary.

Primary Batteries

In the primary batteries, reaction occurs only once and after a period of time battery becomes dead.

Dry Cell or Leclanche Cell

It consists of a zinc container that acts as anode and the cathode is a carbon (graphite) rod surrounded by powdered manganese dioxide and carbon.

A moist paste of ammonium chloride (NH_4Cl) and zinc chloride ($ZnCl_2$) is used as an electrolyte. Dry cell is commonly used in our transistors and clocks.

Mercury Cell

It is commonly used in low current devices such as hearing aids, watches etc.

The electrolyte is a past of potassium hydroxide (KOH) and zinc oxide (ZnO).

Secondary Batteries

Lead Storage Battery

It consists of a lead as anode and a grid of lead packed with lead dioxide (PbO_2) as cathode.

A 38% solution of sulphuric acid is used as an electrolyte. On charging the battery, the reaction is reversed and lead sulphate gives lead on anode and cathode is converted into lead dioxide respectively.

Nickel Cadmium Cell

It has longer life that the lead storage cell. It consists of a cadmium as anode and nickel dioxide as cathode. The electrolyte is a potassium hydroxide (KOH) solution.

Fuel Cells

- Fuel cells convert energy from the combustion of fuels such as hydrogen, carbon monoxide, methane directly into electrical energy
- A fuel cell with hydrogen and oxygen has been used for electric power in Apollo Space Programme.

Corrosion

- When iron is exposed to moist air for a long period of time, its surface acquires a coating of brown flaky substance called rust.
- Rust is mainly hydrated iron (III) oxide ($Fe_2O_3. xH_2O$).
- In corrosion, a metal is oxidized by the loss of electrons to oxygen and form oxide.
- The rusting of iron can be prevented by painting, oiling and greasing, galvanizing (by coating iron objects with zinc), chrome plating etc.

Catalysis

- A catalyst is a substance which alters the rate of reaction.
- The catalyst itself does not alter during the reaction.
- The phenomenon in which the rate of reaction is altered by the presence of a substance (catalyst) is known as catalysis.
- Catalysts are specific in their action.
- A catalyst does not change the equilibrium state of a reversible reaction, only brings it quickly.
- The main function of a catalyst in a reaction is to decrease the activation energy.

Applications of Catalysts in Industrial Processes

(a) Haber process for ammonia—Iron is used as a catalyst and molybdenum is used as a promoter of catalyst iron.
(b) Contact process for sulphuric acid—Vanadium pentoxide is used as a catalyst.
(c) Ostwald process for nitric acid—Platinum gauze is used as a catalyst.
(d) Deacon process for chlorine—cupric chloride is used as a catalyst.
(e) Synthesis of petrol—Nickel, iron, cobalt and alumina is used as a catalyst.

CHEMICAL BONDING

Chemical Bonding

Constituents (atoms, molecules or ions) of different elements except noble gases, do not have complete octet so they combine with other constituent atoms by chemical bonds to achieve complete (stable) octet. The process of their combination is called chemical bonding. Chemical bonding depends upon the valency of atoms.

Types of Chemical Bond

They are divided in the following types depending upon the mode electron transferred or shared electrons or forces of attraction

- Electrovalent or ionic bond
- Covalent bond
- Coordinate or dative covalent bond
- Hydrogen bond
- van der Waals' forces

Electrovalent Bond

The bond formed by the transfer of electrons from one atom to another is called electrovalent bond and the compound is called electrovalent compound or ionic compound. These bonds are formed between metals and non-metals.

These conduct electricity when dissolved in water and also soluble in water. These are insoluble in organic solvents like alcohol etc.

Some Electrovalent Compounds (Ionic Compounds)

Name	Formula	Ions present
Aluminium oxide (Alumina)	AI_2O_3	AI^{3+} and O^{2-}
Ammonium chloride	NH_4CI	NH_4^+ and CI^-
Calcium chloride	$CaCI_2$	Ca^{2+} and CI^-

Covalent Bond

The bond is formed by the sharing of electrons between two atoms of same (or different) elements, is called covalent bond.

Covalent bond may be single, double or triple depends upon the number of sharing pairs of electrons.

Covalent compounds are usually liquids or gases having low melting point and boiling point. These do not conduct electricity and are insoluble in water but dissolve in organic solvent.

Some Covalent bond

Name	Formula	Element's part

Alcohol (Ethanol)	C_2H_5OH	C, H and O
Ammonia	NH_3	N and H
Acetylene (Ethyne)	C_2H_2	C and H

Coordinate or Dative Bond

The bond is formed by one sided sharing of one pair of electrons between two atoms. The necessary condition for the formation of coordinate bond is that octet of one atom should be complete; having atleast one lone pair of electrons and other atom should have a deficiency of atleast one pair of electrons.

The atom having complete octet which provides the electron pair for sharing, is known as donor. The other atom which accepts the electron pair is called the acceptor.

Bonding between A and B is predominantly

- Ionic if there is large difference in electronegativity.
- Covalent if both A and B have approximately same value of electronegativity.
- Coordinate if lone pair on A (or B) is donated to electron deficient B (or A).

Compounds Containing Ionic and Covalent Bonds

Name	Formula
Potassium cyanide	KCN
Sodium hydroxide	NaOH
Calcium carbonate	$CaCO_3$

Compounds Containing Covalent and Coordinate Bonds

Name	Formula
Carbon monoxide	CO
Ozone	O_3
Dinitrogen oxide	N_2O
Dinitrogen trioxide	N_2O_3
Nitric acid	HNO_3

Compounds Containing Electrovalent, Covalent and Coordinate Bonds

Name	Formula
Ammonium chloride	NH_4CI
Ammonium bromide	NH_4Br

Hydrogen Bond

The electrostatic force of attraction between hydrogen atom (which is covalently bonded to a highly electronegative atom) and any other electronegative atom which is present in the same or different molecules, is known as hydrogen bond.

