Unique Technical Institute
B.O.: Shopping Complex, New Housing Board Colony, Barnala Road, Sirsa
H.O OPP.Sihag Hospital ,Hisar road Sirsa-125055

===

Unit-1 (Unit & Dimension)

Measurement: - It is the process in which we do compare a known quantity a with unknown quantity.

Unit: Unit is that standard which we used for measurement for e.g.: Meter is unit of Length, Kg is unit of Mass, and second is for time.

Type of Unit (i) Fundamental Unit (ii) Derived unit

Fundamental Unit: These are those units which are independent to each other and can not create by any other units. Mass, Length, Time is fundamental unit.

Derived Unit: Derived unit are those unit which are derived from fundamental unit.

Area = Length X Breadth = $L \times L = L^2$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{L}{T} = LT^{-1}$$

Physical Quantity: A Physical quantity is that quantity which can be measured directly or indirectly or about which we can say something e.g. mass of book, Length of table etc.

$X = nu$

Where X = Physical Quantity

n = No. of quantity, u = no: of unit.

System of Unit: There are following types of system of unit.

1) C.G.S. System: This is a French system. In this system 'C' is used for Centimeter, which is the unit of length, 'G' is used for gram, which is unit of mass and 's" is used for second, which is unit of Time.

2) F.P.S. System: It is British system. In this system foot is unit of length, Pound is unit of mass, and second is unit of time.

1 Foot = 30.48 cm.

1 Pound = 453.8 gm.

3) M.K.S. System: In this system, meter, kilogram second is the unit of length, mass, time etc.

4) S.I. System: This system is called "System International". It contains seven fundamental and two supplementary units. The three units remain same as in M.K.S. system

Sr. No.		Fundamental		Supplementary		
1	Mass	Kg	Kilogram	Plane angle solid angle	Radian Steradian	Rd Sr.
2	Length	m	Meter			
3	Time	s	Second			
4	Amount of Substance	mole	Mole			

5	Luminous Intensity	Cd	Candela			
6	Electric Current	A	Ampere			
7	Temperature	K	Kelvin			

Advantage of S.I. System

1. It is internationally accepted.
2. It is coherent system (One system is derived from another).
3. It is rational system (One unit is only for one physical quantities).
4. It is metric system (In the power of 10)
5. It is absolute system of unit.

DIMENSION:

It is the power up to which a fundamental unit is raised e.g. Force = $M^1 L^1 T^{-2}$. It means that dimensions of mass is 1, Length=1, Time=2

Dimensional Formula: It is the symbolic representation of physical quantity with the help of fundamental unit with raising their power.

Dimensional equation: It is the equation which is obtained by equating a physical quantity with them dimensional formula', Force = MLT^{-2}

Principal of Homogeneity: It states that "In an accurate formula, the dimensional formula of L.H.S. must be equal to dimension formula of R.H.S.

Advantage of Dimensional Formula:

1. To derive he formula
2. To check the accuracy of formula.
3. To convert one unit into another unit.

Sr. No.	**Physical Quantity**	**Formula**	**Dimensional Formula**	**Unit**
1	Volume	Length* Breadth	(M °L ^{3}T °)	M^3
2	Velocity= Speed	Distance displacement ----------= ----------- Time Time	L --- = (M°LT^{-1}) t	MS^{-1}
3	Acceleration	Velocity ------------ Time	LT^{-1} ---=(M°LT^{-2}) T	MS^{-2}
4	Force	Mass X Acceleration	[MLT^{-2}]	Newton
5	Work= Energy	Force X Distance	MLT^{-2} L = (ML^2 T^{-2})	Joule
6	Power	Work ------------ Time	ML^2T^{-2} ----=(ML^2T^{-3} T	Watt
7	Momentum= Impulse	Mass X Velocity	(MLT^{-1})	$Kgms^{-1}$
8	Pressure= Stress= Elasticity	Force ------------ Area	MLT^{-2} ------=($ML^{-1}T^{-2}$) L^2	Nm^{-2}
9	Density	Mass	M	Kgm^{-3}

		--------- volume	-- $= (ML^{-3})$ L^3	
10	Co-efficient of viscosity	forceXdistance n = --------------- areaXvelocity	MLT^{-2} X L -------------- = $(ML^{-1}T^{-1})$ L^2 X LT^{-1}	Poise
11	Momentum of Inertia	mass X $(Distance)^2$	(ML^2)	Kgm^2
12	Planck IS without= Angular momentum	Linear Momentum X Distance	MLT^{-1} x L $= (ML^2T^{-1})$	$Kgm^2\,s^{-1}$
13	Surface Tension	Force --------- Length	MLT^{-2} -------$= (MT^{-2})$ L	Nm^{-1}
14	angle=Strain	No Dimensions		

