.MEASUREMENT OF LENGTH

Least Count : The minimum measurement that we can find by using an apparatus is called its least count.

Ex : The least count of the common scale is 1 mm..

The fractions of mm can be measured by using Vernier Calipers and Screw Gauge.

SCREW GAUGE : It works on the principle of a screw in a nut. It is used to measure the thickness of a thin glass plate, diameter of a thin wire etc.

Pitch of the screw : The distance traveled by the tip of a screw for one complete rotation of its head is called the pitch of the screw(P).

$$P = \frac{\text{Distance traveled by the screw}}{\text{No. of complete rotations made}} = \frac{x}{n}$$

The smallest distance that can be measured by using the screw gauge depends on the fractional rotation of the screw. For this, the head of the screw is divided into 'N' equal divisions. This is called 'Head scale'.

When the head is rotated such that only one division of the head scale crosses the index line, it moves through the smallest distance called 'Least Count' (L.C). Therefore

$$L.C = \frac{\text{Pitch of the screw}}{\text{No. of head scale divisions}} = \frac{P}{N}$$

This is the Principle of screw gauge.

The index line is divided into some divisions, which is called 'Pitch scale'.

If N = 100 and P = 1mm then L.C = (1/100) mm = 0.01 mm = 0.001 cm.

Description of Screw Gauge :

1. A screw gauge consists of a U – shaped metallic frame(F). To one end of this frame a flat shaft (S) is fixed.
2. On the opposite end of the frame a hollow, long cylinder (C) is fixed which has fine threads inside. This cylinder serves as a nut.
3. A line is drawn on the outer surface of the cylinder parallel to its axis called index

line which is divided into some equal divisions. This is the pitch scale (P).

4. Another flat shaft (S) moves through the cylinder (C). To the other end of this a milled head (M) is connected.
5. One end of the barrel (B) is connected to the milled head, which forms a jacket to the cylinder (C).
6. The other end of the barrel is divided in to 100 or 50 equal divisions on it. This is called head scale (H).
7. When the two shafts are in contact the edge of the head scale must coincide with the pitch scale zero and the index line will be coinciding with the head Scale Zero.

Determination (Measurement) of the diameter of a marble by using Screw Guage:

Aim:- Measuring the diameter of marble by using Screw Guage.

Requirements:- Screw Guage, Marble.

Method:-

1. Check the screw guage for error and note down the error.
2. Find the L.C of Screw Guage by using the following formula

   P = x/n and L.C = P/N.
3. By rotating the milled head fix the object in between the shafts.
4. Identify the P.S.R. The division of the Pitch scale which is preceding the edge of head scale is known as pitch scale reading (P.S.R).
5. Identify the Head Scale Reading (H.S.R). The division of the head Scale which coincides with the index line is called H.S.R.

Sl No.	Object	P.S.R	H.S.R	CHSR	CHSRx L.C	d = PSR+(CHRSx L.C)
1	Marble					

6. Diameter of the Marble is d = PSR + (C.H.S.R x L.C)

-

Zero Error of Screw Gauge:- When the two shafts ($S_1$and S_2) are in contact, if the zero of he head Scale does not coincide with the index line, then the Screw Guage is said to be having zero error.

There are two types of zero errors. They are

-

i.Negative Zero Error:- when the two shafts of the Screw guage are in contact, if the zero of the head scale is above the index line, then the error is said to be negative zero error and the correction is positive.

Corrected H.S.R = observed H.S.R + n

Where n = No. of the head Scale division which coincides with the index line.

ii.*Positive Zero Error:-* when the two shafts of the screw gauge are in contact, if the zero of the head scale is below the index line, then the error is said to be positive zero error and the correction is negative.

Corrected H.S.R = observed H.S.R – n

Where n = No. of the head scale division which coincides with the index line.

Unit 2: OUR UNIVERSE – GRAVTATION

-

The study of celestial bodies is known as Astronomy. The Greek Scientists made earlier attempt in the field of Astronomy.

Ptolemaic theory: (Geocentric Theory)

1. This was proposed by Greek Astronomer "Ptolemy".
2. According to this, Earth is stationary and is at the centre of The Universe.
3. The Sun, the Moon, Planets, Stars etc are revolving around Earth.
4. This theory is also called as Geocentric theory.

Copernican Theory:

1. This was proposed by a polish monk, Copernicus.
2. According to this, the Sun is at the centre of the Universe.
3. The Earth and other planets are revolving around the Sun circularly.
4. This theory is also called as helio centric theory,

A great astronomer Tycho Brahe made observations for the acceptance of helio centric theory. This data was analyzed by the Johannes Kepler (assistant of Brahe) and proposed that the planets revolves round the sun in elliptical orbits.

Newton’s law of universal gravitation:

Newton observed that every object in the universe attracts every other object, and that general force is termed as “force of gravitation” or ‘gravitational force’. The Newton proposed ‘Universal law of Gravitation’. According to this law,

“Every body in the universe attracts every other body with a force which is directly proportional to the product of the masses and inversely proportional to the square of the distance between them. The force acts along the line joining the two bodies”.

If the masses of any two bodies are m_1, m_2 and the distance between them is r, then the gravitational force of attraction between them is F,

$$F = \frac{m_1\, m_2}{r^2} \Longrightarrow F = G\frac{m_1 m_2}{r^2}$$

G = Proportionality constant called Universal Gravitational constant.

$G = \frac{Fr^2}{m_1 m_2}$ the units are Nm^2 / Kg^2 or $Nm^2\ Kg^{-2}$

If $m_1 = m_2 = 1$ kg and r = 1 then F = G.

Definition of “G”:- The gravitational constant is equal to the force of attraction between two unit masses when they are unit distance apart.

Value of “G” is $6.67 \times 10^{-11}\ Nm^2\ Kg^{-2}$

Acceleration due to gravity (g):- The uniform acceleration produced in freely falling body due to the gravitational pull of the Earth is known as acceleration due to gravity and is denoted by ‘g’.

-

Calculation of the value of ‘g’:- Relation between ‘g’ and ‘G’.

If a stone of mass ‘m’ is dropped from a distance ‘r’ from the centre of earth of mass ‘M’, then according to universal law of gravitation the force existed by the earth on the stone (object) is

$$F = G\frac{Mm}{r^2} \text{ ------------ } (1)$$

This force produces acceleration ‘g’ in it from Newton’s Second law of motion

$$F = ma = mg \text{ ---------- } 2$$

From (1) and (2) we have

Mg=$\underline{GMm}$ è g = $\underline{GM}$

r^2 r^2

"g" is independent of the value of the mass of the object (Stone)

Gravitational Constant $G = 6.67x10^{-11}\ Nm^2/Kg^2$

Mass of the Earth $M = 6x10^{24}Kg$

Radius of the Earth $r = 6.4x10^6\ m$

$$\text{Therefore } g = \frac{6.67x10^{-11}x6x10^{24}}{6.4x10^6x6.4x10^6} = \frac{667x6}{64x64}x10^{24}x10^{-11}x10^{-12}$$

$$= \frac{667x6x10}{64x64} = 9.8\ m/s^2$$

- The value of "g" on the moon is $1.67\ m/s^2$, which is 1/6th of "g" on the earth.
- The value of "g" on the sun is $27.4\ m/s^2$.
- The value of "g" on any planet is depending on its mass (M) and radius (r)

Variation of "g" value:-

At a given place on the earth the value of "g" is constant.

The following are the factors which are affecting the "g" value.

i) **Height (Altitude)**

a) The value of "g" is inversely proportional to the square of the distance from the centre of the earth.

b) So, as we move upwards from the surface of earth, the "g" value decreases.

c) At a height "h" if the acceleration due to gravity is 'g_h' then $g_h= g(1-2h/r)$

d) If $h=r/2$, $g_h=0$ i.e., at a height equal to half the radius of the earth, acceleration due to gravity is zero.

ii) **Depth :-**

a) As we go deep inside the earth the 'g' should increase

b) But, it is found that 'g' decreases as we go inside the earth

c) Because the effective mass of the earth decreases, which is given by

$$M=4/3\ \prod r^3\rho \ (\rho=\text{average density of the earth})$$

d) At a depth'd' if the acceleration due to gravity is g_d, then $g_d=g\ \{ 1-d /r\}$

e) If $d=r$, $g_d=0$ i.e., at the centre of the earth ($g_d=o$) acceleration due to gravity is zero.

iii) At the poles the acceleration due to gravity is maximum. Because at the poles the radius of the earth is minimum.

iv) At the equator the acceleration due to gravity is minimum. Because the radius of the earth is maximum.

v) **Local Conditions :-** The acceleration due to gravity (g) is slightly affected by geological deposits, massive concrete buildings and topography.

-

Gravity Meter:- Sensitive instruments used to measure the changes in the value of 'g' at a given location are called gravity meters.

Ex: Boliden gravity meter, Gulf gravity meter.

Mass:-

a) It is the quantity of matter contained in a body and is a fundamental property of the body.

b) The mass of a given body is same any where in the Universe.

c) It is denoted by 'm'.

d) It is measured in Kilograms or grams by using simple balance.

e) It is a scalar.

-

Weight:-

a) The weight is the force with which a body is attracted by the earth towards its centre.

b) Weight is denoted by 'w' and is equal to the product of the mass of the body and the acceleration due to gravity (w=mg).

c) Since the 'g' value changes, the weight of a given body differs from place to place.

d) It is measured in 'Kgf' or 'kgwt' or newtons (N) by using spring balance.

e) The weight is a vector.

Definition: - One kilogram weight is that gravitational force which acts on a body of mass 1Kg.

1Kgwt=1Kgf = 9.8 Newtons

Hooke's Law :- It was given by Robert Hooke "When a spring is fixed at one end and a force is applied to the other end, the stretching of the spring is proportional to the applied force, provided the force is with in the elastic limit of the spring"

Determination of weight of a body:- (Verification of Hooke's Law)

Apparatus:- An extensible spring, pan, pin, weights, retort stand, meter scale, Plasticine.

Method:-

a) Suspend the spring from a retort stand and attach a pan to the lower end of the spring.

b) Fix a pin at the lower end of the spring perpendicularly which serves as a pointer.

c) Fix the meter scale vertically so that the pin (pointer) can move over the scale.

d) Record the initial reading of the pointer (l_o).

e) By placing 10 gm weight in the pan note the reading of the pointer (l_1). Repeat this by increasing loads 10 grams in each step up to 100 gms.

f) Similarly note the readings of the pointer (l_2) while unloading the weights 10gms each time.

g) The mean extension for the each load is $l = (l_1+l_2)/2$

h) Extension of the spring each time is $l-l_o$

i) We can find each time that (l-lo)/F is constant.

Therefore (l-lo) α F. Hence Hooks law is verified.

Force (F) Gm.wt	Balance readings		Mean (l)	Extension of the spring (l-lo)cm	Extension for unit force (l-lo)/F
	loading (l_1)	unloading (l_2)			
10 20 - 100					

-

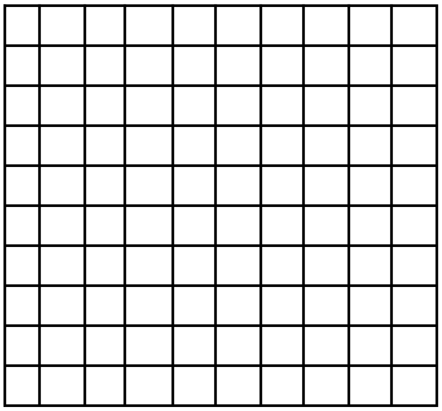
Calibration Graph:- The graph plotted between stretching (l-lo) against force (F) is a straight line passing through origin. This is called calibration graph. This is used to measure the weight of the body.

i) Place the body on the pan and note the reading of the pointer(l^1)

ii) Find the extension l^1-lo

iii) Locate the point of l^1-lo on Y-axis

iv) The corresponding x-coordinate value gives the weight of the body.



UNIT -3 KINEMATICS

When a body is traveling with uniform acceleration we have the equations of motion as

$V=u+at$ $S=ut+\frac{1}{2}at^2$ $V^2-u^2=2as$

To apply these equations for a body which is moving under the gravity of earth (for the body falling down from a height or the body going to a height) we have to make the following changes. They are

i) Here the bodies are traveling vertically the distance ‘s’ is replaced by the height ‘h’

ii) The acceleration produced in the body is the acceleration due to gravity. So ‘a’ is replaced by ‘g’. Here the ‘g’ is taken as + ve or –ve depending on the direction of the body related to earth.

Hence the equations of motion for the bodies in motion under gravity are

$V=u\pm gt$ $h=ut\pm 1/2gt^2$ $v^2-u^2=\pm 2gh$

These equations get modified further into two classess.

i) Equations of Motion for a freely falling body:- When a body is dropped from some height, it falls with a uniform acceleration ‘g’ under the action of gravity. Such bodies are called freely falling bodies.

The direction of ‘g’ and the motion of the body are same. Therefore ‘g’ is taken as positive. The equations of motion for freely falling body are

$v=u+gt$ $h=ut+\frac{1}{2}gt^2$ $v^2-u^2=2gh$

Since no initial force is applied, for freely falling body initial velocity is zero (u=0). Hence the equations can also be written as

$v=gt$ $h= \frac{1}{2} gt^2$ $v^2=2gh$

ii)<u>Equations of Motion for a body thrown up:</u> When a body is thrown vertically up with some initial velocity, the direction of the motion of the body and the direction of 'g' are opposite to each other. Therefore 'g' is taken as negative. The equation of motion for the body thrown up are

$v = u – gt$ $h = ut – \frac{1}{2} gt^2$ $v^2 – u^2 = -2gh$

-

2) Maximum height reached by a body thrown up:-

For a body thrown up, the height (h) where the final velocity of the body becomes zero is called maximum height reached by the body.

For the bodies projected or thrown up, we have

$v^2-u^2 = -2gh$ here v=o

$-u^2 = -2gh$ ======> $2gh =u^2$

OR $h= \frac{u^2}{2g}$

The maximum height reached by a body is directly proportional to the square of the initial velocity (u).

Time of Ascent: Time taken by a body thrown up to reach maximum height is called its tine of ascent (t_1).

We have $v = u-gt$ for bodies thrown up

Here $v = 0$ at maximum height

$u-gt_1 =0 \Rightarrow t_1 = \frac{u}{g}$

Time of ascent is directly proportional to the initial velocity.