It is maximum in the solid state and minimum in the gaseous state.

- Intermolecular H-bonding (e.g. HF, water (H20) molecule) It occurs between different molecules of a compound and results in increasing solubility in water and high boiling point.
- Intramolecular H-bonding (e.g. o -nitrophenol) It occurs within different parts of a same molecule and results in decreasing solubility in water and low boiling point.
- Molecules having O—H, N—H or H—F bond show abnormal properties due to H-bond formation. For example
- Glycerol is viscous and has very high boiling point due to the presence of intermolecular H-bonding.
- H-bonding also plays an important role in biological system and stability of proteins and nucleic acids.

Van der Waals' Forces

The ability of geckos (lizard) which can hang on a glass surface using only one toe to climb on sheer surfaces had been attributed to the van der Waals' forces between these surfaces and their foot-pads.

Metals & Nonmetals

- Metals are generally good conductors of heat and electricity.
- Silver is the best conductor of heat followed by copper.
- Mercury offers a very high resistance to the passage of electric current.
- Metals are generally hard but sodium and potassium are so soft that they can be easily cut with a knife.
- Metals are malleable and ductile. Gold and silver are most malleable and best ductile metals.
- Metals are solids at room temperature except mercury (mp – 39°C) which is liquid, caesium (mp 28.4°C) and gallium (mp 29.8°C) are liquid above 30°C.
- Metals are electropositive in nature, they ionize by the loss of electrons and form positive ions.
- Almost all the metal oxides are basic in nature but zinc oxide and aluminium oxide are amphoteric.
- Lithium, sodium, potassium, rubidium and caesium are alkali metals. Alkali metals are stored under kerosene or liquid paraffins to protect them from action of air.
- Metallic sodium is prepared by the electrolysis of molten mixture of 40% sodium chloride and 60% calcium chloride in a Down's cell.
- Sodium bicarbonate (NaHCO3), baking soda is used in effervescent drinks and fruit salts in fire extinguishers and it is also used in the form of sesquicarbonate. It is used for wool washing.

- Sodium carbonate ($Na_2CO_3 . 10H_2O$) washing soda is used in the manufacturing of glass, soap, washing powder and for softening hard water.
- Mixture of sodium carbonate and potassium carbonate is known as fusion mixture.
- Sodium sulphate ($Na_2SO_4 . 10H_2O$) is Glauber's salt.
- It is used as purgative.
- Sodium thiosulphate ($Na_2S_2O_3 . 5H_2O$) or Hypo It is used in the photography as a fixing agent.
- Potassium superoxide (KO_2) used in space capsules, submarines and breathing masks as it produces oxygen and removes carbon dioxide and carbon monoxide.
- Potassium cyanide (KCN) is used in the extraction of silver, gold and as a germicide in agriculture. KCN is more poisonous than sodium cyanide.
- Potassium hydroxide (KOH) is known as caustic potash used in the preparation of soft soap. Its aqueous solution is known as potash lye.
- Potassium carbonate (K_2CO_3) is potash or pearl ash.

De-icing of Roads after snowfall

De-icing in the process of removing ice from a surface by using salts on the surface. Now-a-days, liquid $CaCl_2$ and $MgCl_2$ are also used for this purpose.

Alkaline Earth Metals and their Compounds

Beryllium, magnesium, calcium, strontium, barium and radium are collectively known as alkaline earth metals. $Be(OH)_2$ is amphoteric in nature. $Mg(OH)_2$ is called milk of magnesia and used as an antacid.

Calcium oxide (CaO) is also called **quick lime**. It is used in the **manufacturing of glass**, calcium chloride, cement, bleaching power, calcium carbide, slaked lime, in the extraction of iron and as a drying agent for ammonia and alcohol.

Calcium hydroxide, **slaked lime [$Ca(OH_2)$]** is used in the **manufacturing of caustic soda**, sodalime and for softening of hard water.

Calcium sulphate, gypsum ($CaSO_4 . 2H_2O$) loses a part of its water of crystallization when heated upto 120°C to from $[CaSO_4]_2 . H_2O$ which is **known as plaster of Paris**.

Plaster of Paris is a white powder, which sets into hard mass on wetting with water and it is used in making statues, toys, etc., in medical applications of setting fractured bones in right positions and indentistry.

Some Important Metals and their Uses

Boron (B)

It is a semimetal (metalloids). In the nature, it occurs in combined state as borax.

Boron and boron carbide rods are used to control the nuclear reactions.

Boron carbide (B4C) is hardest, known as an artificial substance after diamond and is known as Norbia.

Orthoboric acid (H_3BO_3) is used as an antiseptic and eye wash under the name boric lotion.

Aluminium (Al)

It is a third most abundant element of Earth's crust. It is extracted from bauxite ($Al_2O_3.2H_2O$). Aluminium powder is used in fireworks, flash light powder, and thermite welding.

Ammonal (a mixture of aluminium powder and ammonium nitrate) is used as an explosive.

Ruby and sapphire are essentially Al_2O_3. Ruby is red due to the presence of Cr and sapphire is blue due to Fe and Ti. Emerald is green, it contains Ca/Cr and aluminium silicates (Al_2SiO_3).

Tin (Sn)

The important ore of tin is cassiterite (SnO_2) or tin stone. In cold countries, white tin is converted to grey tin (powder), the process is known as tin disease or tin plague. Tin plating is done to prevent the rusting of iron. Tin amalgam is used in making mirrors. Pentahydrate of stannic chloride ($SnCl_4.5H_2O$), is called butter of tin used as mordant in dyeing.