LIMITATION OF DIMENSIONAL EQUATION:-

1. It does not help us to find the value of dimension less constant.
2. It does not give information about more than three physical quantities.
3. It helps only in case of power function. It does not tell about trigonometric function.
4. A dimensionally correct relation may not be true for physical relation.
5. It cannot directly apply to derive relation

   E.g. $V= u + at$, $S=ut = ½ at^2$

---

1. Convert one joule in to erg. Using dimensional equation

Solution :The dimensional formula of work is ML^2T^2

It means a= 1, b=2 c=-2

S.I. System	C.G.S. System
$N_1=1$	$n_2=?$
$M_1= 1kg.$	$M_2 = 1g$
$L_1 = 1m$	$L_2= 1\ cm.$
T_1- Is	$T_2=18$

$$N_2 = n_1 \left(\frac{M1}{M_2}\right)^a \left(\frac{L_1}{L_2}\right)^b \left(\frac{T_1}{T_2}\right)^c = 1\left(\frac{1Kg}{1g}\right)^1 \left(\frac{1m}{1cm}\right)^2 \left(\frac{1\ Sec}{1\ Sec}\right)^{-2}$$

$$1 \left(\frac{10^3 g}{1g}\right) \left(\frac{10^2 cm}{1cm}\right)^2 \left(\frac{IS}{1S}\right)^{-2} = 107$$

Work of 1 joule = 10^7 erg.

2. Find dimensionally an expression for critical velocity Vc which depends upon, coefficient of viscosity, density of liquid, radius of body

SOL: It is given that $V_c = kn^a d^b r^c$,where k=1

Write the dimensional formula of physical quantity

V_c = Critical velocity = $[m° L^{-1})$

n = Co-efficient of viscosity = $(ML^{-1} t^{-1})$

d = Density = (ML^{-3})

r = Radius (L)

Put the dimensional formula of all physical quantity

$(M° L^{-1} T^{-1}) = K (ML^{-1}T^{-1})^a (ML^{-3}T°)^b (L)^c$

$= K (M)^{a+b} (L)^{-a-3b+c} (T)^{-a+c}$

Comparing the powers of MLT on both sides

a+b=0 => a = -b

-a-3b+c=1 =>-a+3b+c=1

-a+c= -1 solving this

a=1,b-1, c=1

Putting the value of a, b, c,

$$\boxed{Vc = Kn/dr}$$

Check the accuracy: write the dimension formula of each quantity

According to homogeneity Principal

LHS $Vc= [M°LT^{-1}]$

$$R.H.S. = \frac{ML^{-1}T^{-1}}{[L]} = (M°LT^{-1}) \qquad [ML^{-1}]$$

L.H.S = R.H.S proved it.

Unique Technical Institute
B.O.: Shopping Complex, New Housing Board Colony, Barnala Road, Sirsa
H.O.: OPP.Sihag Hospital ,Hisar road Sirsa-125055

===Unit 4

PROPERTY OF MATTER

Matter is that thing which occupies space.

ELASTICITY: It is the property which regains its original shape and size after removal the force on body.

When we applied force on body, then their configuration will be changes.

STRAIN: It is defined as change in configuration to the original configuration. There are three types of strain .

(i) Longitudinal Strain (ii) volumetric strain (iii) Shear strain

Longitudinal strain: It is defined as change in length to the original length. Let L_1 be length, after stretching length can be changed as L_2.

Change in Length = $L_2 - L_1 = \triangle L$

$$\text{Longitudinal Strain} = \frac{\text{Change in length}}{\text{Original length}} = \frac{\triangle L}{L}$$

2. Volumetric Strain: It is defined as change in volume to original volume. Let V_1 be original volume and V_2 be final volume, change in volume = $V_2 - V_1$

$$\text{Volumetric Strain} = \frac{\text{Changeinlength}}{\text{Original volume}} = \frac{\triangle v}{V_1}$$

3. Shear strain: When we apply tangential force, a change in lateral displacement and change in angle

$$\text{Shear strain} = \frac{\text{Lateral displacement}}{\text{Displacement}}$$

$\triangle L$

$$\theta = \frac{\quad}{L}$$

Stress: It is defined as deforming force per unit area; where deforming force is apply inward. There are two types of stress (1) Normal Stress

ii) Tangential stress

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

<u>Hook's Law</u>: According to this law, stress is directly proportional to strain, stress α strain

Stress= E Strain

$$E = \frac{\text{Stress}}{\text{Strain}},$$

Where E is co-efficient of elasticity. There are three types of elasticity.

1) Young's modules of Elasticity (ii) Bulk modules (ii) modules or rigidity.