-

Time of descent:

Time taken by a freely falling body to touch the ground is called the time of descent (t_2)

For freely falling body we have $h=1/2gt^2_2$

$t_2^2= \frac{2h}{g} = t_2 = \sqrt{\frac{2h}{g}}$

But we have $h= \frac{u^2}{2g}$ therefore $t_{2} = \sqrt{\frac{2u^2}{2g^2}} = \sqrt{\frac{u2}{g^2}} \Longrightarrow t_2= \frac{u}{g}$

The time of ascent is equal to the time of descent in the case of bodies moving under gravity.

Time of flight: The time for which a body remains in the air is called time of flight. It is given by the sum of time of ascent and time of descent.

$t = t_1+t_2 = \frac{u}{g} + \frac{u}{g} \qquad t = \frac{2u}{g}$

Velocity on reaching the ground:- For the freely falling body, u=o when it reaches the ground let the velocity is V.

For freely falling body we have $v^2-u^2=2gh$

Since u=o, we have $V^2 = 2gh \Longrightarrow V=\sqrt{2gh}$ -----(a)

From $h=\frac{u^2}{2g}$ we have $u^2 == 2gh \Longrightarrow u=\sqrt{2gh}$ -----(b)

"The upward velocity at any point in its flight is the same as its downward velocity at that point."

Phy – 4 : DYNAMICS

Def : - The study of motion of a body under the action of a force is called 'dynamics'.

There are three types of motions depending on the nature of the force. They are (i) Translatory (linear) motion (ii) Oscillatory (vibratory) motion and (iii) Rotatory motion.

ROTATORY MOTION:- A body is said to be in rotatory motion if every particle moves in a curved path about a fixed point.

CIRCULAR MOTION:- Circular motion is a special case of rotatory motion. In this motion the velocity (v) does not change, but direction changes. Here the magnitude of radius(r) remains constant.

The perpendicular imaginary line passing through the centre of the circular motion is called axis of rotation.

Here the body rotates in XY – plane, OZ is the axis of rotation. OA or OP is called the 'radius vector'.

In circular motion, at every point on the path of the particle, the linear velocity 'v' of the particle is directed along the tangent at that point.

ANGULAR DISPLACEMENT:- Let us consider a particle 'P' moving along a circular path. The angular positions of the particle at time t_1 and t_2 are given by θ_1 and θ_2.

"The angle through which the radius vector rotates in a given time is called angular displacement".

Angular displacement $= \theta_2 - \theta_1 = \Delta\theta$

Time interval $= t_2 - t_1 = \Delta t$

The angular displacement is measured in units of "radians".

ANGULAR VELOCITY:- The rate of angular displacement is defined as angular velocity (?).

$$\text{Angular velocity} = ? = \frac{\text{angular displacement}}{\text{time interval}} = \frac{\theta_2 - \theta_1}{t_2 - t_1} = \frac{\Delta\theta}{\Delta t}$$

-

The instantaneous angular velocity is defined as the limit approached by the ratio $\frac{\Delta\theta}{\Delta t}$ i.e. as Δt approaches zero.

$$\text{Instantaneous angular velocity} = ? = \text{Limit}_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}$$

"The time period (T) of a particle in a circular motion is defined as the time taken by it to complete one revolution".

In time 'T' seconds the angular displacement of the particle is $2\prod$ radians. Then $d\theta = 2\prod$ radians and $dt = T$ sec.

$$? = \frac{d\theta}{dt} = \frac{2\prod}{T} \text{ radians/sec}$$

The angular velocity is measured in the units of "radians/sec".

UNIFORM CIRCULAR MOTION:- In a uniform circular motion, the angular velocity, the radius vector and the time period(T) remains constant.

-

RELATION BETWEEN ? AND V : - The time taken by the particle to go from A to P be Δt, the angle is $\Delta\theta$ and the radius vector is 'r', then

arc AP = $r\,\Delta\theta$ ----- (1)

The linear speed 'v' of the particle is given by

$$v = \frac{AP}{\Delta t} = \frac{r\Delta\theta}{\Delta t} = r\,\text{Limit}_{\Delta t\to 0}\ \frac{\Delta\theta}{\Delta t} = r\,\frac{d\theta}{dt} = r?$$

Hence v = r?.

The linear speed of a particle in a circular motion is the product of the angular speed and distance 'r' of the particle from the axis of rotation.

The angular momentum of the particle in circular motion is, $L = mvr = mr^2?$

-

CENTRIPETAL (NORMAL) ACCELARATION:- For a particle moving on a circle, the direction of the linear velocity at any position on the circle will be tangential to the circle at that point.

Thus the force must be acting in a direction normal to the motion of the particle at every point. This force is called normal force (centripetal force). By the action of this force, the particle should have an acceleration, which is called 'normal acceleration' (centripetal acceleration).

Def:- a particle executing uniform circular motion undergoes a continuous change in the direction of its velocity which results in an acceleration directed towards the centripetal(normal) acceleration.

The centripetal acceleration = $a = v^2 / r$

-

CENTRIPETAL FORCE:- The force which acts continuously on a particle initially moving with a linear velocity and makes it travel along a circular path is called 'Centripetal force'.

The centripetal force is always directed along the radius towards the centre of the circle. It is must for uniform circular motion.

$$\text{Centripetal force} = \frac{mv^2}{r} = m?^2r$$

Examples of Centripetal force:-

a) The gravitational force between the Sun and planets.

b) The gravitational force between the satellite and planet.

c) The electrostatic force of attraction between the electrons and nucleus in the atom.

INERTIAL FRAME OF REFERENCE:- An imaginary co-ordinate system which is either at rest or in uniform motion and where Newton's laws are valid is called an "inertial frame of reference".

NON-INERTIAL FRAME OF REFERENCE:- An imaginary co-ordinate system which is attached to a rotating or accelerated body where Newton's laws are not valid is called "non-inertial frame of reference".

CENTRIFUGAL FORCE:- The radially outward force on a body in a uniform circular motion, observable only in a rotator(non-inertial) frame of reference is called 'centrifugal force'.

$$\text{Centrifugal force} = \frac{mv^2}{r} = m?^2r$$

- Centripetal and centrifugal forces both act on the same rotating body.
- Both forces depend on the mass(m), tangential speed(v) and the radius(r) of the circle.
- Both forces are equal in magnitude but opposite in direction.

In an inertial frame of reference the centrifugal force cannot be associated with any object or agent. Hence it is a pseudo force or fictitious force.

APPLICATIONS OF CENTRIPETAL FORCE:-

The centrifugal force is depending on the mass of the object and is more for bodies of higher mass. This is the principle of working of various machines utilizing rotator motion.

CENTRIFUGE:-

a) A centrifuge is a machine which works on the basis of centrifugal force.
b) It is used to separate particles of different mass in a given mixture.
c) It consists of a cylindrical vessel rotated about its own axis at high speed with the help of electric motor.
d) Milk is poured into the vessel and centrifuge is rotated.
e) Higher mass skimmed milk particles are thrown away from the centre.
f) Lower mass cream particles collect at the centre.

g) The same principle is involved in domestic churner.

Uses of Centrifuge:- a) To separate Sugar crystals from molasses and
b) To separate Honey from bee's wax, we are using centrifuge.

LAUNDRY DRIER:-

a) Laundry drier is used to dry wet clothes.
b) The wet clothes are dropped into a cylindrical vessel containing holes.
c) When the vessel is rotated, the wet clothes get stuck to the walls of the vessel.
d) The centrifugal force pushes the water molecules from the clothes out through the holes.
e) Like this the clothes are dried.

BANKING OF ROADS:- When a road is curved the outer edge of the road is slightly raised above the level of the inner edge to provide centripetal force to the vehicles passing through that curved path. This is called 'banking of roads'.

If there is no banking the vehicle has to take the help of frictional force between its tyres and the road, which is limited and is not always dependable. So the banking of roads is necessary. Otherwise the vehicle would skid.

-

ANGLE OF BANKING(θ):- The angle made by the line joining the outer, raised edge of the road to the inner edge with the horizontal line is called 'angle of banking(θ)'.

(FIGURE)

Here AC = Actual road
AB = The horizontal line
∟CAB = Angle of banking(θ)
O = Centre of gravity of car

At 'O', the weight of the car (mg) acts along OP, perpendicular to 'AB'. The normal reaction (R) exerted by the actual road AC on the car is along OQ.

Because of the simultaneous action of 'mg' and 'R', the resultant force acts along 'OS' parallel to the radius of curvature.

By resolving 'R' along the two perpendiculars, we have $RCos\theta$ along OD and $RSin\theta$ along OS. Then

$RCos\theta = mg$ -----(1)

$RSin\theta$ directed towards the centre of curvature. So it provides centripetal force. Therefore

$RSin\theta = mv^2 / r$ -----(2).

From (1) and (2) we have $\theta = Tan^{-1} (v^2 / rg)$

PRINCIPLE OF ORBITING SATELLITE:- The principle of launching an artificial satellite into a proper space orbit is to impart sufficient initial horizontal speed such that it revolves round the Earth at chosen height.

The orbital velocity of an artificial satellite is 8 – 11 km/s.

The escape velocity is more than 11 km/s.

An artificial satellite sends information in the form of electromagnetic waves.

USES OF ARTIFICIAL SATELLITE:-

1) 1. Some satellites are communication satellites, which are used in communications like telephone conversations, FAX, INTERNET etc., between different countries.

2) 2. Satellites are used for ‘weather prediction’.

3) 3. Some satellites are remote sensing satellites, which can see the areas of forests, deserts on the land and areas on the ocean. This satellite is also used to find the fish deposits in certain area of ocean.

4) 4. Presence of minerals, ores and ground water in a region of the land in a country could be detected from the pictures sent by satellites.

5) 5. Satellites have been used for spying by defense services of country.

6) 6. Satellites and space stations are used for study of planets.

6. SOUND

Natural vibrations: When a body is set into vibration and then left to itself, the vibrations are called natural or free vibrations. The frequency of that body is called ‘natural frequency’.

Ex: The natural frequency of tuning form depends on its dimensions and of simple pendulum depends on its length.

DAMPED VIBRATIONS:- Periodic vibrations of decreasing amplitude are called damped vibrations.

FORCED VIBRATIONS:- When a body executes vibrations under the action of an external periodic force, then the vibrations are called forced vibrations.

RESONANCE:- Resonance is a particular case of forced vibrations between two or more bodies of the same natural frequency.

Def:- Resonance is the phenomenon in which if one of the two bodies of the same natural frequency is set into vibration, the other body also vibrates with larger amplitude under the influence of the first body.

EXAMPLES OF RESONANCE PHENOMENON:-

1. When the soldiers are crossing a suspension bridge, if the frequency of vibration of their marching becomes equal to the natural frequency of the bridge, the bridge would vibrate with large amplitude due to resonance and the bridge could collapse.
2. At a particular speed of a car, a rattling sound may occur in the car due to the resonance between the car engine and the body of the car.
3. In radio when the natural frequency of the incoming carrier electromagnetic waves from a radio transmitter is matching with the frequency of 'tuning', the sound is clearly heard with appreciable amplitude, due to the 'Resonance' between them.
4. When the frequency of a swing is equal to the oscillatory force applied by mother, resonance takes place between them and swing oscillates with larger amplitude.

PROGRESSIVE WAVE:- A wave originating in a source and travelling forward in a medium is called a progressive wave.

Ex:- Sound waves, water waves.

Progressive waves are of two types. They are

TRANSVERSE WAVE:- When the displacement of particles of medium is at right angles to the direction of propagation of the wave, the wave is said to be transverse wave. Ex:- Water waves.

The vibration of particles of the medium gives rise to crests and troughs.

LONGITUDINAL WAVE:- When the displacement of particles of a medium is parallel to the direction of propagation of the wave, the wave is said to be longitudinal wave. Ex:- sound waves.

The vibration of particles of the medium gives rise to compressions and rare fractions.

1. The progressive wave will progress forward from the source.
2. In progressive wave the particles vibrate with same amplitude and frequency, but the phase of the vibration is different for different points.
3. The distance between two successive particles with same phase is equal to wavelength (λ).
4. The energy carried by progressive wave is the sum of potential energy (PE) and kinetic energy (KE) of the vibrating particles at every point.
5. The vibrating particles of the medium transfer energy but they do not move forward along with progressive wave.

STATIONARY WAVE:- On reflection from a rigid or fixed end, a wave undergoes a phase change of ∏ or 180°.

"A stationary wave is formed when two waves of equal frequency and amplitude travel opposite directions along the same path."

In a stationary wave due to simultaneous travelling of incident and reflected waves the loops are forming.

The appearance of loops is the result of energy oscillating between two kinds i.e., P.E and K.E.

In stationary wave the particles which undergo minimum displacement are called 'nodes' and the particles which undergo maximum displacement are called 'antinodes'.

In stationary waves the vibration of the particles of the medium in a loop will be having different amplitudes but are in same phase.

Distance between two successive nodes or antinodes is equal to $\lambda/2$ (half of the wave length). Distance between a node and the successive anti node is equal to $\lambda/4$.

The wave length and frequency of a stationary wave are the same as of the incident wave.

VELOCITY OF SOUND IN AIR:-

Apparatus:- A glass jar of 50cm height and 30cm dia, a glass tube of 40cm length and 3cm dia, tuning fork, retort stand.

Arrangement:-

1. 1. Pour water into the jar to about 3/4 level.
2. 2. Fix the glass tube to the clamp of the retort stand.
3. 3. Immerse the tube in the water of the jar.

4. 4. The air inside the tube above the water level is called ‘air-column’.
5. 5. The length of air column can be varied by raising or lowering the tube with the help of screw.

Procedure:-

1. . a. By keeping the length of air column very small take a tuning fork and strike its prongs.

b. b. Hold the vibrating tuning fork just above the air column and increase the length of air column gradually.

c. c. For a particular length of air column we will hear a loud sound. Stop the procedure. This is called first mode.

d. d. The sound is formed due to the resonance between tuning fork and air column.

e. e. In air column standing waves are formed and it is as follows whose length is l_1.

f. f. Repeat the procedure from the first mode. When the length of air-column reaches the length of $3l_1$ again a loud sound can be heard for the second time.

g. g. This is called second mode in which air column vibrates in the following mode where the length of air column is l_2 (=3 l_1).

h. h. From the diagrams we have l_1

Resonating air column:- When the frequency of air-column becomes equal to the frequency of tuning fork, ‘resonance’ takes place between them and that air column is called ‘resonating air column’.

CURRENT ELECTRICITY

Def : The study of various effects of electrical charges in motion is called “Current Electricity”.

Current:- The net charge flowing through a cross section of a conductor in unit time is called current. It is denoted by‘i’.