Lead (Pb)

Lead is mainly found in the form of sulphide ore called galena (PbS). Red lead (minium or sindhur) is Pb_3O_4 used for making protective paint for iron and in match industry.

Zirconium (Zr)

It is used for making core of nuclear reactors and for making pumps, valves and heat exchangers.

Vanadium (V)

Vanadium pentoxide (V_2O_5) is a very good catalyst for manufacturing of sulphuric acid by contact process.

Tungsten

Tungsten filaments are used in electric bulbs. Calcium tungstate is used in X-ray tube.

Iron (Fe)

It is extracted from its haematite ore.

Cast iron It is the most impure form of iron and contains 2.5–4% carbon.

Wrought iron or Malleable iron is the most purest form of iron and contains minimum amount of carbon (0.12–0.5%)

Iron (II) is present in haemoglobin (blood).

Mild steel contain 0.25%–0.5% carbon while hard steels contains 0.5%–1.5% carbon. Soft steels contain carbon upto 0.25%.

Stainless steel is an alloy of iron (Fe), chromium (Cr) and nickel (Ni). Ferric chloride (FeCI3) is used as stypic to stop bleeding from a cut. Ferrous sulphate (FeSO4) is used in making blue black ink.

Copper, Silver and Gold (Cu, Ag and Au)

These are called coinage metals. Silver is used as amalgam for filling teeth and in silvering mirrors. Silver bromide (AgBr) is used in photography. AgNO3 is called lunar caustic used in preparing marking inks and hair dyes.

CuSO4. 5H2O is called blue vitriol or nila thotha and

CuFeS2 is called fool's gold.

Mercury (Hg)

Mercuric sulphide (HgS) is used as a cosmetic in Ayurvedic medicine as Makardhwaja.

Zinc (Zn)

It is used in galvanization to prevent rusting of iron. Zinc sulphide is used in the preparation of X-ray screens.

Zinc oxide is known as philosopher's wool. Zinc sulphate (ZnSO4. 7H2O) is white vitriol.

Metallurgy

The process of extraction of metals from their ores is called metallurgy.

Minerals, Ores and Gangue

The natural substance in which metals and other impurities found in combined state, are called minerals.

The minerals from which metal can be extracted conveniently and beneficially, are called ores. Gangue or matrix are the impurities associated with the ore.

Metal	Ores	Chemical composition
Sodium	Rock salt Chile salt petre Borax	NaCI $NaNO_3$ $Na_2B_4O_7.10H_2O$
Potassium	Carnallita	$KCI.MgCI_2.6H_2O$
	Sylvine	KCI
Magnesium	Carnallite Magnesite Asbestos	KCI.MgCI2. 6H2O MgCO3 CaSiO3. 3MgSiO3

Calcium	Lima stone Gypsum Fluorspar	$CaCO_3$ $CaSO_4.2H_2O$ CaF_2
Aluminium	Bauxite Cryolite Feldspar	$Al_2O_3.2H_2O$ Na_3AlF_6 $KAlSi_3O_8$
Manganese	Pyrolusite Manganite Manganese blende	MnO_2 $Mn_2O_3.H_2O$ MnS
Iron	Haematite Magnetite Iron pyrites Siderite	Fe_2O_3 Fe_3O_4 FeS_2 $FeCO_3$
Copper	Copper glance Copper pyrites Malachite Azurite	Cu_2S $CuFeS_2$ $Cu(OH)_2.CuCO_3$ $2CuCO_3.Cu(OH)_2$
Silver	Silver glance Horn silver	Ag_2S $AgCl$
	Ruby Silver	$Ag_2S.Sb_2S_3$
Gold	Calverite Sylvanite	$AuTe_2$ $AuAgTe_4$
Zinc	Zinc blende Calamine Zincite Franklinite	ZnS $ZnCO_3$ ZnO $ZnO.Fe_2O_3$
Mercury	Cinnabar	HgS
Tin	Cassiterite	SnO_2
Lead	Galena Cerrusite Anglesite	PbS $PbCO_3$ $PbSO_4$

Some Important Alloys and their Uses

Non-Metals

These may be solid, liquid or 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 from oxides with oxygen which are generally acidic. Their examples include noble gases, i.e. helium (He), neon (Ne), argon (Ar), krpton (Kr), xenon (Xe) and some other p- block elements like chlorine (Cl_2), bromine (Br_2) and phosphorus (P) etc.

Alloys are homogeneous mixtures of metals and cannot be separated into their components by physical methods.

Pure metals have poor mechanical properties. Hence, they are not used in their pure form in industry. Their properties are modified by adding other elements.

Characteristics of alloys:

Alloys are harder and tougher than the base metal and are resistant to corrosion.

They are inert to commonly used chemicals and are magnetisable and ductile.

Alloy is considered as a mixture because it shows the properties of its constituents and can have variable composition.

Amalgams:

Alloys of mercury with other metals like sodium, potassium,gold and zinc...etc are called amalgams. Amalgams stored in iron bottles as iron cannot form amalgam with mercury.

Rold Gold is a metal, such as brass, coated with a thin layer of gold, usually of above 9 carat purity.

Brass

Composition- zinc 30%, copper 70%

uses- In making of utensils, pipes and radiator statues etc.

Yellow Brass

composition - Cu 67%, Zn 33% uses - Hardware items

Bronze

Composition - Copper 90%, Tin 10%

Uses - In making of coins, ornaments, utensils and statues.

Stainless steel

Composition - Fe 82 %, (Ni + Cr) 18

Uses - In making of surgical instruments, watches and utensils etc.