1) <u>Young's Modules of Elasticity</u> : It is defined as ratio of deforming force per unit area to longitudinal strain.

consider a body having area 'A' on applying force 'F" change in length L to △L; as

$$\text{Elasticity} = \frac{\text{Stress}}{\text{Strain}}$$

$$Y_E = \text{Elasticity} = \frac{F/A}{\triangle L/L} = \frac{\text{Force} \times \text{Length}}{\text{Area} \times \text{Change}}$$

Where Y is young modules of Elasticity.

<u>Bulk Modules of Elasticity</u>: It is defined ratio of normal stress to volumetric strain. consider a body having volume V, Area A and a force 'F' is applied, then change is volume $\triangle V$.

$$K = \text{Bulk Modules} = \frac{F/A}{\triangle V/V} = \frac{\text{force}\times\text{change in volume}}{\text{AreaXvolume}}$$

Where K is called bulk modules of elasticity.

3. <u>Modules of Rigidity:</u> It is defined as ratio of shear stress (tangential stress) to shear strain.

$$n = \frac{F}{A\theta}$$

Where n is a module of rigidity

<u>PRESSURE</u>

<u>FLUID</u>: A fluid is a substance that does not have fixed shape and can easily flow. Liquid and gas are fluids.

Thrust: The total force exerted by a body on another body in contract is called thrust.

Pressure: The pressure is defined as the ratio of applied force per unit area. If F is applied force act on body surface area 'A'', then pressure 'P'

$$P = F/A$$

Unit of Pressure: $1Pa = N/M^2$; Pascal = $\dfrac{1\text{Newton}}{1m^2}$

Dimensional formula = $\dfrac{MLT^{-2}}{L^{-2}} = [ML^{-1}T^{-2}]$

ATMOSHPHERIC PRESSURE: The pressure exerted by atmosphere is called atmospheric pressure.

Measurement of Atmospheric Pressure:

To Measure the atmospheric pressure,

Take a straight glass tube of about 1

Meter long in vertical in mercury vessel.

The mercury column in the tube will be stand at a height 'h' above. The level. Let P be the density and g be acceleration, as we know that

$$P=F/A$$

As we know that F = Mg= weight of mercury

$$= PVg= PAhg$$

$$P = \frac{F}{A} = \frac{PAhg}{A} = h\rho g.$$

$$\boxed{P= h\rho g.}$$

The device used for measuring atmospheric pressure is called Barometer. It decreases with height. Atmospheric pressure at sea level is 0.76 m of mercury

P= 13.6 No^3 kg/m^3, g= 9.81 mis^2.

$P=\rho hg = 101396.1\ N/M^2$.

Absolute Pressure: The actual pressure at a point is called absolute pressure.

Gauge Pressure: The difference pressure absolute pressure and atmospheric pressure at a point is called Gauge pressure.

Surface Tension: The property of a Liquid due to which its free surface at rest behaves like a stretched membrane or an elastic skin is called surface Tension.

It is measured by force per unit length. It is devoted by T

$$T = \frac{F}{L} = \frac{MLT^{-2}}{L} = [MT^{-2}]$$

Unit: In S.I. system unit of surface Tension is N/M. In Cgs Unit of surface tension is dyne/cm

Molecular Force: The force of attraction or repulsion existing between the molecules of matters are called molecular force.

There are two types of force.

1. Force of Cohesion: The force of attraction between the molecules of same substance is called force of cohesion.

2. Force of adhesion: The force of attraction between the molecules of different substance is called force of adhesion.

Molecular Range: The maximum distance up to which the force of attraction between molecules is appreciable is called molecular range.

A sphere with a molecule as center and radius equal to the molecular range is called sphere of influence.

Surface Energy: The potential energy of surface molecule per unit area of the surface is called surface energy.

Angle of contact: The angle between the tangent to the liquid surface at the point of contact and the solid surface inside the Liquid is called angle of contact.

If $\theta > 90°$; = obtuse angle

$\theta < 90°$ = actuate angle

Capillary: A tube having a very fine bore is called a capillary tube.

The phenomenon of rise or fall of liquid in a capillary tube is called capillary action.

e.g.:1) Kerosene oil in lamp rise due to capillary action.

2) Tip of nib split ink due to capillary action.

3) A piece of blotting paper.

Rise of liquid in a capillary tube: Let us consider a liquid of surface tension 'T' in a capillary tube of Radius R. Let Q be angle of contact between liquid and gases. Liquid rises due to capillary action at the height h.

Surface tension T acts along the tangents of spherical.

Resolve R = T in two

Rectangular component

i) T Cos θ which acts at an every point of

in the upward direction and for rise.

ii) T sin θ acting in Horizontal direction and cancel each other.