If ‘q’ is the net charge passing in a time ‘t’. Then $i = q/t$ coulombs/sec (or) ampere. The current is measured in amperes by using an ammeter.

Ampere:- If a net charge of one coulomb passes through any cross section of a conductor in a time of one second then the current is said to be one ampere.

Electrical Potential:- Electrical potential at a point in a space is defined as the work done in moving a single unit positive charge from infinity to that point. Potential is denoted by 'V' and measured in Volts by using Voltmeter.

If 'w' joules of work is done in moving '+q' coulombs of charge then

$V = w/q$ joules / coulomb (or) volt.

Def:- Potential difference between two points is the work done in carrying one coulomb of +ve charge from one point to the another. Potential difference is also measured in 'volts' by using voltmeter.

Volt:- The electric potential difference between two points is said to be one 'volt' when one joule of work is done in carrying one coulomb of +ve charge from one point to the another.

The potential difference of an electrical device or energy source is called its voltage.

Electromotive Force:- The electromotive force(e.m.f) is defined as the amount of work done by the seat(cell) on charge carriers to force them to go to the point of higher potential. E.M.F is measured in volts.

SIMPLE ELECTRIC CIRCUIT:- A simple electric circuit is an arrangement consisting of a source of electric energy, a device which utilizes this energy and conducting wires which connect them.

The electrical device which utilizes the energy supplied by the source is called "Power consumer".

The copper or any conducting wires which are connecting the source and consumer are called 'connectors'.

In order to make or break a circuit an electrical device called tap-key is used in the circuit.

CELLS IN THE SERIES:- When negative terminal of a cell is connected to the positive terminal of the next cell, then the cells are said to be in "series".

When cells are connected in series, the total potential difference of the combination is the sum of the potential differences of individual cells.

If the e.m.fs of three cells which are connected in series are E_1,E_2 and E_3. Then the effective e.m.f of the circuit is $E= E_1+ E_2+ E_3$.

CELLS IN PARALLEL:- When all positive terminals of two or more cells are connected to a single point and similarly all the negative terminals are connected to another single point, then the cells are said to be in "parallel".

When cells of different e.m.f are connected in parallel, the effective potential difference is equal to the e.m.f of that cell whose e.m.f is great.

If the cells of e.m.fs E_1,E_2 and E_3 are connected parallel and $E_1>E_2>E_3$ then the effective e.m.f $E = E_1$.

SERIES COMBINATION OF BULBS:- In an electric circuit, bulbs are said to be connected in series, if the second terminal of one bulb is connected to the first terminal of the next bulb and so on.

In the series of bulbs,

a)same amount of current exists through all the bulbs.

b)potential difference will be divided among the bulbs.

c)the brightness of each of the bulb decreases compared to the brightness of only a single bulb in the circuit.

d)if one of the bulb is removed or if it fails to work the circuit will be disconnected and the rest of the bulbs will not glow.

PARALLEL COMBINATION OF BULBS:- In an electric circuit, bulbs are said to be connected in parallel, if the first terminals of all the bulbs are connected to a common point and similarly all the second terminals to another common point.

In parallel combination of bulbs,

a)same amount of potential difference exists across all the bulbs

b)current will be divided among all the identical bulbs

c)the brightness of each of the bulb remains same as that of a single bulb in the circuit

d)if one of the bulb is removed or if it fails to work, the rest of the bulbs will continue to glow.

9.2 Electrical Resistance- Ohm's law and it's verification

Every material offers some opposition to the flow of electric current and is termed 'electrical resistance(R)', which is a characteristic property of the conductor.

The current prefers a path of least resistance in the circuit. The method of this connection is called 'short circuiting'.

RESISTANCE:- The electrical property of a conductor by virtue of which opposition is offered to the free flow of electrons in the conductor is called 'resistance'.

The conductor used in a circuit to provide resistance is called a 'resistor'. It is represented by letter 'R' or with a symbol –^^^^^–.

OHM'S LAW:- This was proposed by G.S.Ohm(1826) to give the relation between potential difference(V) and current(i) for a conductor. This law states that,

"The electric current(i) in a conductor is directly proportional to the potential difference(v) between its ends, at a constant temperature(T)".

According to Ohm's law, $v \propto i$ => $v = iR$

R= proportionality constant called electrical resistance of the conductor.

Unit of resistance : $V = iR$ => $R = V/i$ volt/ampere

The unit of resistance is volt/ampere and is called 'ohm(Ω).

Def:- The resistance of a conductor is said to be one 'ohm' if a potential difference of one volt between its ends cause a current of 1 ampere in it.

If v = 1 volt, i = 1 amp then R = 1 volt / 1 amp = 1 ohm.

-

Verification of Ohm's law:- To verify the Ohm's law we have to show that v/i = constant.

Requirements:- Battery, ammeter, voltmeter, a resistance and rheostat.

Arrangement:- Arrange the above apparatus as shown in the circuit.

(Diagram from the text book)

Procedure:- By adjusting the rheostat position note down the readings of voltmeter and ammeter 5 to 6 times. Each time calculate the ratio v/i. These values will almost constant. This means the Ohm's law is verified.

(Table from the text book)

“The resistance of a conductor remains constant at constant temperature no matter what applied voltage is used to measure it”

Ohmic conductors:- The conductors which obey the Ohm’s law are called Ohmic conductors. For these the graph between v and i is linear and hence also called as linear conductors. Ex:- Metallic conductos.

Non-Ohmic conductors:- The devices or conductors which do not obey Ohm’s law are called ‘non-Ohmic conductors’ or ‘non-linear conductors’.

Ex:- Semi conductors,electrolytes etc.

9.3 Laws of Resistance

Factors affecting the resistance:-

The resistance of a conductor

1) Depends upon the nature of material.
2) Is directly proportional to its length(R□l).
3) Is inversely proportional to its area of cross section(R□1/A).
4) Is directly proportional to the temperature of the specimen.

Laws of Resistance:- There are two laws of resistance. They are

i)The resistance(R) of a conductor of a given material is directly proportional to its length(l) when temperature and area of cross-section remain constant.(R□l)

ii)The resistance of a conductor of a given material is inversely proportional to its area of cross section(A) when length(l) and temperature remain constant(R□1/A).

combining the two laws, we have $R \square \frac{l}{A}$

$R = \frac{\rho l}{A}$ where ρ = proportionality constant(Specific resistance or Resistivity)

if $l = 1m$, $A = 1m^2$ then $\rho = R$.

Def:- The specific resistance or resistivity of a material is defined as the resistance of its specimen of unit length and unit area of cross section.

Units of specific resistance are 'ohm-mtr(Ωm)'.

9.4 Resistances in Series and Parallel

SERIES COMBINATION OF RESISTORS:- In a circuit, resistors connected end- to-end are said to be in series if the same current exists in all of them through a single path.

The voltage in series of resistors is equal to the sum of the voltages across individual resistors. $V = V_1 + V_2$ ------- (1)

EQUIVALENT RESISTANCE OF SERIES COMBINATION:- Let a current 'i_s' is passing through the resistors R_1 & R_2 which are connected in series. By applying Ohm's law to the resistors R_1 & R_2 we have $V_1 = i_sR_1$ & $V_2 = i_sR_2$.

By substituting in (1) we have $V = i_sR_1 + i_sR_2 = i_s(R_1+R_2)$ -------(2)

Let R_1 & R_2 are replaced by a single resistance 'R', then we have $V= i_sR$ --(3)

From (2) and (3) $i_sR = i_s(R_1+R_2)$ è $\underline{R = R_1+R_2}$

"When resistances are connected in series, their equivalent resistance is equal to the sum of the individual resistances"

PARALLEL COMBINATION OF RESISTORS:- In a circuit, resistors connected to common terminals are said to be in parallel, if identical p.d. exists across all of them.

The current in the parallel of resistors is equal to the currents through the resistors.
$i_P = i_{P1} + i_{P2}$.--------- --(1)

EQUIVALENT RESITANCE OF PARALLEL COMBINATION: Let a potential difference 'v' exists across the resistors R_1 , R_2 which are connected in parallel. By applying Ohm's law to the resistors R_1 & R_2, we have

$i_{P1} = \frac{V}{R_1}$, $i_{P2} = \frac{V}{R_2}$. è By substituting in (1) we have

$$i_P = \frac{V}{R_1} + \frac{V}{R_2} = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right) \text{ --------(2)}$$

Let a resistance 'R' replace the parallel combination of R1&R2 then iP =V/R--(3)

From (2) and (3) we have $\frac{V}{R} = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{(or)} \quad R = \frac{R_1 \text{ x } R_2}{R_1 + R_2}$$

"When resistances are connected in parallel, the reciprocal of their equivalent resistance is equal to the sum of the reciprocals of the individual resistances".

9.5 Heating Effects of Electric Current : Joule's Law

When a p.d is applied between the ends of a conductor, the electrons drifts, colloids with the ion core of the conductor and transfer energy. Then the ions begin to vibrate with increased amplitude and hence the temperature of the conductor increases and will be transmitted to the surrounding in the form of heat. This is called the heating effect of electric current.

A metallic wire having resistance which is used to produce heat is called 'heating element' or 'filament'.

FACTORS GOVERNING HEATING EFFECTS OF ELECTRIC CURRENT:

The quantity of heat produced by a current

a)in a given time is directly proportional to the resistance (Q□R).

b)in a resistance is directly proportional to time for which current flows through it (Q□t)

c)in a resistance is directly proportional to the square of the magnitude of the current(Q□i^2)

By combining these factors we get the relation Q □ i^2Rt

ELECTRICAL ENERGY: When a p.d ‘V’ is applied by the cell across a resistor ‘R’ it drives the charge ‘q’ through it and causes a current ‘I’.

Then the electrical work done ‘W’ by the cell is $W = Vq$ (from def. of potential)

But from the def. of current, we have $q = it$ è $W = Vit$.
From Ohm’s law we have $V = iR$ è $W = i^2Rt$.

This gives the ‘electrical energy’, whose S.I unit is ‘joule’. If the resistor is a heating appliance, the entire electrical energy is converted into heat energy.

Joule’s Law: Joule’s law states that a given amount of work done in different ways produces the same quantity of heat in all cases.

If W is the mechanical work done in Joules and Q is the heat produced in calories, then according to Joule’s law

W □ Q è $W = JQ$ (J=mechanical equivalent of heat or Joule’s const)

The value of J is 4.18 Joules/calories.

$$W = JQ \quad \Rightarrow \quad Q = \frac{W}{J} = \frac{Vit}{J} = \frac{i^2Rt}{J}$$

ELECTRIC POWER: Rate of electric work done is defined as electric power(P).

$$P = \frac{\text{work}}{\text{time}} = \frac{W}{t} \quad \frac{\text{joules}}{\text{sec}} \text{ (or) Watt}$$

Watt: Electric power is said to be one watt if 1 joule of work is done in one sec.

$P = Vit / t = Vi$ è power = voltage x current(volt-ampere or watt)

Wattage of electrical appliances: Wattage of an electrical appliance is defined as the rate at which electrical energy is consumed by it. Wattage of appliance is the power consumed by it and expressed in watts.

HOUSE HOLD CONSUMPTION OF ELECTRICAL ENERGY:

The electricity cables entering our house pass the current through an electric meter. These cables supply an A.C of 230 volts. This is called mains supply.

The units of house hold consumption of electrical energy are kilo-watt-hours(KWH).

Electrical energy(W) = Power(wattage) x Time(seconds) (watt-seconds)

Watt-hour is defined as the electrical energy consumed by an appliance of 1 watt for an hour.

1 watt-hour = 1 watt x 1 hour = 1 watt x 60 x 60 sec = 3600 watt-seconds

The commercial unit of electrical energy is KWH.

1 KWH = 1000 WH = 1000 x 3600 watt-seconds= 36×10^5 watt-seconds.

9.6 Faraday's Laws of Electrolysis

Electrolysis: The process of decomposition of a chemical compound in a solution when an electric current passes through it is called Electrolysis.

If the solution decomposes into its constituents when current passes through it in its liquid state, it is called 'electrolyte'. Ex:$CuSO_4$, $AgNO_3$ etc.

Voltameter: The vessel which contains an electrolyte and allows electrolysis to take place is called a VOLTAMETER or Electrolytic cell.

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MECHANISM OF ELECTROLYSIS:

1. When the electric current passes through the electrolyte solution, its molecules dissociates into ions.

   Ex: $CuSO_4$ è $Cu^{2+} + SO_4^{2-}$
2. During eletrolysis the concentration of electrolyte($CuSO_4$) remains unaffected.
3. The anode gains electrons and the cathode loses same no., of electrons. (2 electrons in the case of $CuSO_4$ electrolyte)
4. The flow of electrons constitutes an electric current in the external circuit.
5. The no., of electrons extracted at the cathode is equal to the no., of electrons supplied at anode.
6. The metal atoms are deposited on the cathode and for each deposit one metal atom(Cu) goes into the solution.
7. So, the mass of cathode increases and the mass of anode decreases by an equal amount.

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Faraday's Laws of Electrolysis:

In 1833, Michael Faraday conducted a series of experiments on liquid electrolytes and proposed two laws of electrolysis.

FARADAY'S FIRST LAW OF ELECTROLYSIS: The Faraday's first law of electrolysis states that the mass(m) of ions liberated from an electrolyte is directly proportional to the strength of the current(i) and time(t) for which the current passes.

According to this law m œ i and m œ t

m œ it ==> m = Zit (Z= electro chemical equivalent of the metal e.c.e)

$Z = \frac{m}{it}$ but from def., of current q = it $Z = \frac{m}{q}$ gram/coulomb

Def:- The electro chemical equivalent(e.c.e) of an element is defined as the mass of its ions liberated at the electrode when one coulomb of electricity is passed through the electrolyte.

Equivalent Weight(E):- The ratio of atomic weight(A) of an element to its valency(V) defined as 'chemical equivalent or equivalent weight(E)'.

FARADAY'S SECOND LAW OF ELECTROLYSIS:- This law states that when the same quantity of electricity passes through different electrolytes, the masses of ions liberated at the respective electrodes are proportional to their chemical equivalents.

When the same quantity(q) of electricity is passed through three different electrolytes and if

E_1, E_2, E_3 = chemical equivalents of the metals present in the electrolytes

Z_1, Z_2, Z_3 = electro chemical equivalents of these metals

m_1, m_2, m_3 = masses of the ions liberated at respective electrodes.