Magnalium

Composition- Al 95%, Mg 5%

Uses - In making light articles and physical balance etc.

Duralumin

Composition- Al 95%, Cu 4%, Mn 0.5%

Uses -In making parts of aeroplane and ship etc.

Alnico

Composition - Al 8-12%, Ni 15-26%, Co 5-24%, Cu 6%

Remaining: Fe, Tl

Uses - It is useful in making of magnets.

Composition - Al 8-12%, Ni 15-26%, Co 5-24%, Cu 6%

Remaining: Fe, Tl

Uses - It is useful in making of magnets.

German silver

Composition - Cu 60%, Zn 20%, Ni 20%

Uses - It is useful in electroplating and making of utensils.

Sterling Silver

Composition - silver 92.5%, copper 7.5% uses - jewelry, art object

Gun metal

Composition - Cu 88%, Sn 10%,Zn 2%

Uses - It is useful in making of guns, machine parts and canons.etc

Solder metal

Composition - Pb 50%, Sn 50%

Uses - It is mainly useful to join electric wires.

Bell Metal

Composition - copper - 77%, tin - 23% uses- casting of bells

Coin metal -

Composition - copper 75%, nickel 25% uses - U.S coins

Wood's metal

Composition - Bi 50%, Pb 25%, Sn 12.5%, Cd 12.5% uses - fuse plugs, automatic sprinklers.

Monel

Composition - Ni 67%, and copper, with small amounts of iron, manganese, carbon, and silicon.

Uses - It is resistant to corrosion and acids and thus used for making valves, pumps, shafts, fittings, fasteners, and heat exchangers.

Plumber's solder

Composition - Pb 67%, sn 33% uses- soldering joints.

SOME COMMON ELEMENTS & COMPOUNDS

❖ **Carbon:**

The three states of carbon are diamond, amorphous, and graphite.

- Carbon exhibits allotropy and shows maximum catenation.
- Carbon occurs both in Free State as diamond, coal etc. and also in the combined form as CO2.
- Diamond is one of the allotropic forms of carbon and is the purest form of natural carbon. It is the hardest natural substance.
- Graphite is also an allotropic form of carbon, which is very soft and slippery. Graphite is prepared artificially by Acheson process.
- Fullerene (C60) looks like a soccer ball. It contains 20 six membered and 12 five membered rings of carbon atoms.
- Graphene is an allotrope of carbon. It is a strong substance and used as a conducting material for touch screen, LCD and LED

❖ **Compounds of Carbon**

Carbon monoxide (CO)

- Carbon monoxide (CO) combines with haemoglobin to form carboxyhaemoglobin which is not able to absorb oxygen and as a result of this, suffocation takes place (Asphyxia).
- The death of persons in closed rooms with wood, coal or coke fires and in closed bathrooms with gas geyser is due to the formation of carbon monoxide.

Carbon dioxide (CO2)

- 0.03-0.05 percent in atmosphere.
- Solid CO2 is known as dry ice. It is used in refrigerators under the name drikold. It is used in transport of perishable food materials as it provides cold as well as the inert atmosphere.

Carbides

They are the compounds of carbon with metals or electronegative elements.

- Destructive distillation of coal gives products like coal gas, gas carbon, coal tar and ammonical liquor.

Lamp Black is also known as Soot.

❖ **Nitrogen:**

- Nitrogen is a neutral gas and is neither combustible nor a supporter of combustion.
- In air (79% by volume). In combined state, nitrogen is found as nitrates (Chile saltpetre— sodium nitrate (NaNO3), Indian saltpetre— potassium nitrate (KNO3)

❖ **Ammonia**

- It is prepared from nitrogen and hydrogen by

Haber's process. It has pungent odour.

- Ammonia is used in manufacturing fertilizers and explosives etc.
- Nitrogen fixation involves the fixation of atmospheric nitrogen into nitrate by lightning and by nitrogen fixing bacteria called Rhizobia.

❖ **Oxygen:**

- Oxygen is an important constituent of atmosphere (21% by volume). Supporter of combustion.
- Liquid oxygen mixed with freshly divided carbon, is used in place of dynamite in coal mining.
- Ozone (O3) - It protects the life on the earth by not allowing UV rays to reach the Earth.The common refrigerants, chlorofluorocarbons deplete this ozone layer.
- Its bleaching action is due to its oxidizing action.
- Ozone is also used as a germicide and disinfectant, for sterilizing water.

❖ **Phosphorus (P):**

- It is highly reactive non-metal, so it occurs only in combined state.
- Phosphorus is an essential constituent of bones, teeth, and blood and nerve tissues. Bone ash contains about 80% of phosphorus.

❖ **Sulphur (S):**

- It occurs in Free State in volcanic region.
- Rhombic sulphur is the most stable form at ordinary temperature and all other forms gradually change into this form.

Compounds of Sulphur

- Sulphuric acid is also known as oil of vitriol or king of chemicals. It has a great affinity for water and thus it acts as a powerful dehydrating agent. Corrosive action of sulphuric is due to its dehydrating action.
- Hypo (Sodium thiosulphate) It is mainly used in photography as a fixing agent. It is used to remove undecomposed silver halide on photographic paper or film.

❖ **Halogens:**

Halogens are highly reactive elements and therefore, they do not exist in Free State but exist only in combined form.

Halogens have highest electron affinity so they act as strong oxidizing agent.

Their oxidizing power decreases from fluorine to iodine.

❖ **Chlorine:**

Chlorine was first discovered by Scheele (1774) Chlorine is used as a germicide, disinfactant, oxidizing agent, bleaching agent in paper and textile industry. Chlorine being an acidic gas turns moist blue litmus paper to red and then bleaches it.