The total upward force

$F = T \cos\theta \times 2\pi r$ …… (ii)

As we known that $W = Mg$

Where m is mass

$W = \rho Vg$. (ρ= density)

$V = \pi r^2 h$ (V = volume, h = height)

$W = \rho\pi r^2 hg$ ….i

F= W (Newton Third law)

$T \cos\theta\, 2\pi r = \pi r^2 h\rho g.$

$$\boxed{H = 2t\cos\theta / r\rho g}$$

Where h is height

Application of surface tension:

i) Industrial product likes soap and detergents have the ability to reduce surface tension.

ii) Agricultural spray have low surface tension.

Effect of temperature: Surface tension of liquid decreases with rise in temperature. For small temperature difference, It is Linear. if a mixture of water and detergents are heated, surface tension decreases.

Fluid Motion:

1) Stream Line flow: The flow of a fluid is said to be steady if the velocity at every point in the Liquid remains constant in magnitude as well as direction.

Turbulent Flow: The flow liquid in which velocity of all practice crossing a given point is not same.

Reynolds Number: Flow will be steady or turbulent depends upon density, critical velocity

$K = \rho VcD/H$

Where ρ and h is density of fluid and co-efficient of viscosity

If k is Reynold number

1) $K < 2000$, Flow is steady

$K > 3000$, Flow is turbulent

$2000 < K < 3000$, flow is unstable.

Viscosity: The property of liquid by virtue of which an opposing force come into play whenever there is relative motion between different layer of liquid is called viscosity.

Co-efficient of Viscosity: Consider two layers AB and CD of Liquid moving with velocities V and V+ dv at a distance X and X+dX respectively from the fixed surface dv represent change in velocity with change in displacement dx. The ratio dv/dx

is called velocity gradient.

According to Newton's law, if F be force

$F \alpha\ A dv/dx$

$F = hA\ dv/dx$

Where h is constant, known as co-efficient of viscosity. The negative sign shows that it is opposite to the direction of flow

If A= 1 F=dv/dx

Co-efficient of viscosity may be defined as tangential viscous Force per unit area require to maintain a unit velocity gradient.

Unit: The unit of co-efficient of viscous if poise.

Dimensional:-

$$\eta = \frac{Fdx}{Adv} = \frac{MLT^{-2} X L}{L^2 X LT^{-1}} = [ML^{-1}T^{-1}]$$

STOKE'S LAW: It states if a small spherical body of radius r moves with a small uniform velocity V through a homogenous viscous fluid of unlimited extent having co-efficient of viscosity, F= 6 πhrv

This is stoke's law.

Unique Technical Institute
H.O.: Shopping Complex, New Housing Board Colony, Barnala Road, Sirsa
B.O.:OPP. SIHAG HOSPITAL HISAR ROAD

FORCE & MOTION

Scalar & Vector

1- Scalar Quantities: Scalar quantities are these quantities which have any magnitude but not direction, like distance traveled by a man is 10 km. Here 10 km is just magnitude e.g. distance, speed, volume, energy, Temp. etc.

2- Vector Quantities: - Vector quantities are those quantities which have magnitude as well as direction e.g. displacement velocity, Force, Acceleration etc.

Classification of vector

1. Equal vector: Two vectors is said to be equal of they have same magnitude & direction.

2. Negative vector: A vector is said to be negative vector of another if they same magnitude & opposite direction.

3- Co-initial vector: A number of vector having a common initial points are called co-initial vector.

4. Co-linear vector: If all vector lie on a same line called as co-linear vector.

5. Zero Vectors: If a vector having zero magnitude & independent to direction.

ADDITION OF VECTORS

The vector can be added by using these laws.

i- Triangle Law (2) Parallel-gram law.

ii Polygon Law

i) Triangle Law: It states that if two vectors are represented by two sides of triangles taken in same direction, then the third side represents the resultant of these two vectors but in opposite direction.

Let $\vec{A}$ + $\vec{B}$ be two vectors represents by AB, $\overrightarrow{BC}$ side of triangle, then R be the resultant in opposite direction.

2. <u>Polygon Law</u>: If a number of vectors simultaneous at a point are represented by the different sides of a Polygon, taken in same order. Then resultant will be represented by closing side of polygen taken in opposites order.

2. Parallelogram Law:

It States that if two adacent sides of parallelogram acting simultaneously, at a point are represented by two vectors in magnitude & direction, of a parallelogram, then resultant will be diagonal of the Parallelogram passing through that Point in opposite order.

Component of vector

The Projection of vectors along the two axis (X-axis, y- axis) is called component of vector

Let AB= Fx, be force along

x-axis, BC= FY

$\vec{R} = \vec{F}x + \vec{F}y$ (By triangle law of vector)

In $\triangle$ ABC

AB/AC=COS AB= Fx=R Cosθ ……….