Then according to second law of electrolysis

$\frac{m_1}{E_1} = \frac{m_2}{E_2} = \frac{m_3}{E_3}$ (or) $m_1 : m_2 : m_3 = E_1 : E_2 : E_3$ -------(1)

This is one form of second law of electrolysis. By applying first law of electrolysis to these three electrolytes, we have

$m_1 = Z_1q, m_2 = Z_2q, m_3 = Z_3q$ è $m_1 : m_2 : m_3 = Z_1 : Z_2 : Z_3$ ------(2)

from (1) and (2) we get $Z_1 : Z_2 : Z_3 = E_1 : E_2 : E_3$

This is another form of second law of electrolysis. Form this, "the ratio of electrochemical equivalents of elements is equal to the ratio of their chemical equivalents".

Determination of e.c.e(Z) of an element:

1. Record the initial weight of the cathode(w_1).
2. Allow the current 'i' for the time of 't' sec and record it.
3. After stopping the current record the final weight of the cathode(w_2).
4. The mass of the ions of the element $m = (w_2 - w_1)$gm.

5. The e.c.e of the element can be calculated by substituting the values in

$$Z = \frac{m}{it} \quad \text{gm / coloumb}$$

Verification of Faraday's first law of electrolysis: To verify the Faraday's first law we have to prove that 'Z' is a constant for a given substance.

Take $CuSO_4$ voltameter. The current can be varied by using Rheostat and can be measured by using ammeter.

Pass a current i_1 for a time t_1 seconds. Measure the mass m_1 of the copper deposited on the cathode. Calculate Z by using $Z=m_1 / i_1t_1$.

Change the slider position in rheostat and allow a current i_2 for a time t_2 seconds. Again determine mass m_2 of copper deposited on the cathode and calculate Z by using $Z = m_2 / i_2t_2$.

The value of Z in both the cases is same. This verifies the Faraday's first law of electrolysis.

Verification of Faraday's second law of electrolysis:

1. Take three voltameters containing CuSO4, AgNO3 and ZnSO4 all with copper electrodes.
2. Determine the weights of the individual cathodes of voltameters.
3. Arrange the voltameters in series, and adjust the rheostat such that one ampere current passes through the voltameters.
4. Allow current for half-an-hour time. At the end determine the final weights of the individual cathodes.
5. The differences between the final and initial weights gives the mass of copper(m_1), silver(m_2) and zinc(m_3) deposited on the respective cathodes.
6. If E_1, E_2 and E_3 are the chemical equivalents of copper, silver and zinc respectively, then $\frac{m_1}{E_1} = \frac{m_2}{E_2} = \frac{m_3}{E_3}$

This verifies the Faraday's second law of electrolysis.

APPLICATIONS OF ELECTROLYSIS:

Metallurgy: The process of electrolysis is used in the refining and extraction of metals like copper, tin, lead, gold etc.,

In this method anode is an impure metal or its ore and cathode is the same but pure metal. The electrolyte should be a solution of the same metal. The pure metal gets deposited on the cathode.

Electroplating: It is a process of coating a thin film of costlier or less corrodible metal on a base metal by the method of electrolysis. The article forms the cathode and the metal to be coated forms the anode.

Electrotyping: It is a method of obtaining exact copy of an engraved block containing letters or figures by the method of electrolysis.

By pressing the block on a soft material like wax and coated with powdered graphite or lead. This mould serves as the cathode and the pure material rod serves as the anode. After electrolysis the mould is removed and wax is eliminated.

9.7 Magnetic effects of Electric Current

When an electric current flows in a conductor it sets up a magnetic field around the conductor. The following are some rules to know the direction of that Magnetic field.

Maxwell's cork-screw rule: If we rotate the screw-head such that its tip advances in the direction of current in the conductor, then the direction of rotation of head of the screw gives the direction of magnetic lines of force. This magnetic line of force is circular.

Ampere's Right hand Rule: If a current carrying conductor is held by our right hand such that the thumb points along the direction of current, then the direction in which the remaining fingers curl around the wire is the direction of magnetic field around the conductor.

Magnetic Induction B at a point near a straight current carrying conductor:

The magnetic induction B at a point due to a straight current carrying conductor is inversely proportional to the distance(r). $B \propto 1 / r$ ----(1)

The magnetic induction B at a point near a straight current carrying conductor is directly proportional to the strength of the current(i). $B \propto i$ ---(2)

From (1) and (2) $B \propto \frac{i}{r}$ or $B \propto k \frac{i}{r}$ or $B = \frac{\mu_o}{2\pi} \frac{i}{r}$

where μ_o = permeability constant.

Force on a current carrying conductor in a magnetic field:

When a conductor of length ‘l’ is placed in a magnetic field of strength ‘B’, perpendicular to the field and if a current ‘i’ passes through the conductor then a magnetic force ‘F’ acts on that conductor and is given by $F = ilB$.

Fleming’s Left Hand Rule: If we stretch our left hand such that the fore-finger, the central finger and the thumb are mutually perpendicular and remaining finder curled, then the fore-finger indicates the direction of magnetic field(B), central finger indicates the direction of current and the thumb indicates the direction of movement of conductor.

9.8 Principle of working of an Electric Motor

Electric motor: Electric motor is a device which converts electrical energy into mechanical energy.

Construction of an Electrical motor:

1. If an insulated copper wire is wounded on a soft iron rectangular core ABCD, that core and coil together forms the ‘armature’.
2. NS is a permanent horse-shoe magnet with cylindrical concave poles.
3. The armature is mounted on a shaft(Sh) symmetrically between the poles of the magnet.
4. C_1 and C_2 are two metallic half-rings called commutator. The two ends of the coil of armature are connected to C_1 and C_2.
5. The commutator are mounted on shaft which are insulated from each other and rotates with the shaft.
6. Two carbon brushes B_1,B_2 are always in contact with commutator and are connected to Battery.

Working of an Electric Motor:

1. When armature is in horizontal position initially the brushes B_1,B_2 are in contact with the commutator C_1,C_2 respectively.
2. When current flows in the armature a torque is produced and the armature rotated by anticlockwise.
3. The direction of the rotation of armature can be found by using Fleming’s left hand rule.
4. When armature is rotated by 90^0, the brushes come into the gap of commutator and the flow

of current temporarily stopped.

5. Due to inertia the armature moves forward and after another 90^0 rotation the positions of the commutator are interchanged.
6. Due to this again a torque will be produced in the armature and it will be rotated.
7. In this way the armature continues to rotate in the electric motor whose speed is measured in RPM.
8. In A.C. motor there is no need of commutator.

9.9 Electro-Magnetic Induction

Def:- The phenomenon of electro magnetic induction is simply the production of electricity by a changing magnetic field associated with an electric circuit containing no source.

Faraday's Experiment:

1. Take a circular coil of a copper wire and connect the two ends to the terminals of a sensitive galvanometer with zero at its center.
2. When a pole of a bar magnet moved towards the coil the galvanometer deflects and hence a current is set up in the coil.
3. When the magnet moved away from the coil the galvanometer deflects in the opposite direction. Now the current is set up in the opposite direction.
4. When the pole of a magnet is changed the directions in the galvanometer are also changed.
5. When the magnet is stationary near the coil, there is no current in the coil.
6. Hence 'A relative motion of a magnet and a coil induces current in the coil.
7. The cause of induced e.m.f in a coil is the change in the magnetic flux, Φ_B linked with it.

FARADAY'S LAW OF ELECTROMAGNETIC INDUCTION:-

The Faraday's law of electromagnetic induction states that the induced e.m.f in a closed circuit(coil) is equal to the negative rate at which the magnetic flux through it changes.

If $d\Phi_B$ = change in the magnetic flux

dt = time interval and ε = induced e.m.f , then

$\varepsilon = -\dfrac{d\Phi_B}{dt}$ if the coil contains N turns $\varepsilon = -N\dfrac{d\Phi_B}{dt}$

LENZ'S LAW:- The induced current will appear in such a direction that it opposes the change that produced it.

1. When the North pole of the bar magnet pushed towards the coil, the face of the coil towards the pole acts as North pole and the current in the coil is such that it opposes the North pole.
2. When the magnet is pulled away from the coil, the face of the coil acts as South pole and the direction of current changes.
3. Like this the motion of magnet is always opposed by the coil.

FLEMING'S RIGHT HAND RULE:- When the thumb, the fore finger and the central finger of the right hand are stretched mutually perpendicular to each other and are held such that the fore finger is along the direction of magnetic field(B) and the thumb is along the direction of motion(M) of the linear conductor, then the central finger points along the direction of the induced current(i) or e.m.f.

DYNAMO:- A dynamo is an electrical device which converts mechanical energy into electrical energy utilizing the phenomenon of electromagnetic induction.

The principle of working of a dynamo is the law of electromagnetic induction.

Description of an AC Dynamo: -

1. An insulated copper wire is wound on a cylindrical soft-iron core forms the armature which rotates rapidly about a horizontal axis perpendicular to the magnetic field.
2. NS is a permanent horse-shoe magnet to provide magnetic field.
3. The ends of the armature are connected to two slip rings S_1, S_2 which are insulated from each other and rotates along with the armature about the same axis of the coil.
4. Two carbon brushes B_1, B_2 are always in contact with slip rings and connected to external circuit.

Working of an AC Dynamo:-

1. Initially when the plane of the coil is perpendicular to the magnetic flux (Φ_B), maximum number of lines passes through the coil.
2. As the coil rotates from zero to 90° ($\pi/2$) in the anti clock wise direction, the change in the magnetic flux ($d\Phi_B$) linked with the coil is maximum and hence the value of current is maximum in one direction.
3. As the coil reaches to π the current 'i' reduces to zero from the maximum as this position is similar to the reference position.
4. At $3\pi/2$ position of the coil the value of i increases to maximum in reverse direction.

5. In the last part at 2п position the value of current again decreases to zero from the maximum.

The direction of current in the external circuit alternates in each half cycle and such currents are called alternating currents (A.C.).

If commutators are used in place of slip rings a direct current (D.C) is generated and the dynamo is called DC dynamo.

Self-Induction:- The production of an induced e.m.f. in an isolated coil due to a change in the current in the same coil is called self-induction.

Self-induced e.m.f.(ε) in the coil is directly proportional to the rate of change of current in the coil.

$$\varepsilon \propto -\frac{di}{dt} \quad ==> \quad \varepsilon = -L\frac{di}{dt}$$

L = Self inductance which is the property of the coil.

$$L = \frac{-\varepsilon}{(di/dt)} \quad \frac{\text{volt-second}}{\text{ampere}} \quad \text{(or) HENRY.}$$

"The self-inductance of coil is numerically equal to the ratio between the induced e.m.f and the rate of change of current in the coil".

Mutual Induction:- The production of an induced e.m.f in one coil due to change in current in another close by coil is known as mutual induction.

The induced e.m.f in the second coil Q (E_Q) is directly proportional to the rate of change of current in the first coil P(i_P).

$$E_Q \propto -\frac{di_P}{dt} \quad E_Q = -M_{QP}\frac{di_P}{dt}$$

M_{QP} = Mutual inductance of coil Q with respect to the coil P.

$$M_{QP} = \frac{-E_Q}{(di_P/dt)} \quad \frac{\text{volt-second}}{\text{ampere}} \quad \text{(or) HENRY}$$

"Mutual inductance of a coil with respect to another coil is numerically equal to the ratio between the induced e.m.f in it and the rate of change of current in the other coil."

TRANSFORMER:- A transformer is an electrical device which either increases or decreases the magnitude of an alternating voltage by utilizing the phenomenon of electromagnetic induction.

Transformer works on the principle of electromagnetic induction using mutual inductance of two coils.

Description:- The essential parts of a transformer are

i) core ii) primary coil iii) secondary coil

The core is in the form of a rectangular frame built by placing thin sheets of soft iron one above the other which are insulated from each other.

On one side of the core, an insulated copper wire is wound to make a coil of n_1 turns. If voltage is applied across this coil it is called a primary coil. The voltage in this coil is V_1.

On the opposite side of the core, another wire is wound to make a coil of n_2 turns called secondary coil. The voltage in this coil is V_2.

Working:- In the transformer the primary coil(P) is connected to the source of A.C.Voltage. The A.C. current produces an alternating magnetic flux in the core. Since the core is common for both the coils it makes the flux a 'mutual magnetic flux'. So induced e.m.f will be produced in secondary coil.

According to Faraday's law $V_1 = -n_1 \frac{d\Phi}{dt}$ and $V_2 = -n_2 \frac{d\Phi}{dt}$ è $\frac{V_1}{V_2} = \frac{n_1}{n_2}$

$$\Longrightarrow \frac{\text{input voltage in primary coil}}{\text{output voltage in secondary coil}} = \frac{\text{No., of turns in primary coil}}{\text{No.,of turns in secondary coil}}$$

$V_2 = V_1 \frac{(n_2)}{(n_1)}$ If $n_2 > n_1$ then $V_2 > V_1$

Step-up transformer:- The transformer with number of turns in the secondary coil is higher than those in primary coil is called step-up transformer.

If $n_1 > n_2$ then $V_2 < V_1$.

Step-down transformer:- The transformer with number of turns in the secondary coil is smaller than those in primary coil is called step-down transformer.

For ideal transformer, power-input must be equal to power-output i.e. there should not be any power loss. If i_1 and i_2 are the currents in primary and secondary coils. Then $V_1 i_1 t = V_2 i_2 t$ $\Rightarrow \frac{V_1}{V_2} = \frac{i_2}{i_1}$

There fore we have $\frac{V_1}{V_2} = \frac{i_2}{i_1} = \frac{n_1}{n_2}$.

This is the equation of transformer. The transformer converts high voltages with lower currents into lower voltages with higher currents or vice-versa.

11. ELECTRONICS

11.1 Band Theory of Solids:-

Mostly the solids are having crystalline structure. A crystal is a three dimensional array in which atoms are bound together with equal distances between them.

- Chemical bond between the atoms keeps them fixed to their positions in the crystal.
- The chemical bond modifies the energy levels of electrons in the individual atoms.
- The separation of the atoms in a crystal is extremely small and hence the energy levels of the outer shell electrons will superpose on each other.
- This leads to a range of energy values for the electrons in the crystal. This group of energy levels is called as **'energy band'**.
- Depending on the electronic configuration of the atoms of the crystal we have different energy bands.
- There are Valence Band and Conduction Band in the solids.
- The gap between these bands is called as Energy Gap (E_G).

Based on electrical conduction solids are classified into insulators, semi conductors and conductors.

INSULATORS:- A very poor conductor of electricity is called an insulator.