❖ **Iodine (I2)**

Chile saltpeter or caliche contains iodine as sodium iodate (5-20%).

It turns starch solution blue. Solution of KI/I2 is used in the treatment of goiter. It is used as an antiseptic as tincture of iodine.

Noble Gases

- Helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn) are known as inert gases or noble gases or rare gases.
- These elements have completely filled valence shell.
- It atmosphere, argon is most abundant noble gas but in universe, helium is most abundant gas.
- Natural gas in the most important source of helium.
- The mixture of helium and oxygen is used for artificial breathing of asthama patients.
- 85% helium + 15% hydrogen is used for filling in balloons and airships.
- Mixture of helium and oxygen is used for respiration by sea divers.
- Helium is used as pressuring agent in rockets to expel liquid oxygen and liquid hydrogen.
- Xe is also known as stranger gas and Xe-Kr is used in high intensity photographic flash tubes.
- Radon is used in the preparation of ointment for the treatment of cancer.

Water (H2O):

- Water is called the “Universal Solvent”.
- Hardness of water –

Temporary hardness - Water is said to be temporarily hard when it contains bicarbonates of calcium and magnesium (or hydrogen carbonates). This type of hardness can be easily removed by boiling.

Permanent hardness - Water is said to be permanently hard when it contains sulphates and chlorides of calcium and magensium.

This hardness cannot be removed by boiling.

- Degree of Hardness - It is defined as the number of parts of $CaCO_3$ or equivalent to various calcium or magnesium salts present in 106 parts of water by mass.

- Heavy water is prepared either by prolonged electrolysis or by fractional distillation of ordinary water. Heavy water (D_2O) is colourless, tasteless and odourless liquid. Fission in uranium-235 is brought by slow speed neutron. Heavy water is used for this purpose in nuclear reactors as moderators.

Hydrochloric Acid (HCL):

- Hydrochloric acid is prepared by dissolving hydrogen chloride gas in water.

It reacts with metals to form their respective chlorides and liberates hydrogen.

Hydrochloric acid is used in the production of dyes, drugs, paints, photographic chemicals and in the preparation of aqua-regia. Aqua regia is a mixture of nitric acid and hydrochloric acid, optimally in a molar ratio of 1:3. Aqua regia is a yellow-orange fuming liquid because it can dissolve the noble metals gold and platinum

Nitric Acid (HNO_3):

It is manufactured by the Ostwald's Process by the reaction of ammonia and air in presence of platinum as catalyst.

- Nitric acid is colourless in pure form. Commercial nitric acid is yellowish due to the presence of dissolved nitrogen dioxide.

- Nitric acid is a strong monobasic acid. It ionizes in water readily.

- Nitric acid is a strong oxidizing agent. When it undergoes thermal decomposition, it yields nascent oxygen.

BAKING SODA

- Chemically Baking soda is sodium hydrogen carbonate, $NaHCO_3$.

- Baking soda is manufactured by Solvey's process

USES

1. Used for cooking of certain foods.
2. For making baking power (a mixture of sodium hydrogen carbonate and tartaric acid). On heating during baking, baking soda gives off carbon dioxide. It is this carbon dioxide which raises the dough. The sodium carbonate produced on heating the baking soda gives a bitter taste. Therefore, instead of using the baking soda alone, baking powder is

used. The tartaric acid present in it neutralises the sodium carbonate to avoid its bitter taste.

3. In medicines Being a mild and non-corrosive base, baking soda is used in medicines to neutralise the excessive acid in the stomach and provide relief. Mixed with solid edible acids such as citric or tartaric acid, it is used in effervescent drinks to cure indigestion.
4. In soda acid fire extinguishers.

WASHING SODA

- Chemically, washing soda is sodium carbonate decahydrate, $Na_2CO_3.10H_2O$.
- Washing soda is manufacturing by Solvey's process.

USES

1. It is used in the manufacture of caustic soda, glass, soap powders, borex and in paper industry.
2. For removing permanent hardness of water.
3. As a cleansing agent for domestic purpose.

PLASTER OF PARIS

- Plaster of Paris, also called POP.
- Chemically, it is $2CaSO_4.H_2O$ or $CaSO_4.1/2H_2O$ (calcium sulphate hemi hydrate)
- Gypsum, ($CaSO_4.H_2O$) is used as the raw material

USES

1. In making casts for manufacture of toys and statues.
2. In hospitals for making plaster casts to hold fractured bones in place while they set. It is also used for making casts in dentistry.
3. For making the surface of walls and ceiling smooth.
4. For making 'chalk' for writing on blackboard.
5. For making fire proof materials.

BLEACHING POWDER

- Bleaching is a process of removing colour from a cloth to make it whiter.
- Chemically, it is calcium oxychloride, $CaOCl_2$.
- It is manufactured by Hasen-Clever Method.

USES

1. For bleaching of cotton, linen and wood pulp.
2. In making wool unshrinkable.
3. Used as disinfactant and germicide for sterilization of water.
4. For the manufacture of chloroform.
5. Used as an oxidizing agent in chemical industry.

CHEMISTRY IN EVERYDAY LIFE

Synthetic Materials

The materials created by man using the natural materials, are known as synthetic materials.

Cement

- It was discovered by an English Mason, Joseph Aspdin in 1824. He called it Portland cement because he thought that it resembled the limestone found in Portland.
- **Approximate Composition of Portland cement**

Calcium oxide (CaO)	60-70%
Silica (Si$O2$)	20-25%
Alumina ($AI2O3$)	5-10%
Ferric oxide ($Fe2O3$)	2-3%

- Raw materials are limestone (provides lime), clay (provides alumina and silica), gypsum (reduces the setting time of cement).
- When water is mixed with cement and left as such for sometime, it becomes a hard mass. This is known as setting of cement. It is an exothermic process; therefore cement structures have to be cooled upto 7 days by sprinkling water.
- Mortar is a mixture of cement, sand and water. It is used for plastering walls and binding bricks and stones.
- Concrete is a mixtures of cement, sand, gravel or small pieces of stone and water. It is used for the construction of floors.
- The structure having iron rods embedded in wet concrete, is known as reinforced concrete.