BC/AC=Sinθ=> FY=R Sinθ ………. (ii)

Squaring & adding both sides

$Fx^2 + Fy^2 = (R\ Cos\theta)^2 + (R\ Sin\theta)^2$

$FX^{-2}+FY^2+R^2$

$$\boxed{R = \sqrt{Fx^2 + Fy^2}}$$

<u>Force</u>: It is defined as a push or pulls which change or tends to change the state of body when it is in rest or uniform motion of body is called force.

E.g. when a football is kicked, it moves. It means, we apply a force.

There are three law of forces

Newton Law of Motion:

1. First Law: Every body remains in same state (e.g. state of rest or uniform motion) until any external any force is applied.

2- IInd Law: The rate of change of momentum is directly proportional to applied force.

3. IIIrd Law: Every action & reaction are equal & opposite direction

. Momentum: The quantity off motion possessed by a body is called momentum.

It is Product of mass of body & velocity of the body. It is denoted by ‘P’.

Let m be mass of body and velocity of body be ‘V’ then momentum will be P=mv

It is vector quantity

$P= [M]\ [LT^{-1}] = [MLT^{-1}]$

According to Newton IIIrd law

F=dp/dt

Where dp/dt is change in momentum with put the time value of ‘P’ in (i)

F=kd (mv)/dt where k=1

F=mdv/dt

We know that dv/dt=a

F= ma

Where F is force & a is acceleration.

Principal off conservation of momentum: The algebraic sum of moment a of bodies in a system remains constant & does not change due to their mutual action & reaction each other.

Resolution of Forces: The Process of dividing a single force in two force components is called resolution of force.

In x- axis, the force will be F Cos θ

In Y – axis, the force will be F Sin θ

Resultant of Force: If a number of force acting simultaneously on a body, then a single force, which can produce the same effect in the body is done by all the forces together is called resultant of force. It is represented by R

Expression for resultant of vector:

Let two vectors: P & θ are two

Vector represented by OA & AC & OC

Be resultant an diagonal of Parallelogram

Of vector △ABC

$$R=P+Q$$

Let θ be angle between Q and p

$\sin\theta = CD/AC$ OR $CD = AC \sin\theta$

$\cos\theta = AC/AD$ or $AC = AD \cos\theta$

$$AC = Q\cos\theta$$

$OD = OA + AD$

$OD = P + Q\cos\theta$

$CD = Q\sin\theta$

By using Phythagorous theorem

$(OC)^2 = (OD)^2 + (CD)^{-2}$

$R^2 = (P+Q\cos\theta)^2 + (Q\sin\theta)^2$

$R^2 = P^2+Q^2\cos^2\theta + 2PQ\cos\theta + Q\sin^2\theta$

$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

<u>Circular Motion</u> --- The motion of body in a circle with a fixed radius & at a constant speed is called circular motion.

2 Linear velocity: The distance traveled by a body along a straight path per time is called linear velocity. It is denoted by V

3. Angular velocity--- The angle described by a rotating body per unit time is called angular Velocity. It is denoted by (w)

Let a body moves A to B in a time t at angle then angular velocity

= W=V/R

V= wr =Linear velocity=Radius×AngularVelocity

<u>Time period:</u> The time taken to complete one revolution is called the time period.

$T = 2\pi r$

$W = 2\pi/T$ rad/s

Where W is angular velocity, T is time period

$F = I/T$ where F is frequency

$W = 2\pi f$

<u>Angular Acceleration</u>: It is defined as the state of change of angular velocity with respect to time. It is denoted by α

<u>Centripetal force</u>: The force acting along the radius towards the center of circle to keep a body moving with uniform speed in a circular path is called centripetal force. It is denoted by force (F)

The speed should not change along circular path. This is positive anus. If the force acts to the direction of motion of body & no component of force the dire action of motion to change the speed. The force acts along radius towards the center.

Example (i) The moon revolves towards the earth the centripetal force provided by the gravitational attraction between them.

In order to move a body in circular path with constant speed, a force must act along the radius of centre. This force is called centripetal force.

Expression-

Consider a particle of mass (M)

Moving in a circle of radius ‘r’

With a uniform speed in time‘t’

The distance AB covered with a

Velocity ‘v’ in time “t’

$AB = v \times t$ .... (I)

The acceleration required to move a body from

A to B = V^2/R

Force= Mass x acc.

$F = M \times V^2/r$

<u>Centrifugal force</u>: A body moving in a circle with a uniform speed experiences a force which in to take a way from the centre of the circle is called centrifugal force.