Ex:- Plastics, Rubber, Wood, Diamond etc.

The energy gap of an insulator is very large (more than 3 eV). The concentration of free electrons is small (about 10^7 per m^3). 10^8 volt/meter electric field is required to take an electron from valence band to conduction band, which is impossible.

Insulators are used for coating of electrical wires to prevent flow of electricity to unwanted points.

CONDUCTORS:- Substances that conduct electricity efficiently are known as electric conductors. Ex:- All metals.

There is no energy gap in conductors as the valence band and conduction band overlap. The concentration of free electrons is large (10^{28} per cubic meter). A small electric field is enough to move an electron into higher energy state.

SEMI CONDUCTORS:- The solid in which the Energy gap or forbidden gap is relatively small(about 1 eV) is called as semiconductor.

Ex :- Silicon (energy gap about 1.1eV) , Germanium (energy gap about 0.72eV).

The electrical properties of semiconductor are intermediate between those of insulators and conductors. The conductivity of the semiconductor depends on temperature (it increases with temperature).

In semiconductors the concentration of free electrons is approximately 10^{17} electrons per cubic meter.

EFFECT OF TEMPARATURE ON A SEMICONDUCTOR:-

a. At 0^{o}K all the free electrons of a semiconductor occupies only valence band.

b. So at 0^{o}K the value of E_G is more and the semiconductor acts as insulator.

c. As the temperature rises some of the electrons from the valence band occupy the levels in the conduction band.

d. The state in the valence band with missing electron is called as 'hole'.

Def:- The absence of an electron in the valence band of a semiconductor is called ***hole.***

e. Holes also take part in the electrical conduction. Hence the electric current in a semiconductor is the sum of currents due to electrons and holes.

11.2 Intrinsic and Extrinsic Semiconductor

Depending on the relative concentration of electrons and holes, the semiconductors are classified into two types. They are

1.Intrinsic semiconductors and 2. Extrinsic semiconductors

INTRINSIC SEMICONDUCTORS:- In intrinsic semiconductors the number of electrons in the conduction band and the number of holes in the valence band are equal.

These semiconductors are pure (without any impurities) semiconductors.

Ex:- Pure germanium (energy gap is 0.72 eV) and Pure silicon (energy gap is 1.21 eV).

As the temperature is raised from room temperature some of the electrons from valence band move to conduction band. This creates holes in the valence band. The electrons in the conduction band are free. Every free electron creates a hole in the valence band.

If a small electric field is applied across the intrinsic semiconductor, conduction takes place by free electrons in conduction band and holes in the valence band. The motion of holes is said to constitute a **'hole current'**.

When a hole is created in the valence band, the neighbouring electron occupies that position and creates hole in the new position. This process continues step by step in valence band and is equivalent to a hole moving in the opposite direction to the electron movement. This causes the hole current in the valence band.

CONDUCTION IN AN INTRINSIC SEMICONDUCTOR:-

When an intrinsic semiconductor is connected to a battery, the electrons move towards the positive terminal and the holes move in the opposite direction to the negative terminal. The total current I is sum of the hole and electron currents

$$I_{hole} + I_{electron} = 2\, I_{hole} = 2\, I_{electron}$$

DOPING:- The process of introducing impurities in small quantities into a material is called doping.

EXTRINSIC SEMICONDUCTORS:-An extrinsic semiconductor is one which contains small quantities of selected impurities introduced into an intrinsic semiconductor.

An extrinsic semiconductor is a doped semiconductor. This is of two types depending on the type of impurity. They are (1) p-type semi conductor and (2) n-type semi conductor.

p–type semiconductor:- A p-type semiconductor is formed when a small quantity of acceptor impurity is added to the pure semiconductor.

1. The valency of Germanium (Ge) is 4 and hence it can form 4 covalent bonds.
2. When a trivalent atom Gallium (Ga) is added as impurity it can form 3 bonds only, by creating shortage of one electron for bonding.
3. Thus each Gallium atom is creating a **hole** in the semiconductor.
4. Ga atom is ready to accept one electron and hence such impurity is called ‘acceptor impurity’.
5. This semiconductor is called as p-type semiconductor (p for positive).
6. In a p-type semiconductor the majority carries are ‘holes’ and the minority carriers are ‘electrons’.

n-type semiconductor:- A n-type semiconductor is formed when a small quantity of donor impurities added to a pure semiconductor.

1. The valency of Germanium (Ge) is 4 and hence it can form 4 covalent bonds.
2. When a pentavalent atom Phosphorous (P) is added as impurity it can provide 5 electrons for bonding. 4 electrons forms 4 bonds and one excess electron remains.
3. Thus each Phosphorous atom is creating an excess electron in the semiconductor.
4. P atom is ready to donate one electron and hence such impurity is called ‘donor impurity’.
5. This semiconductor is called as n-type semiconductor (n for negative).
6. In a n-type semiconductor the majority carries are ‘electrons’ and the minority carriers are ‘holes’.

11.3 p-n junction Diode:

The p-n junction consisting p-type and n-type semiconductors provided with two terminals is called a p-n junction diode.

The symbol of p-n junction diode is –I>|–. The arrow mark indicates p-type and the bar indicates n-type semiconductors.

The method of connecting the diode in the circuit is called biasing.

FORWARD BIAS:- In a p-n junction diode, when p-side is connected to the +ve terminal and n-side is connected to the –ve terminal of a battery, then the diode is said to be in ‘forward bias’ condition.

REVERSE BIAS:- In a p-n junction diode, when p-side is connected to the -ve terminal and n-side is connected to the +ve terminal of a battery, then the diode is said to be in ‘reverse bias’ condition.

Properties of p-n junction diode: - A p-n junction diode

1) Conducts electricity in forward bias condition and offers low resistance.
2) Offers high resistance in reverse bias and no current flows in the circuit.

Uses of p-n junction diode:-

1. Diode can be used as an electronic switch.
2. p-n junction diode is used as rectifier.
3. Certain p-n diodes glow on supply of electricity, which are called ‘Light Emitting Diodes(LEDs) and are used in digital clocks and calculators.

11.4 Transistors – Properties and Uses

The transistor was invented by J. Bardeen, W.H.Brattain and William Shockley in 1948.

Transistor: A transistor consists of two p-n junctions formed by sandwiching either a p-type semiconductor or n-type semiconductor between a pair of opposite type semi conductors.

There are two types of junction transistors.

1) p-n-p transistor 2)n-p-n transistor

A transistor is provided with three terminals and are called

i) emitter(E) ii) base(B) iii) collector(C)

The symbols of p-n-p and n-p-n transistors

p-n-p transistor n-p-n transistor

Properties of Junction transistor:-

In a circuit one p-n junction transistor is forward biased and the other is reverse biased.

Uses of a Junction transistor:-

1. Transistor acts as an amplifier.
2. Transistors are used in electronic circuits called “Oscillators”.
3. Transistors are used in stabilized power supply system.
4. Transistors form important components of micro-electronic systems called ICs (Integrated Circuits) or ‘chips’.

11.5 Radio and Television – Basic Principles of working

The main stages in the radio or TV communication are

1. Production of messages 2. Transmission 3. Detection in a receiver

Messages are converted into signals and are fixed to electromagnetic waves of high frequency which are called radio frequency (r.f) carriers.

In radio communication the frequency range of carrier waves is from 300 KHz to 30 MHz and for television it is from 30 MHz to 300 MHz.

Modulation:- The process of ‘fixing’ the messages to r.f carrier waves is called modulation.

The two methods of modulation are i) Amplitude Modulation
ii) Frequency Modulation

Demodulation:- The process of extracting information from the modulated r.f. carrier waves is called ‘demodulation’.

Basic Principles of Radio-Broadcasting:

1. Sound produced in the studio is converted into electrical signals and are amplified.
2. The amplified signals are superimposed on r.f. carrier waves generated in a transimitter.
3. The modulated waves are fed to ‘transmitting antenna’ which spreads these waves in all directions. This is called ‘broadcasting’.
4. The ‘receiving antenna’ of the radio converts these waves into current signals and sends to receiver of the radio.
5. Tuning circuit selects the desired wave from different broadcasting stations.
6. The selected wave is now fed to a detector circuit where demodulation takes place in an oscillator.
7. The separated signal is now sent to amplifier and then to speaker which enables to hear the sound.

RADIO BROADCASTING TV TELECASTING

Television:- “Television is the art of transmission and reproduction of pictures, scenes and moving figures along with the associated sounds”.

SCANNING:- Scanning by a TV camera is a process of dividing an image on the screen into a very large number of very small squares formed by sets of horizontal and vertical straight lines.

In previous days ‘Nipkow disc’ was used for scanning and now-a-days ‘Iconoscope’ is used. Iconoscope is a camera consisting of a cathode ray beam and a photo-electric cell.

MODULATION OF VIDEO AND AUDIO SIGNALS:- The degree of variations in the light intensity on different portions of the image is detected by photo-cells and will be converted into electrical signals. These video signals are amplified and used for modulation. Along with video signals the associated sound(audio) signals are also used for modulation.

The video signals are modulated in ‘AM picture transmitter’ and audio signals are modulated in ‘FM sound transmitter’.

The video and audio modulated waves together are fed to the transmitting antenna.

The receiving antenna of a TV receives the modulated waves from different stations. The desired signals are selected by ‘tuning circuit (channel selector)’. The selected signals are amplified as light pulses(video) and sound waves. The TV set is called kinescope.

Channel:- The range of frequency of r.f. carrier wave for transmission of a complete TV programme is called a channel. It is 6 MHz. In this audio r.f. carrier frequency is 4.5 MHz and video r.f. carrier frequency is 1.5 MHz.

11.6 Computer – Basic Principles of Working

Microprocessor:- A combination of IC s is called a microprocessor. This can perform mathematical operations, can take logical decisions. It can understand instructions given to it through ‘input device’. Through this device data is also supplied which is of two types. They are ‘numeric data’ and ‘non-numeric data’.

The microprocessor consisting of ‘control unit (CU)’, ‘memory’ and ‘Arithmetic-logic-unit(ALU)’ – and this combination is called “Central Processing Unit(CPU)”.

The results are transferred to a device called ‘output device’.

In computers binary number system is used with two digits ‘0’ and ‘1’. ON/YES is equivalent to ‘1’ and OFF/NO is to ‘0’.

BIT:- A binary digit either ‘1’ or ‘0’ is called a BIT.

BYTE :- A group of 8 bits is a BYTE.

WORD :- One or more bytes make a word.

In computer the information is stored in the form of 8-bit codes. The common code is BCD(Binary Coded Decimal). In this first four bits are called “zone bits” and the remaining four “numeric bits”.

PROGRAM:- A group of instructions is called a program.

MACHINE LANGUAGE:- It is the internal language of a computer. It can understand instructions only in BCD. The machine language depends on CPU of a computer.

Ex :- Assembler.

HIGH-LEVEL LANGUAGE:- It is a collection of a limited number of English words and symbols which are used according to a set of rules called ‘syntax’. This is easily learnt and understood by us. Ex :- BASIC, FORTRAN, COBOL, ‘C’ etc.

COMPILER:- This is a program which translates the high level language instructions into ‘machine language’ instructions.

HARDWARE :- All the physical components like CPU, input and output devices put together are called ‘hardware’ of a computer.

SOFTWARE:- The compiler and programs together called ‘software’ of a computer.

PROCESSING OF INFORMATION:- Solving a problem by using computer is called processing of information. This involves following steps.

1. understand a problem to be solved.
2. write a suitable program and store in memory.
3. supply the input data.
4. get the results as output data.

Chem-1: ATOMIC STRUCTURE

The atomic model gives information about the arrangement of subatomic particles in the atom. The first atomic model was proposed by J.J.Thomson.

Rutherford's Atomic model:-Rutherford proposed an atomic model in 1911, based on his α – ray scattering experiment. The model is also known as "Planetary model or Nuclear model". The postulations of this model are

i) Atoms are spherical in shape and mostly hollow.
ii) The mass of the atom is almost due to its nucleus which is at centre of the atom and is made up of protons and neutrons.
iii) Electrons revolve around the nucleus, like planets around the sun.
iv) The atom is stable due to the two forces which are equal and opposite. They are
    (a) The force of attraction between the electrons and nucleus which pulls the electron towards nucleus (Centripetal force).
    (b) A Centrifugal force which pulls electrons away from the nucleus.

Defects:

i) According to classical laws of physics the revolving electron should lose energy and come closer to the nucleus and it should fall into it. Then atom should collapse but atoms are stable.
ii) If electron loses energy continuously, the atomic spectra should consist of continuous bands, but it has discrete lines.

Planck's Quantum Theory:-This was proposed by Max Planck in 1900 to explain the absorption and emission of electromagnetic radiation by a body. According to this the radiation is in the form of packets called 'Quanta'. The energy(E) of radiation is proportional to its frequency (υ) i.e. $E \alpha \upsilon$ or $E = h\upsilon$.

h = Planck's constant = 6.625×10^{-27} erg sec or 6.625×10^{-34} J.sec.

Bohr's Atomic model:- To overcome the defects of Rutherford's atomic model, a Danish scientist Niels Bohr proposed another atomic model in 1913. This model is based on quantum theory of radiation. According to this,

a) Electrons are moving with high velocity around the nucleus in specified paths called "orbits or shells".
b) As long as the electron is in a particular orbit its energy is constant. Hence the orbits

are called as “Stationary Orbits”.

c) The stationary orbits are designated by K,L,M,N,… or 1,2,3,…

d) Each stationary orbit corresponds to a definite energy. The orbit close to the nucleus has less energy compared to the orbit away from the nucleus.

e) When an electron jumps from higher energy orbit to lower energy orbit the difference in energy is emitted as radiation.

$E_2 - E_1 = h\upsilon$; E_1, E_2 = Energies of the orbits.

f) The angular momentum (mvr) of revolving electron is equal to integral multiples of $h / 2\prod$ i.e., $mvr = nh / 2\prod$ (n = 1,2,3..)

Where m = mass of the electron
r = radius of the orbit
v = velocity of the electron
h = planck’s constant

The angular momentum is confined to limited values ($1h / 2\prod$, $2h / 2\prod$, $3h / 2\prod$……..)

Thus the angular momentum is said to be quantized and ‘n’ is named as ‘principal quantum number’.

Limitations:-

1. Bohr’s theory could not explain the atomic spectra of higher elements which have more than one electron.
2. It could not account for the “Zeeman Effect”. (Splitting of spectral lines into fine spectrum in the presence of magnetic field is called Zeeman Effect).
3. It could not justify the quantization of angular momentum (i.e. why $mvr = nh / 2\prod$)
4. It could not account for the formation of chemical bond.