Glass ($Na2O.CaO.6SiO2$)

- It is a supercooled liquid of silicates.
- Raw materials used for the formation of glass are sodium carbonate, calcium carbonate and sand.
- Finely powdered mixture known as batch is mixed with cullet (broken glass pieces) and then fused in a tank furnace at 1673 K. After few hours, molten glass is obtained.
- Molten glass is cooled slowly and uniformly. The process of slow and uniform cooling is known as Annealing
- Different addition may produce different coloured glasses.

Substance used	Colour of glass

Cuprous oxide	Red
Cupric oxide	Peacock blue
Potassium dichromate	Green or Greenish yellow
Ferrous oxide	Green
Ferric oxide	Brown
Manganese dioxide	Light pink, in excess black
Cobalt oxide	Blue
Gold chloride	Ruby
Cadmium	Yellow
Carbon	Amber colour

CHEMICALS IN AGRICULTURE

Fertilizers

- Urea is the best fertilizer as it leaves only carbon dioxide after ammonia, has been assimilated by plants.
- It has 46.6% mitrogen and it does not alter the pH of the soil.
- Mixture of Ca(CN)2 and C is known as nitrolim. Commerically, calcium nitrate is known as Norvegian salt petre.
- The mixture of nitrogenous, phosphatic and potash fertilizers in suitable amounts, is called NPK fertilizers.

Pesticides

Pesticides are the chemicals which are applied to crops, e.g. DDT and Malathion.

Difethialone

Vitamin K has been suggested and successfully used, as antidote for pets or humans accidentally or intentionally exposed to anticoagulant poisons.

Chemicals in medicines

Analgesics (Pain relievers)

These reduce pain. Aspirin and paracetamol are non- narcotic analgesics. Aspirin reduces fever, prevents platelet coagulation.

Narcotic analgesics are chiefly used for the relief of post-operative pain, cardiac pain and pains of terminal cancer and in child birth.

Polymerization

- Polymers are defined as high molecular mass macromolecules, which consist of repeating structural units derived from the corresponding monomers.

- Polymers occur in nature also. Cotton, for example, is a polymer called cellulose. Cellulose is made up of a large number of glucose units.

On the basis of intermolecular forces Polymers are classified as:

1. Elastomers- rubber, buna-S, buna-N, neoprene etc.
2. Fibres – polyamides (nylon 6, 6), polyesters (Terylene), etc.
3. Thermoplastic polymers - Such plastic which gets deformed easily on heating and can be bent easily are known as thermoplastics. Polythene and PVC, Polythene, Polystyrene, Polyvinyls, etc.
4. Thermosetting Polymers - some plastics which when moulded once, can not be softened by heating. These are called thermosetting plastics.eg: bakelite, melamine etc.

Few important polymers are:

(a) Polythene

(i) Low density polythene – polymerisation of ethane under high pressure in the presence of traces of dioxygen or a peroxide initiator (catalyst).

(ii) High density Polythene – polymerisation of ethene in the presence of a catalyst such as triethylaluminium and titanium tetrachloride (Ziegler- Natta catalyst).

(b)Polytetrafluoroethene (Teflon)

Teflon is manufactured by heating tetrafluoroethene with a free radical or persulphate catalyst at high pressures.

(c)Polyacrylonitrile

Polymer of acrylonitrile in presence of a peroxide catalyst.

Condensation Polymerisation

(a) Polyamides - possess amide linkages

(i) **Nylon** 6, 6 - prepared by the condensation polymerization of hexamethylenediamine with adipic acid under high pressure and at high temperature

ii) **Nylon 6** - obtained by heating caprolactum with water at a high temperature.

(b) Polyesters – polycondensation products of dicarboxylic acids and diols. Polyester is another synthetic fibre. Fabric made from this fibre does not get wrinkled easily. It remains crisp and is easy to wash. So, it is quite suitable for making dress material. Eg: Terylene is the best known example of polyesters. It is prepared by ethylene glycol and terephthalic acid. It can be drawn into very fine fibres that can be woven like any other yarn.

(c) Phenol – formaldehyde polymer (Bakelite and related polymers)

Prepared by the condensation reaction of phenol with formaldehyde in the presence of either an acid or a base catalyst.

The initial product could be a linear product – Novolac used in paints. Novolac on heating with formaldehyde undergoes cross linking to form an infusible solid mass called bakelite. It is used for making combs, phonograph records, electrical switches and handles of various utensils.

Eg. **Melamine** – Melamine formaldehyde polymer is formed by the condensation polymerisation of melamine and formaldehyde. Melamine is a versatile material. It resists fire and can tolerate heat better than other plastics. It is used for making floor tiles, kitchenware and fabrics which resist fire. It is used in the manufacture of unbreakable crockery.

Copolymerisation.

Natural rubber - Natural rubber may be considered as a linear polymer of isoprene (2-methyl-1, 3- butadiene) and is also called as cis - 1, 4 - polyisoprene.

Vulcanisation of rubber-This process consists of heating a mixture of raw rubber with sulphur and an appropriate additive at a temperature range between 373 K to 415 K so that rubber gets stiffened.

Synthetic Rubbers -

(i) **Neoprene** - by the free radical polymerisation of chloroprene.