Example of centrifugal force—

1. Cream Separator It is a device used to separate the lighter contents to milk i.e. cream from milk. When milk is rotated in a cylinder a very large speed, the heavier particles move towards the wall of cylinder where as the lighter particle i.e. cream collects near the corners of cylinder
2. Centrifugal drying machine— The cloth can be drier very quickly. The clothes are placed in a large cylindrical vessel having large no. of fine holes along the side walls. When the wet clothes are rotated at a very High speed, the water particle fly tangentially towards the outer walls & such escape through the holes & clothes get dried.
3. Crystals of sugar are separated from& heavier fluid.
4. Butter contents can be separated from milk.

Banking of rods-- When four wheeler like cars they are moving on a circular path, centripetal force is required to move a circular path, centripetal force is required to move a circular path.

Consider a car of mass ‘m’, moving with

Speed ‘v’ in a circular radius ‘r’, then

Centripetal force is

$FC = mv^2/R$

If the friction between road & tyre is less than F

Then skidding, with high speed, then

R is reaction act on opposite direction to weight mg. It has two components

1) $R \cos\theta = mg$

The $R \sin\theta = mv^2/R$

$\tan T = V^2/Rg$

$Q = \tan^{-1}(V^2/Rg)$

When T is angle between at which road should be banked for speed 'v' & radius 'r'. The angle T is not dependent of mass or vehicle.

Lami Thoerm: - It states that when three forces acting at a point in equilibrium, each of force is proportional to the sin of angle enclosed between two other forces.

Proof: Suppose P, Q, R. are three
Forces in equilibrium acting at a
Point O. These forces are represented
By a triangle ABC
The side of AB which is 11 to R

$$\frac{P}{BC} = \frac{Q}{AC} = \frac{R}{AB}$$

$$\frac{P}{a} = \frac{Q}{b} = \frac{R}{c} \quad \text{----------} \text{ (i)}$$

Where a, b, c, are sides

According to sine formula

$$\frac{a}{\text{Sin } A} = \frac{b}{\text{Sin } B} = \frac{c}{\text{Sin} C} \quad - (1)$$

$<A = 180 -<, <B-180-B, <C = 180- Y$

Sin A = Sin L, Sin B= Sin B, Sin C = Sin Y

$$\frac{a}{\text{Sin } L} = \frac{b}{\text{Sin } B} = \frac{c}{\text{Sin } Y} \quad -(2)$$

From (1) & (2)

$$\frac{P}{\text{Sin } L} = \frac{Q}{\text{Sin } B} = \frac{R}{\text{Sin } Y}$$

Which is Lami's Theorem

Friction: - It is the opposing force which comes into play when a body tends to slide over the surface of the body is called friction.

Equilibrium of Forces: - Any vector sum of all the forces acting is zero, the body is in equilibrium. Any body remaining at rest or moving with uniform motion is in equilibrium. If the resultant of all forces acting upon it is zero.

NEWTON 2nd Law is Real Law of Motion:

Newton 2nd states that force is directly proportional to rate of change of momentum. It contains first law.

(a) First law: According to Newton Ist Law, if no force is applied on the body, there will be no change in body. According to F= ma' If F=0, It means that there will no force. Therefore m=0 or a=0;

but m =0, then a=0; It means body have no acceleration and remains in same position.

(b) IIIrd (3rd Law): If two bodies A and B which are dependent to each other. Let FAB be the force exerted on A by B and FBA be the force exerted on B by A. In case

FAB + FBA = 0; there is change in body. But FAB + FBA = 0; It means net resultant force is Zero, and body does not change its position; and FAB = -FBA; It means action and reaction are equal and opposite.

<u>Conservation of Momentum</u>: According to this principle; in the absence of any external force, total linear momentum of a system is constant

$$F = dp/dt$$

if $F = 0$; $dp/dt = 0$ $P = \text{Constant}$

Let $P_{1,} P_{2}$ $^{\ldots\ldots pn}$ linear momentum of particle

$$P = P_1 + P_1 + \ldots\ldots pn$$

$F = dP/dt = d/dt = (P1 + P_2 + \ldots\ldots\ldots\ldots Pn)$ ‘

If $F = 0$

$d/dt = (P_1 + P_2 + \ldots\ldots\ldots\ldots pn) = 0$

$$P_1 + P_2 + \ldots\ldots\ldots\ldots\ldots Pn \text{ Constant}$$

$m_1v_1 + m_2v_2 + \ldots\ldots\ldots m_nv_n = \text{constant}$

Impulse:

Impulse is defined as the change in momentum. It is measured as the product of force and time. It is impulse;

$J = F \times t$

The unit of impulse is Newton second.

Projectile: Any body thrown with velocity and it move to under the influence of gravity is called Projectile. The path followed by projectile is called trajectory.

Horizontal Projection: Let OX and OY be two mutually perpendicular axes.

(a) Uniform velocity with which it is Projected in horizontal direction.