Sommerfeld’s Elliptical Model:- To explain the fine spectrum (Zeeman effect) Arnold Sommerfeld proposed elliptical orbits. The angular momentum of the electron is equal to integral multiples of $h / 2\prod$ i.e. $mvr = kh / 2\prod$ (k=1,2,3…)

Where k = Azimuthal quantum number.

An ‘ellipse’ is characterized by a major axis (AB) and a minor axis (CD). Principal quantum number(n) and Azimuthal quantum number(k) are related to ellipse by

$$\frac{n}{k} = \frac{\text{length of major axis(AB)}}{\text{length of minor axis(CD)}}$$

When n=k, the orbit will become circular. Sommerfeld proposed that for a given 'n' value, k values are from 1 to n and these represents 'Sub – stationary orbits' or 'Sub-levels'.

But it is found to be incorrect mathematically. The Azimuthal quantum number can take values from 0 to (n-1) and is designated as 'l'. When 'l' is zero the orbit becomes circular.

==> In 1930 Louis de Broglie proposed the dual nature (particle and wave nature) of the electron

==> Schrodinger's wave equation solutions gave birth to the 'atomic orbital' and gave the limiting values of quantum numbers.

Modern concept of Atomic structure:-

1. Atoms consist of 'Stationary Orbits' or 'Stationary States' which are designated by 'n' values.
2. Each stationary state is having sub-states or sub-energy levels whose no., depends on 'n' values. These are designated by 'l' values.
3. Corresponding to 'l' values the sub-states are designated as s (l=0), p (l=1), d (l=2)
4. First stationary state (n=1) has one sub state(s), second state(n=2) has two sub states (s, p) etc., (Figure)
5. Under the influence of magnetic field, these sub-states are further split into groups of states. (Figure)
6. The electrons are placed in the 'sub-levels' and revolve around the nucleus. In addition the electrons rotate on their axes clock wise or anti clock wise.

QUANTUM NUMBERS:-

1. Principal Quantum Number:-

a) This was proposed by Niels Bohr.

b) It is designated as 'n'. It take integer values 1(K-shell), 2(L-shell), 3(M-shell) etc.

c) Principal quantum number gives the size and energy of the stationary orbit.

d) As 'n' value increases the size and energy of the orbit increases.

e) The number of sub energy levels in a given shell is n^2.

2. Azimuthal Quantum Number:-

a) This was proposed by Sommerfeld.
b) It is also known as 'angular momentum quantum number' or 'subsidiary quantum number'.
c) It is designated as 'l' and the values are from '0' to 'n-1'.
d) It gives information regarding the shape of sub-shell.
e) For different values of 'l' the sub-shells are named as s (l=0), p (l=1), d (l=2) etc.

3. Magnetic Quantum Number:-

a) This was proposed by Lande.
b) It is designated as 'm'.
c) It gives information about orientation of electrons of different sub-shells in an external magnetic field.
d) The values of 'm' depends on 'l' and they are from '–l' to '+l'.
e) Total values of 'm' for a given 'l' are (2l+1).

Ex: - If l=1, m values are -1, 0, +1. Total values = (2x1+1) = 3.

In the absence of magnetic field these sub-shells will have same energy. Sub shells or "orbitals" having same energy are called "degenerate orbitals".

4. Spin Quantum Number:-

a) This was proposed by Uhlenbeck and Goudsmith.
b) It is designated by 's'.
c) It explains the revolution or its own axis (i.e., spinning of electron).
d) The electron can spin clockwise or anti clock wise.
e) 's' can take the values +½ for clock wise and - ½ for anti clock wise spinning.
f) An orbital can accommodate two electrons provided their spins are opposite.

Atomic Orbital:- It is defined as the region in space where there is finite probability of finding the electron.

s – Orbital:-

a) s- orbital is starting from K- shell and present in 's' sub-shell.
b) To differentiate between 's' orbitals of different orbits, principal quantum number is to be written before the orbital. Ex:- 1s, 2s, 3s …

c) The number of s-orbitals is one.

d) The shape of ‘s’ orbital is “spherical”.

e) Except ‘1s’ the remaining s-orbitals are having “nodal regions”.

“The region corresponds to zero probability for locating the electron is nodal region.”

(diagram)

p- Orbital:-

a) p- orbital is present in ‘p’ sub shell (l=1) and starting from L- shell.

b) The shape of ‘p’ orbital is “dumb-bell”.

c) The no., of p-orbitals is 3. They are p_x, p_y and p_z.

d) p_x, p_y and p_z orbitals lie along X, Y and Z axes respectively.

e) The angle between any two ‘p’ orbitals is 90^0.

(DIAGRAMS)

d- Orbital:-

a) d- orbital is present in d- sub shell (l=2) and starting from M shell.

b) The shape of d – orbital is “double dumb-bell”.

c) The no., of d-orbitals is 5. They are d_{xy}, d_{yz}, d_{zx}, $d_{x^2-y^2}$ and d_{z^2}.

d) d_{xy}, d_{yz} and d_{zx} orbitals lie in the XY, YZ and ZX planes respectively.

e) $d_{x^2-y^2}$ lies along X and Y axes and d_{z^2} lies along Z-axis.

(DIAGRAMS)

Relative Energies of the atomic orbitals:- To fill the electrons in the orbitals, we require a knowledge of the relative energy of the atomic orbitals.

The atomic spectra provide the information regarding the energies of atomic orbitals. The order is,

1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < ……….

Moellar Diagram: - Moellar has given a simple procedure representing the orbitals of increasing energies diagrammatically. The sequence of orbitals continues as shown by arrows in the diagram.

Electronic Configuration: - Electronic configuration is a representation of occupation of electrons in the orbitals.

The electronic configuration is governed by

a) Aufbau's (building up) principle b) Hund's rule c) Pauli's exclusion principle.

Aufbau's Principle: - According to this principle the electron occupies the orbital having the lowest energy. The incoming electrons go to an orbital whose (n+l) is minimum.

Ex:-

orbital	(n+l) value
2s	2+0 = 2
2p	2+1 = 3

Here the electron first enters into '2s' orbital.

If (n+l) values of two orbital same, then the electron occupies the orbital having lower 'n' value.

Ex :-

orbital	(n+l) value
3d	3+2 = 5
4p	4+1 = 5

Here the electron first enters into '3d' orbital, whose 'n' value is less.

Hund's rule:- This is also known as Hund's rule of maximum multiplicity. Hund's rule states that electron pairing takes place only after all the available degenerate orbitals are occupied by one electron each.

Ex:- a) Carbon atomic number is 6. It has 6 electrons.

b) First electron goes into '1s' orbital.

c) Second electron will be paired up with the first electron in the '1s' orbital.

d) Third and fourth electrons occupy the '2s' orbital.

e) Fifth electron goes into one of the '2p' orbitals (say $2p_x$).

f) Sixth electron should be paired with the electron in $2p_x$. But according to Hund's rule it enters into $2p_y$ or $2p_z$ but not $2p_x$.

So the electronic configuration of Carbon is

$1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^0$

Similarly the electronic configuration of Nitrogen (atomic no. 7) is

$1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$

Pauli's exclusion principle:- Pauli's exclusion principle states that no two electrons will have all the four quantum numbers same. According to this principle the number of electrons in a single orbital is two.

Physical properties of atom:-

Atomic size:- Atomic size or atomic radius is defined as the distance between the center of the nucleus and outermost orbital.

Atomic size is expressed in angstrom ($1A^0 = 10^{-8}$ cm).

Atomic size depends on the principal quantum number. Atomic size is determined by x – ray diffraction and electron diffraction.

Ionization Energy or Ionization Potential (I.E or I.P):- Ionization energy is defined as the minimum energy required to remove an electron from the outer most orbital of an atom in gaseous state.

Ionization energy can be obtained from discharge tube experiment and is expressed in unit of eV (electron volt) or k.cal/mole or k.J/mole.

The following are the factors influencing the I.E.

i) *Nuclear charge:-* As the nuclear charge increases I.E. increases.
ii) *Size of the atom:-* As the atomic size increases I.E. decreases.
iii) *Charge of the ion:-* As the charge on the ion increases I.E. decreases.
iv) Electronic configuration of the atom is also affecting the I.E.

Chem-2 : CHEMICAL BOND

The electronic configuration with 8 valence electrons is referred to as “octet configuration”. The octet configuration is associated with bond formation between atoms leading to the formation of a molecule.

The another reason for the formation of chemical bond is the reduction of potential energies of individual atoms.

“The energy of the molecule is less than the combined energies of the individual atoms present in the molecule.”

The chemical bond involves redistribution of electrons of the atoms to get stability by acquiring octet configuration.

The nature of forces involved in the chemical bond formation is explained by quantum theory. According to this

a) When the combining atoms are apart the force of attraction is only between electrons and nucleus of the same atom.
b) As the atoms approach each other, the attractive forces between electrons of one

atom and the nucleus of the other atom increases.

c) Due to this the combined potential energy of the atom decreases.

d) As the atoms approach closer the potential energy continues to decrease and reaches to minimum at a particular inter nuclear distance.

e) At this critical inter nuclear distance, the energy of combined atoms is lower than the sum of energies of individual atoms and chemical bond is formed.

f) In this position the distance between the two nuclei is known as 'bond-length'.

Orbital overlap: - In the formation of a covalent bond the valence orbital of the two atoms overlap each other. When pure atomic orbitals overlap, they give rise to 'hybrid' orbital. The extent of overlap decides the strength of the chemical bond.

The overlap can occur between (a) two pure atomic orbitals (b) pure atomic orbital and hybrid orbital (c) two hybrid orbitals

The overlapping of two pure atomic orbitals of's' and 'p' is as follows:

s-s overlap:- When the 's' orbitals of two atoms overlapping each other, it is called as s-s overlap.

Ex:- Electronic configuration of Hydrogen is $1s^1$. When the two hydrogen atoms approach each other the s-orbitals of two hydrogen atoms attain the electronic configuration of nearest inert gas i.e. Helium. The bond between the hydrogen atoms is represented by a line (-).

The electron dot picture is $H^{\circ} + H^{*} \rightarrow H\,^{\circ}_{*}\,H$ (or) H – H

(Diagram)

p-p overlap:- When the 'p' orbitals of two atoms overlapping each other it is called as p-p overlap.

Ex:- The electronic configuration of fluorine is $1s^2 2s^2 2p^5$ (or) $1s^2\, 2s^2\, 2p_x^2\, 2p_y^2\, 2p_z^1$

In the bond formation of fluorine molecule the unpaired $2p_z$ orbital of two fluorine atoms overlap with each other.

(Diagram)

s-p overlap:- When 's' orbital of one atom and 'p' orbital of another atom overlaps each other it is called as s-p overlap.

Ex:- The electronic configuration of hydrogen is $1s^1$ and of chlorine is $1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p_x^2\, 3p_y^2\, 3p_z^1$.

In the bond formation of HCl '1s' orbital of hydrogen and '$3p_z$' orbital of chlorine overlap with each other.

The electron dot picture is $H^{\circ} + Cl^{x}$ -> $H\,^{\circ}_{x}\,Cl$

Types of overlap:- There are two types of overlaps for the orbitals. They are

(i) End-on-end overlap (ii) Side on overlap

(i) End-on-end overlap:-

a) If the end part of an orbital overlaps with the end part of another orbital, that overlap is called end-on-end overlap.

b) The bond formed by end-on-end overlap is called as sigma (σ) bond.

c) Due to maximum orbital overlap, the sigma bond is strong.

d) Sigma bond can exist independently.

(Diagram)

(ii) Side-on overlap:-

a) If an orbital overlaps with another orbital sideways, the overlap is called side-on overlap.

b) The bond formed by side-on overlap is called as “pi (∏)” bond.

c) ‘p’ and ‘d’ orbitals are capable of forming “pi” bond.

d) Due to less extent of orbital overlap, the ‘pi’ bond is weak.

e) ‘pi’ bond cannot exist independently, it requires at least one sigma bond.

(Diagram)

Multiple Covalent Bonds:- The double bond and triple bond are called as multiple covalent bonds.

Double bond:- If two pairs of electrons are shared by two atoms, the bond is called as ‘double bond’.

The molecules having double bond are O_2, CO_2, C_2H_4 etc.

Formation of Double Bond:-

a) The electronic configuration of oxygen is $1s^2\ 2s^2\ 2p_x^2\ 2p_y^1\ 2p_z^1$.

b) Oxygen has two unpaired electrons, one each in $2p_y$ and $2p_z$.

c) When two oxygen atoms come together, the $2p_z$ orbital of one oxygen atom overlaps with $2p_z$ orbital of another oxygen atom by end-on-end overlap.

d) So a ‘sigma’ bond is formed between $2p_z$ orbitals.

e) As the $2p_y$ orbitals of the two oxygen atoms are parallel to each other, they overlap side-on and form a ‘pi’ bond.

f) Thus oxygen molecule has two bonds (one sigma and one pi) and this bond is ‘double bond’.

(Diagram)

Triple bond:- If three pairs of electrons are shared by two atoms, the bond is called as ‘triple bond’.

The molecules having triple bond are N_2, HCN, CaC_2, C_2H_2 etc.

Formation of triple bond:-

a) The electronic configuration of nitrogen is $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$.

b) Nitrogen has three unpaired electrons one each in $2p_x$, $2p_y$ and $2p_z$.

c) When two nitrogen atoms come together, two $2p_z$ orbitals overlap end-on-end and forms a sigma bond.

d) $2p_x$ and $2p_y$ are perpendicular to each other and perpendicular to $2p_z$.

e) Two $2p_y$ and two $2p_x$ orbitals overlaps side ways and forms two ‘pi’ bonds,.

f) Thus nitrogen molecule has three bonds (one sigma and two pi) and this bond is called triple bond.

(Diagram)

Co- ordinate covalent bond:- In the formation of covalent bond, if one atom contributes two electrons and both the atoms share that electrons, the bond is called co – ordinate covalent bond.

The atom which contributes the electrons is ‘donor’, the atom which accepts and shares that electrons is ‘acceptor’.

The co-ordinate covalent bond is indicated by an arrow mark (->) from donor to acceptor.

Ex:- Ammonia boron tri fluoride [H_3N -> BF_3]

Formation :- Ammonia (NH_3) molecule is pyramidal and has a lone pair of electrons on nitrogen which it can donate.

Boron tri fluoride (BF_3) molecule is planar triangular and has an empty ‘p’ orbital with Boron which can receive the electrons.