Rayon - rayon or artificial silk. Although rayon is obtained from a natural source, wood pulp, yet it is a man-made fibre.

Nylon - Nylon is also used for making parachutes and ropes for rock climbing. A nylon thread is actually stronger than a steel wire.

ORGANIC CHEMISTRY

Organic chemistry is defined as the study of hydrocarbons and their derivatives. Most atoms are only capable of forming small molecules. However one or two can form larger molecules.

Urea was the first organic compound prepared in laboratory. It was prepared by Wohler (1828) from inorganic compound i.e. ammonium cyanate.

Acetic acid was the first organic compound synthesized from the elements by Kolbe.

Functional group is responsible for the chemical properties of the molecules ex. OH is alcoholic group

Isomers Compounds having the same molecular formula but different structures, e.g. C2H6O can have the structure, i.e. CH3OCH3 (dimethyl ether) and C2H5OH (ethanol).

Hydrocarbons

These are the compounds of only carbon and hydrogen.

Saturated hydrocarbons They contain only single bonds. These are also called alkanes or paraffins and have general formula $CnH2n$+2. Methane is the first member of this group.

Unsaturated hydrocarbons They have general formula $CnH2n$ for alkene and $CnH2n$−2 for alkynes. These have atleast one double (=) or triple (≡) bond and are called alkenes and alkynes respectively.

Aromatic hydrocarbons They have ring structure with alternate double bonds and (4n + 2) πe– (Huckel's rule) e.g. benzene.

Important Hydrocarbons and their Uses

Methane (CH4) It is also known as marsh gas or damp fire. Natural gas contains mainly 90% methane along with ethane, propane, butane etc. Rice agriculture is a big source of atmospheric methane.

- It is the cause of occurrence of the explosions in mines.
- It is used as a fuel gas in making carbon black.

Biogas

Produced during decay of biomass in the absence of oxygen. Methane (75%) is the main constituent of biogas).

Ethane ($C2H6$)

Natural gas contains approx. 10% ethane. Its hexachloro derivative $C2CI6$ is used as an artificial camphor.

Butane ($C4H10$)

It is the main constituent of LPG (liquefied petroleum gas).

Ethylene ($CH2 = CH2$)

In World war | (1914-18), it was used for the manufacturing of mustard gas (poisonous gas). It is used as an anesthetic for the preservation and artificial ripening of green fruits.

Acetylene (CH ≡ CH)

Benzene ($C6H6$)

It is the simplest aromatic hydrocarbon. It was discovered by Faraday in 1825. It is also used as a motor fuel under the name benzol.

Toluene ($C6H5CH3$)

is used as a commercial solvent in the manufacturing of explosive (TNT), drugs (chloramines T) and dyestuffs. Used in the manufacturing of saccharin and printing inks. toluene is used as antifreeze.

Naphthalene ($C10H8$)

It is used for preventing moths in clothes, as an insecticide.

Halogen Derivatives of Hydrocarbons Chloroform ($CHCl3$)

- It was discovered by Sir James Young Simpson.
- It is stored in closed dark coloured bottles completely filled because it is oxidized by air in the presence of sunlight to an extremely poisonous gas phosgene ($COCl2$).
- It reacts with conc. $HNO3$ and form chloropicrin ($CI3C - NO2$). Chloropicrin is an insecticide and also used as poisonous gas at the time of war.
- The major use of chloroform today is in the production of the Freon refrigerant, R-22.

Iodoform ($CHI3$)

It is used as an antiseptic due to liberation of free iodine.

Carbon tetrachloride ($CCI4$)

Used as a fire extinguishers under the name pyrene.

Dichloro diphenyl trichloro ethane (DDT)

It was the first chlorinated organic insecticides and originally prepared in 1873.

Alcohols

Methyl alcohol ($CH3OH$)

- It is also known as wood spirit or wood naphtha.
- Methyl alcohol is poisonous in nature and when taken internally it can cause blindness and even death.
- It is used for denaturing alcohol (methylated spirit is denatured ethyl alcohol).

Ethyl alcohol ($C2H5OH$)

It is simply known as alcohol, spirit of wine or grain alcohol.

Glycerol ($CH2OH. CHOH. CH2OH$)

- It is an important trihydric alcohol known as glycerine.

- It is sweet in taste and very hygroscopic in nature. It is used in the manufacturing of cosmetics and transparent soaps.

Phenol ($C6H5OH$)

It is a monohydric benzene derivative. It is commonly known as carbolic acid or benzenol.

Methyl isocyanate ($CH3NCO$)

Leakage of this gas is responsible for Bhopal gas tragedy.

Coal

- It is believed that is was formed by (carbonization). Different varieties of coal are anthracite (90% carbon), bituminous (70% carbon), lignite (40% carbon) and peat (10-15% carbon).
- On heating at 1270-1675 K in the absence of air, coal decomposes and gives the following products.
- Coke is the solid residue left after the distillation.
- Coal tar It is a mixture of about 700 substances.
- Now-a-days bitumen, a petroleum product, is used in place of coal tar for metalling the roads.
- The most significant characteristics of Indian coal are its high ash content, entrained gasifires and low sulphur content.
- The process of separation of various constituents/ fractions of petroleum is known as refining.
- Knocking - In a petrol engine, vapours of petrol and air are first compressed to a small volume and then ignited by a spark. If the quality of petrol is not good, it leads to the pre-ignition of fuel in the cylinder. This gives rise to a metallic sound known as knocking. Tetraethyl lead (TEL) and Benzene – Toluene – Xylene (BTX) are common antiknock compounds.
- Octane number - The antiknocking property of petrol is measured in terms of octane number. Higher the octane number, better is the quality of fuel. Gasoline used in automobiles has an octane number 80 or higher while in aeroplane, it has an octane number 100 or over higher.