Equation Let

X = Distance traveled along OX

Y = distance traveled along OY

Along OX $X = ut$

Along OY $S = ut + \frac{1}{2} at^2$

$Y = \frac{1}{2} gt^2$ (4=0, Initial velocity is zero)

$$\frac{X^2}{Y} = \frac{(ut)^2}{\frac{1}{2} gt^2} = \frac{2u^2}{g}$$

Angular Projection:

In case of angular projection

$V_x = V \cos\theta$; $V_y = V$ Sing θ

Equation of Trajectory: Along O $X = V_x\, t$

$= V \cos\theta \times t$ – (1)

Along OY $S = ut + ½\, at^2$ $(S = y,\ u = V_y,\ a = -g)$

$y = V_y t + ½\,(-g)\, t^2$

$y = V \sin\theta\ t - ½\, gt^2$

From (1) $t = x/V \cos\theta$

$Y = v$ Sing θ $X/V \cos\theta$!/2 $g\ (X/V \cos\theta)^2$

$Y = x \tan\theta - gx^2/2v^2 \cos^2\theta$

1) <u>Maximum Height of Projectile</u>: The maximum height is that vertical velocity becomes zero

As we know that $v^2 - u^2 = 2as$

In vertical a = -g, s= hmax, u=vy, v= 0 -2g hmax = $0-v^2y$

hmax = V^2y /2g= V^2 $Sing^2\theta$ /2g

2) Total time of Flight: It is time taken by the projectile from the instant from starting point to last point

T = time taken by body 0 to A + time taken from A to B

T = t + t = 2t

V = u |+ at

In vertical at A; v=0, u=Vy; a=-g

0= Vy=gt => t = Vy /g = V Sin θ/g

$T = 2\ V\ Sin\ \theta\ /g$

Horizontal Range: The maximum distance traveled in the Horizontal direction is called Horizontal range

R= uniform velocity × time of Flight

$= \quad V\ Cos\ \theta\ X \quad 2V\ Sin\ \theta\ /g$

$= \quad V^2/g\ X\ (2\ Sin\ \theta\ Cos\ \theta) = -\ V^2\ Sin2\theta/g$

$R = V^2\ sin2\ \theta\ /g$

Unique Technical Institute
H.O.: Shopping Complex, New Housing Board Colony, Barnala Road, Sirsa
B.O: OPP. SIHAG HOSPITAL HISAR ROAD SIRSA

Chapter –9

(Transfer of Heat)

THERMAL EXPANSION

a) Linear Expansion: The increase in linear dimension of a solid with increase in temperature is called linear expansion

$\triangle L = \alpha L \triangle T$

Where α is called coefficient of linear expansion. It is always positive and its SI unit is k^{-1}.

b) Superficial expansion: The increase in area of a solid plate of negligible thickness with a rise in temp. Is called superficial expansion.

$\triangle A = \beta\ A \triangle T$

Where β is coefficient of superficial expansion. It is always positive and its SI units is k^{-1}

c) Cubical Expansion: The increase in volume is a solid with increase in temperature is called cubical expansion

$\triangle V = {}_{\gamma}V\triangle T$

Where γ is called coefficient of cubical expansion. It is also positive and have same units as X & B.

A, b and Y are related as

$$\boxed{A= \quad \beta /2= \quad \gamma/3}$$

THERMAL STRESS

Definition: The force developed in a solid when it undergoes expansion or contraction with a charge in temp. is called thermal stress.

Let us consider the rod of length L and cross-section as A

Let the temp. be changed by $\triangle T$ then Change in length of rod, if free to do so, will be given by

$$\triangle L = A\, L\triangle T \text{ (I)}$$

Young's modules of elasticity is written as

Normal stress/long .strain

Thus thermal stress developed is given by

MODES OF TRANSER OF HEAT:

(i) Conduction: It is defined as that mode of transfer of heat in which the heat travels from particle to particle in contact, along the direction of fall of temperature without any net displacement of the particles of solid.

Consider a rod of bross held in such a way that its one end is on an ignited burner. The heated & experiences more energetic vibrations of the atoms. The meaning is that the atoms starts vibrating with larger amplitude. By a coupling of such vibrations the energy is transferred to the atoms in the colder region...

. It can be checked by touching it or melting a piece of wax

(ii) <u>Coefficient of thermal conductivity</u>: Consider a block of a homogeneous solid. Let its two opposite faces are maintained at two diff. Temp. Q1 and Q_2 such $Q_1 > Q_2$, therefore heat is conducted from the hotier to the other cold face..

Let us assure that there is no loss of heat from the sides of the slab. The amount of heat Q flowing from one side to the other depends

i) Directly on the face area, A
ii) Directly on the temp. diff. (Q_1 - Q_2,)
iii) Directly on time t

iv) Inversely upon the thickness of slab, d

v) On the nature of the material.