The electrons are shared by BF_3 and NH_3, which are donated by ‘N’ atom and co – ordinate covalent bond is formed.

F_3B + **:**NH_3 à F_3B **:** NH_3 à [F_3B ß NH_3]

Shapes of molecules:- The shapes of molecules depends on the no., of atoms present in the molecule and the nature of the that take part in the bond formation. All diatomic and some tri atomic molecules (CO_2, HCN, BeF_2 etc) are linear.

i) ***Water (H_2O) :-*** The shape of water molecule is "V". In this the oxygen atom is left with two lone pairs of electrons.

(Diagram)

ii) ***Ammonia (NH_3):-*** Ammonia has 'pyramidal' shape. Three hydrogen atoms are in one plane and the nitrogen is above the plane. Nitrogen has one lone pair of electrons.

(Diagram)

iii) ***Phosphorous tri chloride (PCl_3):-***It has 'pyramidal' structure. Three chlorine atoms are in one plane and phosphorous lies above the plane. Phosphorous has a lone pair of electrons.

(Diagram)

iv) ***Phosphorous penta chloride:-*** It has trigonal bi pyramidal structure. Three chlorines and phosphorous lie in one plane, one chlorine above the plane and one chlorine below the plane.

(Diagram)

v) ***Carbon dioxide:-*** Its shape is linear with carbon at center and the two oxygen atoms lying on either sides.

(Diagram)

Chem-3: PERIODIC CLASSIFICATION OF ELEMENTS

Classification of elements enables a better understanding of their properties and fundamental properties which govern them. The properties of their compounds also are understood.

Classification of elements also led to a number of discoveries pertaining to atomic structure.

DOBEREINER'S TRAID: The first classification of elements was done by Dobereiner in 1817. He arranged the elements into groups of three elements each, in ascending order of their atomic weights.

He observed that the atomic weight of the middle element is approximately equal to the arithmetic mean of the atomic weights of first and third elements or three elements have nearly same atomic weight.

The group of three elements is called 'Dobereiner's triad'.

Ex: a) Li (7) , Na (23) , K (39) - 23 is the average of 7 and 39.

b) Fe (56) , Co (59) , Ni (59) – atomic weights are nearly same.

Pettenkofer in 1850 and de Chacourtois in 1862 also classified the elements.

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NEWLANDS CONCEPT OF OCTAVES :

John A.R.Newlands, an English chemist classified the elements in 1863.

If the elements are arranged sequentially in the increasing order of their atomic weights, every eight element is having similar properties to that of the first element.

This is similar to the repletion of the eight note of an octave in music. This hypothesis is called "Newlands concept of octaves".

Ex: Li Be B C N O F Na Mg Al Si P S
1 2 3 4 5 6 7 8 9 10 11 12 13

Here the elements Li(1) , Na(8) , K(15) have similar properties.

This system failed when higher elements are included.

-

PERIODIC LAW: In 1869 Dimitri Mendeleef in Russia and Lother Meyer in Germany, proposed that 'atomic property should be the basis for classification'. The only atomic property known at that time is atomic weight. They proposed periodic law.

While classifying the elements, Mendeleef gave more consideration to the chemical properties, but Lother Meyer considered physical properties.

-

MENDELEEF'S PERIODIC LAW: ***“The properties of elements are the periodic functions of their atomic weight.”***

MENDELEEF'S PERIODIC TABLE:

1) In 1869 Mendeleef arranged the elements in a table in the order of increasing atomic weights. It is called Mendeleef's periodic table.
2) In 1872 this periodic table is altered to accommodate few more elements.
3) In periodic table the horizontal rows are called 'periods' and vertical columns are called 'groups'.

4) Mendeleef predicted existence of some of the elements.

Ex : a) He predicted an element with atomic weight 68 and named as 'eka aluminium'. In that place in 1875 deBoisbaudran discovered 'Gallium'.

b)He predicted an element with atomic weight 44 and named as 'ekaboron'.

in 1879 it is replaced by 'Scandium' discovered by 'Nilson'.

5) The arrangement of elements is in accordance with the periodicity of their valences.
6) Mendeleef gave more consideration to chemical properties and reversed the orders of atomic weights in the case of following 3 pairs of elements.
   (a) Argon (Ar) and Potassium (K) (b) Cobalt (Co) and Nickel (Ni)
   (c)Tellurium(Te) and Iodine (I).

LIMITATIONS (DRAWBACKS) OF MENDELEEF'S PERIODIC TABLE:

1) The arrangement of elements does not reflect the periodicity in the electronic configuration of elements.
2) There are inconsistencies in oxidation states of elements placed in the same group.

3) There are marked differences in the properties of elements placed in the same group(ex: Mn Vs Cl).
4) The metals and non-metals were not separated.
5) Lanthanoids and Actinoids were not given proper place.

-

MODERN PERIODIC LAW: After the Mosley's work on characteristic X-rays of elements, since the atomic number corresponds to the number of positive charges and number of electrons, it was realized that the atomic number is the more fundamental property than atomic weight. The modern periodic law states that

"The properties of the elements are periodic functions of their atomic numbers".

-

MODERN PERIODIC TABLE:

1) This table is also known as the 'long form of periodic table'.
2) The modern periodic table relates the properties of elements to their electronic configuration.
3) This table is divided into 7 horizontal rows called 'periods' and 18 vertical columns called 'groups'.
4) The number of elements from first to sixth period are 2,8,8,18,18 and 32 respectively.

5) Seventh period is incomplete.
6) Lanthanoids and Actinoids are separately placed at the bottom of the periodic table.
   a) Elements from atomic number 57 (Lanthanum) to 70(Ytterbium) are known as Lanthanoids.
   b) Elements from atomic number 89(Actinium) to 102(Nobelium) are known as Actinoids.
7) Every period starts with a new orbit and ends with an inert gas.
8) Most of the elements of Mendeleef's periodic table are still in the same place in Modern periodic table.

CLASSIFICATION OF ELEMENTS BASED ON ELECTRONIC CONFIGURATION:

Based on the electronic configuration the elements are classified into four classes. They are inert gases, representative elements, transition elements and inner transition elements.

Inert gases:Gases such as He, Ne, Ar, Kr, Xe and Rn are 'inert gases'. Their outer most electronic configuration is ns^2 np^6 except helium whose configuration is $1s^2$. Each period of the periodic table ends with an inert gas.

Representative elements: Elements having incomplete filled valence shells are known as 'representative elements'. General configuration of these elements is from ns^1 to ns^2 np^5. These are further divided into two types.

a) *S-block elements*: Elements having ns^1 and ns^2 as outermost electronic configuration are known as 's-block ' elements. They are group IA and IIA elements.

b) *P-block elements*: Elements having ns^2 np^1 to ns^2 np^5 as outermost electronic configuration are known as ' p-block' elements. They are group IIIA , IVA , VA , VIA and VIIA elements.

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Transition elements: These are also known as d-block elements.

-
Inner transition elements: These are also known as f-block elements.

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GRADATION OF PROPERTIES IN A PERIOD AND GROUP:

Atomic radius:"Atomic radius is defined as the distance between the centre of the nucleus and the outermost orbital".

Period: In a period from left to right the atomic radius decreases. Because the nuclear attraction over the electron charge cloud increases from left to right.

Group: In a group from top to bottom the atomic radius increases. This is due to addition of one extra shell from one element to another from top to bottom.

Ionization energy or Ionization potential (IE or IP):

"Ionization energy is defined as the minimum energy required to remove an electron from the outermost orbital of an atom in the gaseous state".

Period: In a period from left to right IE do not follow any regular trend.

Group: In a group from top to bottom the IE decreases. Because as we go from top to bottom the atomic size increases and the attractive power of the nucleus on the outermost electron decreases.

Electronegativity (EN):"Electronegativity is defined as the tendency of bonded atom in a molecule to attract the electron density of the shared pair of electrons".

Linus pauling introduced a scale to represent electronegativity which is referred as 'pauling's electronegativity scale'.

Period: In a period from left to right electronegativity increases. This is due to decrease in size of the atom from left to right.

Group: In a group from top to bottom electronegativity decreases. This is due to increases in the size of the atom from top to bottom.

Electro positive character: Electropositive character is ability of atom to lose electrons and become positively charged ion. Fluorine is least electropositive and Cesium is the most electropositive element.

Period: In a period from left to right the electro positive character decreases.

Group: In a group from top to bottom the electropositive character increases.

Oxidizing and reducing properties: Addition of Oxygen to a given compound or removal of hydrogen from the compound is called as oxidation. The reagent used to oxidize a given compound is called "oxidizing reagent".

Addition of hydrogen to a given compound or removal of oxygen from the compound is called reduction. The reagent used to reduce the given compound is called "reducing reagent"

Oxidizing property increases in a period from left to right and decreases in a group from top to bottom.

Reducing property decreases in a period from left to right and increases in a group from top to bottom.

Chem-4: ALKALINE EARTH METALS

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The elements of group IIA are called as alkaline earth metals. They are Beryllium(Be), Magnesium(Mg), Calcium(Ca), Strontium(Sr), Barium(Ba) and Radium(Ra). The minerals containing these elements are

Beryl	$Be_3Al_2(SiO_3)_6$
Dolomite	$CaCO_3. MgCO_3$
Carnalite	$MgCl_2 KCl.6H_2O$
Barytes	$BaSO_4$
Magnesite	$MgCO_3$
Epsom salt	$MgSO_4.7H_2O$

ATOMIC NUMBER AND ELECTRONIC CONFIGURATION:

Element	Symbol	Atomic No.,	Configuration
Beryllium	Be	4	$[He] 2s^2$
Magnesium	Mg	12	$[Ne] 3s^2$
Calcium	Ca	20	$[Ar] 4s^2$
Strontium	Sr	38	$[Kr] 5s^2$
Barium	Ba	56	$[Xe] 6s^2$
Radium	Ra	88	$[Rn] 7s^2$

Atomic size: The atomic size of Alkaline earth metals increases from Beryllium to Radium.

Ionization Energy: The I.E of Alkaline earth metals decreases from Beryllium to Radium.

Electronegativity: The electronegativity of Alkaline earth metals decreases from Be to Ra.

Melting and Boiling points: The M.P and B.P of group IIA elements are higher than alkali metals. Because the metallic bond between atoms of alkaline earth metals is stronger than in alkali metals. There is no regular trend in M.P and B.P with in the group of alkaline earth metals due to the differences in packing of atoms in the crystals and inter atomic forces.

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REACTIONS OF ALKALINE EARTH METALS:

Alkaline earth metals are very reactive due to their high electropositive character.

***Reaction with water*:** These elements react with water to liberate hydrogen.

The reactivity of these elements increases from Be to Ra. Be does not react with water. Mg reacts with hot water. Ca , Sr and Ba readily react with water.

$Mg + 2H_2O\ (hot) \rightarrow Mg(OH)_2 + H_2$ (or)

$Mg + H_2O\ (hot) \rightarrow MgO + H_2$

$M + 2H_2O \rightarrow M(OH)_2 + H_2$ (M = Ca , Sr , Ba)

Reaction with oxygen: These elements burn in oxygen to form oxides. Beryllium powder is more reactive than bulk and does not react below 600 ^{0}C.

$2M + O_2 \rightarrow 2MO$ (M= Be,Mg, Ca, Sr,Ba and Ra)

In addition to oxide, barium forms peroxide when heated in excess of oxygen.

$Ba + O_2 \rightarrow BaO_2$

When these elements burn in air they give rise to a mixture of oxides and nitrides.

$Mg + air \rightarrow MgO + Mg_3N_2$

This reaction generates a lot of heat. This reaction is used in the thermite process in metallurgy of Al.

The oxides of Mg,Ca,Sr and Ba are basic.

***Reaction with hydrogen*:** Except Be the remaining alkaline earth metals react with hydrogen to form hydrides(MH_2).

$M + H_2 \rightarrow MH_2$ (M = Mg, Ca, Sr and Ba)

BeH_2 is prepared by reducing $BeCl_2$ with lithium aluminium hydride. It is unstable.

$2BeCl_2 + LiAlH_4 \rightarrow 2 BeH_2 + LiCl + AlCl_3$

The hydrides of alkaline earth metals are reducing reagents and. They react with water to give hydrogen.

$MH_2 + 2H_2O \rightarrow M(OH)_2 + 2H_2$

__Reaction with Chlorine:__ The alkaline earth metals react with chlorine to form chlorides(MCl_2).

$M + Cl_2\uparrow \rightarrow MCl_2$ (M = alkaline earth metal)

The chlorides of alkaline earth metals can also be prepared by the reaction of the metals with HCl.

$M + 2HCl \rightarrow MCl_2 + H_2\uparrow$

$BeCl_2$ is covalent, hygroscopic(absorbs moisture) and fumes in air due to hydrolysis.

The chlorides of Mg, Ca, Sr and Ba are ionic and are soluble in water.

-

__Extraction of Magnesium__: Magnesium is extracted by electrolytic reduction of molten $MgCl_2$ or MgO. This method involves two steps.

(1)__PREPARATION OF ANHYDROUS MAGNESIUM CHLORIDE__:

(A)***From Magnesite:-*** When Magnesite is heated in the presence of air to 450 ^{0}C, it decomposes to magnesium oxide.

$MgCO_3 \rightarrow MgO + CO_2$

MgO is mixed with carbon powder and heated to about 1000 ^{0}C in a flow of chlorine gas.$MgCl_2$ and CO are formed.

$MgO + Cl_2 + C \rightarrow MgCl_2 + CO\uparrow$

(B)***From Carnalite:*** When Carnalite is heated it loses four water molecules.

$KCl.MgCl_2.6H_2O \rightarrow KCl.MgCl_2.2H_2O + 4H_2O$

The resultant dehydrate is heated in a stream of HCl gas at 350 ^{0}C.

$KCl.MgCl_2.2H_2O + HCl \rightarrow KCl.MgCl_2 + 2H_2O\uparrow$

(2)ELECTROLYSIS OF ANHYDROUS $MgCl_2$:

1. Add NaCl and KCl to MgCl2. This will lower the melting point of MgCl2 and increase the conductivity of the electrolyte.
2. Take the electrolyte in an iron pot which acts as cathode.
3. A graphite rod enclosed in a porcelain tube is dipped in the electrolyte which acts as anode.
4. The iron pot(Cathode) is maintained at 700 ^{0}C.
5. During the electrolysis the following reactions takes place.