Fuels:

- Producer gas is a mixture of carbon monoxide and nitrogen. Water gas in mixture of carbon monoxide and hydrogen.
- Coal gas is a mixture of hydrogen, methane, carbon monoxide, ethane, acetylene, carbon dioxide, nitrogen and oxygen.

- Oil gas and petrol gas is a mixture of methane, ethylene and acetylene etc., and is obtained by cracking of kerosene.
- LPG (Liquefied Petroleum Gas) the mixtures of hydrocarbons such as propane, propene, n- butane, isobutene and various butane with small amount of ethane.The major sources of LPG are natural gas.
- CNG (Compressed Natural Gas) It is highly compressed from of natural gas, octane rating of CNG is 130.
- Gasohol+ It is a mixture of ethyl alcohol (10%) and petrol (90%).

ATMOSPHERIC POLLUTION

The substance which causes pollution is known as pollutant.

Pollutants are of two types

— **Primary pollutants** persist in the environment in the form, they are produced, e.g. sulphur dioxide (SO2), nitrogen dioxide (NO2) etc.

— **Secondary pollutants** are the products of reaction of primary pollutants, e.g. peroxyacetye nitrate (PAN), ozone (O3), aldehyde etc.

Major Gaseous Air Pollutants

Major gaseous air pollutants are oxides of sulphur, nitrogen, carbon and hydrocarbons.

Sulphur dioxide (SO2)

It is highly toxic for both animals and plants, bronchitis, asthma, emphysema. It also causes eye and throat irritation and breathlessness.

Sulphur dioxide reduces the rate of formation of chloroplast and thus, causes chlorosis. SO2 is highly corrosive and damage buildings, marbles (Taj Mahal) and textiles.

SO2 is oxidized to SO3 which reacts with water to give H2SO4. H2SO4 remains suspended in the air as droplets or come down in the form of acid rain.

Oxides of nitrogen

Among the oxides of nitrogen, nitric oxide (NO), a colourless, odourless gas and nitrogen dioxide (NO2), a brown gas with pungent odour act as tropospheric pollutants.

NO2 is highly toxic for living tissues causes leaf fall. It is a corrosive oxide and helps in the formation of smog.

In the presence of oxygen, NO2 reacts with water or moisture and produces nitric acid (HNO3) which is an important factor for making acid rain.

Carbon monoxide (CO)

From more stable carboxyhaemoglobin complex with haemoglobin due to which the delivery of oxygen to the organs and tissues is blocked.

Hydrocarbons

Out of the hydrocarbons, methane (CH4) is the most abundant hydrocarbon pollutant. Higher concentrations of hydrocarbons given carcinogenic effect, i.e. are cancer producing. They cause ageing of plants, breakdown of plant tissues and shedding of leaves.

Consequences of Atmospheric Pollution

Greenhouse gases such as carbon dioxide, methane and water vapours trap the heat radiated from Earth. This leads to an increase in Earth's temperature. This heating up of Earth and its objects due to the trapping of infrared radiation by greenhouse gases in the atmosphere, is called **greenhouse effect**.

Greenhouse effect is very essential for the existence of life because in its absence, Earth would be converted into extremely cold planet. When concentration of greenhouse gases increases, greenhouse effect also increases. This is known as global warming.

Acid rain

It is caused by the presence of oxides of nitrogen and sulphur in the air. These oxides dissolve in rain water and from nitric acid and sulphuric acid respectively. The rain carrying acids, is called acid rain.

Particulates

Diseases caused by particulate

Diseases	**Cause**
Pneumoconiosis	Due to inhalation of coal dust
Silicosis	Due to inhalation of free silica (SiO_2)
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 **two types**:

Classical smog

These occur in cool, humid climate. Sulphur dioxide (SO2) and particulate matter from fuel combustion are the main components of classical smog.

Photochemical smog

These occur in warm, dry and sunny climate. It consists of a mixture of primary pollutants (nitrogen oxides and carbon monoxides) and secondary pollutants (ozone, formaldehyde).

Peroxyacetyl nitrate (PAN) and aldehydes present in smog causes irritation in eyes. PAN has the highest toxicity to plants. It attacks younger leaves and causes bronzing and glazing of their surfaces.

Stratospheric Pollution

In stratosphere, ozone layer absorbs the ultraviolet radiation of the Sun which are harmful to living organisms.

Depletion of ozone layer causes skin cancer and cataract in human and reduction of planktons in ocean and depletion of plants.

Depletion of ozone layer is caused by chlorofluoro carbons which are used in refrigeration, fire extinguishers and aerosol sprayers.

In stratosphere, the depletion of ozone layer leading to ozone hole has been mainly observed in the stratosphere of Antarctica.

The formation of this hole occurs due to the accumulation of special clouds in the region called Polar Stratospheric Clouds (PSCs) and inflow of chlorofluoro carbons (CFCs).

Water pollution

In some part of India, drinking water is contaminated by the impurities of arsenic, fluoride, uranium, etc.

In water, some dissolved Oxygen (DO) is also present. For a healthy aquatic life, the optimum value of DO is 5-6 ppm. If DO is below 5 ppm, the growth of fishes is inhibited.

Biochemical Oxygen Demand (BOD) is the total amount of oxygen (in mg) required by microbes to decompose the organic matter present in 1L of water sample while Chemical Oxygen Demand (COD) refers to the total amount of oxygen (in ppm) consumed by the pollutants in a water sample.

BOD = Amount of oxygen required (in mg) Volume of water sample (in L)

For clean water, BOD is less than 5 ppm while for highly polluted water; it is 17 ppm or more.