$MgCl_2$(molten) $\rightarrow$ Mg^{2+} + $2\,Cl^-$

Reaction at cathode : $Mg^{2+} + 2e^- \rightarrow Mg$

Reaction at anode : $2\,Cl^- \rightarrow Cl_2 + 2\,e^-$

$MgCl_2 \rightarrow Cl_2 + Mg$

6. Chlorine gas liberated at anode escapes through the outlet of the porcelain tube.
7. The Mg formed at cathode floats on the electrolyte.
8. A stream of coal gas is passed over the magnesium to prevent the oxidation.
9. This magnesium is 99.9 % pure.

DIAGRAM

Chem-4: ALKALINE EARTH METALS

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DIAGRAM

Chem-5 : SOLUTIONS

When two or more substances are mixed that is called as a mixture. That is of two types homogeneous and heterogeneous.

In homogeneous mixtures the properties are same through out the mixture and the components cannot be separated by simple methods such as filtration.

In heterogeneous mixtures the properties are not same through out the mixture.

SOLUTION:- The homogeneous mixture of two or more substances is called as solution. The physical properties such as density, refractive index, viscosity etc., are same in any part of the solution

Ex :- Salt + Water à Salt solution

$CuSO_4$ + Water à Blue colored solution

SOLVENT:- The relatively more quantity component of the solution is called as solvent.

SOLUTE:- The relatively less quantity component of the solution is called as solute.

Ex:- In sugar solution the water is a solvent and the sugar is solute.

SOLVENT + SOLUTE = SOLUTION

In a solution if solvent is water the solution is called as ‘aqueous solution’ and if the solvent is alcohol the solution is called as ‘alcoholic solution’.

If the two components are in equal quantity then any one component is taken as solvent or solute.

SOLUBILITY:- Solubility is defined as the maximum amount of solute by weight in grams dissolved in 100 grams of solvent at constant temperature.

Depending on the solubility of the solution the solutions are of three types.

UNSATURATED SOLUTION:- The solution in which the amount of solute present is less than its solubility at constant temperature is called as unsaturated solution.

SATURATED SOLUTION:- The solution in which the amount of solute present is equal to its solubility at constant temperature is called as saturated solution.

In saturated solution there is equilibrium between the undissolved and already dissolved solute.

SUPER SATURATED SOLUTION:- The solution in which the amount of solute present is more than its solubility at constant temperature is called as super saturated solution.

Preparation of super saturated solution:-

Dissolve Hypo(Sodium Thiosulphate) in a beaker and prepare a saturated solution. Now heat the solution by adding some more hypo. Then the undissolved hypo slowly dissolves. After heating slowly cool the resultant solution. Now allow the solution to cool with out shaking or disturbance. This solution is called super saturated solution since it contains the solute more than its solubility at room temperature.

FACTORS AFFECTING THE SOLUBILITY:- The solubility of a given compound in a given solvent depends on the following factors.

a) Nature of the solute and the solvent and b) Temperature

NATURE OF THE SOLVENT AND THE SOLUTE:- The solubility of a substance depends on the nature of solvent and solute. Because “like dissolves in like”. That is polar substances dissolves in polar solvents and non-polar substances dissolves in non-polar solvents.

Ex:- Copper sulphate dissolves in water but not in kerosene. Because copper sulphate and water are polar but Kerosene is non-polar.

TEMPARATURE:-

1. Solubility of some substances increases with temperature.(Ex:-$NaNO_3$)
2. Solubility of some substances decreases with temperature.(Ex:-$Ce_2(SO_4)_3.9H_2O$)
3. Solubility of some substances remain same with temperature.(Ex:-NaCl)
4. Solubility of all the gases decreases with temperature.(Ex:-O_2,H_2 etc)

CONCENTRATION OF SOLUTION:- It is the amount of solute present in unit volume of solution. Concentration can be expressed in different ways.

1) **WEIGHT PERCENTAGE:-**The weight of solute (in grams) present in 100 grams of solution is called weight percentage.

If ‘w’ grams of solute is added to ‘W’ grams of solvent, then the weight percentage (w%) of the solution is given by

$$\text{Weight percentage} = w\% = \frac{w}{w + W} \times 100$$

Weight percentage has no units.

2) **VOLUME PERCENTAGE:**- The volume of solute (in ml) present in 100 ml of solution is called ‘volume percentage’.

If ‘v’ ml of solute is added to ‘V’ ml of solvent, then the volume percentage (v%) of the solution is given by

$$\text{Volume percentage} = v\% = \frac{v}{v + V} \times 100$$

Volume percentage has no units.

3) **MOLARITY:**- Molarity is defined as the number of moles (or gram moles) of a solute present in one litre of solution. It is represented by the symbol “M”.

If “V” litres of a solution contain “n” moles of solute dissolved in it, then the molarity of the solution is given by

$$\text{Molarity} = M = \frac{n}{V} \quad \frac{\text{moles}}{\text{litre}}$$

$$\text{But no. of moles} = n = \frac{\text{weight of solute}}{\text{Gram molecular weight of solute(gm.mol.wt)}}.$$

Therefore

$$\text{Molarity} = \frac{w}{\text{gm.mol.wt}} \times \frac{1}{V} \quad \text{(V in litres)}$$

$$\text{Molarity} = \frac{w}{\text{gm.mol.wt}} \times \frac{1000}{V} \quad \text{(V in millilitres)}$$

4) **MOLE FRACTION:-** It is the ratio of number of moles of a constituent to the total number of moles of all constituents present in the solution.

$$\text{Mole fraction (X)} = \frac{\text{number of moles of constituent}}{\text{Total no. of moles of all constituents present in the solution}}$$

If n_A moles of solute "A" is dissolved in n_B moles of solvent "B". Then mole fractions of A and B are calculated as follows

Total no., of moles in the solution = $n_A + n_B$

$$\text{Mole fraction of solute A} = X_A = \frac{\text{No., of moles of A}}{\text{Total no., of moles in the solution}} = \frac{n_A}{n_A + n_B}$$

$$\text{Mole fraction of solvent B} = X_B = \frac{\text{No. of moles of B}}{\text{Total no. of moles in the solution}} = \frac{n_B}{n_A + n_B}$$

The sum of the mole fractions of all constituents present in the solution is equal to unity.

$$X_A + X_B = \frac{n_A}{n_A + n_B} + \frac{n_B}{n_A + n_B} = 1$$

Mole fraction has no units and it is independent of temperature.

STANDARD SOLUTION**:-** The solution for which the concentration is known accurately is called as standard solution.

Standard solutions are prepared by using standard flask.

Preparation of standard solution (100 ml 0.1 M sodium carbonate solution**)**:-

AIM ***:-*** To prepare 100 ml 0.1 M sodium carbonate solution.

APPARATUS AND CHEMICALS:- Standard flask of 100 ml, funnel, rubber stopper, glass rod, analytical balance, sodium carbonate and distilled water.

CALCULATION OF REQUIRED SODIUM CARBONATE:-

Here M = 0.1 M, gm. Mol. Wt of sodium carbonate = 106gm and volume = 100 ml.

And Molarity = $\frac{w}{\text{gm.mol.wt}} \times \frac{1000}{V}$ (V in millilitres)

There fore the weight of sodium carbonate = w = 1.06 gm

PREPARATION OF THE SOLUTION:-

1. Take 1.06 gm of sodium carbonate by using analytical balance in standard flask.
2. Add some distilled water with the help of funnel.
3. Stir with glass rod to dissolve the sodium carbonate.
4. Now add the distilled water up to the 100 ml mark.
5. Close it with rubber stopper and invert it 2 to 3 times.
6. The required standard solution is formed.

IONIZATION:- The process of a molecule giving rise to ions is called “ionization”. The substances which ionizes, passes electricity through them. These are called ‘electrolytes’. These are of two types. They are Strong electrolytes (which ionizes completely Ex:-NaCl, KCl) and weak electrolytes (which ionizes partially Ex:- CH_3COOH, NH_4OH).

The substances which are not ionizing are called as ‘non-electrolytes’(Ex:-sucrose, urea, glucose).

For weak electrolytes dilution and increase in temperature increases the extent of ionization.

Chem-6 : ACIDS, BASES AND SALTS

ACID :- Acids are sour to taste. They turn blue litmus to red.

Preparation :- Acids are formed when non-metallic oxides are dissolved in water.

$SO_2 + H_2O \rightarrow H_2SO_3$ (sulphurous acid)

$SO_3 + H_2O \rightarrow H_2SO_4$ (sulphuric acid)

$CO_2 + H_2O \rightarrow H_2CO_3$ (carbonic acid)

$N_2O_5 + H_2O \rightarrow 2HNO_3$ (nitricacid)

Properties:-

1. Acids change the colour of the indicators.

   Ex:- Blue colour of litmus to red.

   Orange colour of Methyl Orange to red.

2. Acids liberate hydrogen gas by reacting with metals like Zn, Mg etc.

   $2HCl + Mg \rightarrow MgCl_2 + H_2$

3. Acids react with bases to form salt and water.

   $HCl + NaOH \rightarrow NaCl + H_2O$

   $HNO_3 + KOH \rightarrow KNO_3 + H_2O$

4. Acids react with metallic oxides to form salt and water.

   $2HCl + CuO \rightarrow CuCl_2 + H_2O$

5. Acids liberate carbon dioxide by reacting with carbonates and bicarbonates.

   $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$

6. Aqueous solutions of acids show electrical conductivity.

BASE:-Bases are soapy to touch and they turn red litmus to blue.

Preparation:- Bases are formed when metallic oxides are dissolved in water.

$Na_2O + H_2O \rightarrow 2NaOH$

$MgO + H_2O \rightarrow Mg(OH)_2$

Properties:-

1. Bases change the colour of the indicators.

   Ex:- Red colour of litmus to blue.

   Orange colour of Methyl Orange to yellow.

2. On heating bases decomposes into metal oxides and water.

$Cu(OH)_2$ --> CuO + H_2O

3. The bases react with acids to form salt and water.

$NaOH$ + HCl --> $NaCl + H_2O$

4. Aqueous solutions of bases show electrical conductivity.

<u>ARRHENIUS THEORY</u>:-This was proposed by a Swedish scientist in 1887. According to this theory

ACID:- An acid is a substance which produces H^+ ions in aqueous solution.

Ex:- HCl --> H^+ + Cl^-

HNO_3 --> H^+ + NO_3^-

BASE:- A base is a substance which produce OH^- ions in aqueous solution.

Ex:- $NaOH$ --> Na^+ + OH^-

KOH --> K^+ + OH^-

<u>Limitations of Arrhenius Theory</u>**:-**

1. This theory is limited to aqueous solution. This theory could not explain the nature of the substance which is insoluble in water or when it is dissolved in other solvent.

Ex:-SiO_2 is acidic and $CaCO_3$ is basic in nature but they are insoluble in water.

2. This theory fails to explain the acidic nature of some substances(CO_2, SO_2 etc)which do not have H^+ ions of their own. These are producing the H^+ ions by reacting with water not by ionization.

SO_2 + H_2O --> H_2SO_3 --> H^+ + HSO_3^-

CO_2 + H_2O --> H_2CO_3 --> H^+ + HCO_3^-

3. Similarly there are certain bases which are producing the OH^- ions by reacting with water.

MgO + H_2O --> $Mg(OH)_2$ --> $Mg2^+$ + $2OH^-$

CaO + H_2O --> $Ca(OH)_2$ --> $Ca2^+$ + $2OH^-$

4. There is no existence for H^+ (proton) in aqueous solution. It reacts with water molecule and forms H3O+.

H^+ + H_2O --> H_3O^+

Ionization of water:- Water ionizes to a little extent and produces H^+ and OH^- ions. The ions are in equilibrium with undissociated water molecules.

$$H_2O \;<\!\!==\!\!>\; H^+ + OH^-$$

The ionization is temperature dependent. At 25^0C the concentrations of H^+ and OH^- ions are equal and the value is $[H^+] = [OH^-] = 1.0 \times 10^{-7}$ mole ions / ltr.

Ionic product of water:- The product of concentrations of H^+ and OH^- in one mole of water is defined as the ionic product of water and is represented by K_w.

$$K_w = [H^+] \times [OH^-]$$

K_w is temperature dependent and the units are mole ion^2 / ltr^2.

At 25^0C $K_w = 1.0 \times 10^{-14}$ mole ion^2 / ltr^2

K_w remains constant in acid, base and neutral solution. Because if the value of $[H^+]$ decreases the value of $[OH^-]$ increases and vice versa.

For Acids $[H^+] > 1.0 \times 10^{-7}$ mole ions / ltr

For Bases $[OH^-] > 1.0 \times 10^{-7}$ mole ions / ltr

For neutral solutions $[H^+] = [OH^-] = 1.0 \times 10^{-7}$ mole ions / ltr

Hydrogen ion concentration and P^H value:- This was introduced by Sorensen and is defined as the negative logarithm of H^+ ion concentration.

$$P^H = -\log_{10}[H^+]$$

For acidic solution $P^H < 7$, for basic solution $P^H > 7$ and for neutral solution $P^H = 7$.

$[H^+]$	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	10^{-13}	10^{-14}
P^H	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Nature	**ACID**						**Nuetral**	**BASE**						

The strength of acids and bases:- The strength of acids and bases is measured by using Arrhenius theory i.e. by using the extent of ionization.

STRONG ACID:- The acid which completely ionizes is called 'strong acid'.

Ex:- HCl (100% ionization)

WEAK ACID:-The acid which partially ionizes is called as 'weak acid'.

Ex:- CH_3COOH (less than 100 % ionization)

STRONG BASE:- The base which completely ionizes is called as 'strong base'

Ex:-NaOH (100% ionization)

WEAK BASE:-The base which partially ionizes is called as 'weak base'.

Ex:-NH_4OH (less than 100% ionization)

Neutralisaton:- The reaction between acid and base to form salt and water is known as neutralization reaction. This is exothermic reaction.

Heat of neutralization:- The heat liberated when one mole of acid react with one mole of base (or) one mole of H^+ ions combine with one mole of OH^- ions is known as the Heat of Neutralization.

The heat of neutralization for the reaction between strong acid and strong base is found to be 13.7 K.Cal/mole.

$$NaOH + HCl \rightarrow NaCl + H_2O + 13.7 \text{ k.cal/mole}$$

In neutralization reaction if the acid or base or both are weak, the heat of neutralization is less than 13.7 k.cal/mole. This is due to the consumption of some heat for the complete ionization of weak acid or base.

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O + 13.4 \text{ k.cal/mole}$$

In this reaction 0.3 k.cal energy is consumed by CH_3COOH for complete ionization.