Hence,

$Q \propto A (Q_1 - Q_2,)t/d$

$$Q=KA (Q1-Q2) T/d$$

Where k is a constant depending on the nature of the material of the slab and is known as coefficient of thermal conductivity or co-efficient of heat conduction.

If eqn (i) above, $A = 1m^2$; $d=1m$, $Q_1-Q_2 = 1$ K

T=1sec then Q=K (numerically)

Hence, co-efficient of thermal conductivity is numerically equal the amount of heat conduct through its sample of area $1m^2$, thickness 1m in a time of one second when a temp. difference Of one Kelvin is maintained across its two opposite faces.

Unit = Watt m^{-1} k^{-2}

THERMAL CONDUCTIVTY:

(i) Searle's Method:

Construction & working: The material of which the coefficient of thermal conductivity is to be determined is taken in the form of thick rod AB. The end A is enclosed in a steam chamber to get heated and a copper tube is rounded at the end B which carries two thermometers T3 and T4 for measuring the temp. Of

Incoming and out going water two thermometers T_1 and T_2 placed in small cavities mode in the rod at a known distance 'd' as shown in figure. Some heat insulating material to minimize heat losses surrounds the rod. The whole of the apparatus is kept in a wooden box backed with some insulting material.

Heat is conducted through the material of a rod when steam is passed into the chamber. After sometime when the temp. Of thermometers T_1 and T_2, become stationary, the heat flowing through every section of the rod becomes equal. Now take a stop watch and collect say 'm' Kg of water

Flowing out of the exit of the copper tube in t seconds the temp. Of incoming and outgoing water is recorded.

Observations:

Area of cross –section= A m^2

Mass of the water collector = m Kg

Time = t

Distance between T_1 and T_2 = dm

Temperature given by T_1 = Q_1 ° C

Temperature given by T_2 = Q_2 ° C

Tem. T_3 = Q_3 ° C

Temp T_4= Q_4 ° C

Specific heat of water = S

Calculations:

Rise in temp. Of water = (Q_3-Q_4) ° C

Heat gained by water in t second

Q = mass X sp heat ×Temp. rise

$= m \times s \times (Q_3 - Q_4)$ …. (I)

Heat flowing between two pt at a distance d in t seconds will be

$= KA (Q_1 - Q_2) t/d$ ……………………….. (II)

From eqn (i) and (ii)

$KA (Q_1 - Q_2) t/d = ms (Q3 - Q4)$

$$k = \frac{ms (Q_3 - Q_4) d}{A (Q_1 - Q_2) t}$$

Lee's Disc Method for poor conductors:

Construction and working: The material of which the co-efficient of thermal conductivity is to be determined is taken in the form of two thin circular discs D_1 & D_2. The size of disc is about 10 cm in diameter and 2 to 3 mm thickness. The disc 1 is sand witched in between two copper plates C_1 and C_2 same diameters. The disc D_2 is pressed between the copper disc C_3 and C_4 as shown in figure. Between the copper discs C_1 and C_3 a heater element is placed which is heated by passing a current I through it by an outside battery. Four thermo couples on both sides of discs D_1 and D_2 are used to second the temp. Q_1, Q_2, Q_3 and Q_4.

A constant current is passed through the heater coil with the help of a battery. Current I is measured by an ammeter and potential difference by a voltmeter. The heat generated by the heating element is conducted through C_1, and C_3 and then passed through D_1 and D_2. The copper plates C_1 and C_3 ensure uniform distribution of heat through discs D_1 and D_2. After some time when steady state is reached the temp. Are recorded. Neglecting the heat loss through the edges of the disc, we can assure that all the heat produced by heater element is conducted away through D_1 and D_2 and then radiated outside.

Circulations

Thickness of D1 = d1 m

D_2 $=d_2 m$

Are of cross section of D_1 or D_2 = Am^2

Vol-meter reading = Vdv

Ameter reading = I amp.

Tmp. D_1 = (Q_1-Q_2)

Tmp. D_2 = (Q_3-Q_4)

Heat Produced by heater coil i.e.

Electrical energy consumed = Q= VIt joule…..(1)

Let K be the co-efficient of thermal conductivity of the material of discs D_1 & D_2

Heat passed through D_1 in t second

$KA\ (Q_1-Q_2)\ t/d$

Passed through D_2 in t second

$$KA\ (Q_3-Q_4)\ t/d$$

Total heat passed through D_1 and D_2

$$KA\ (Q_1-Q_2)\ t/d1+KA\ (Q_3-Q_4)\ t/d2=VIT$$

PREVOST THEORY OF HEAT EXCHANGES:

According to Prevost's theory every body which is at a temp. Of zero Kelvin, continuously emit radiations to its surrounding. The rate of emission of radiation depends on nature of the surface and temperature of the body.

During the same time, the body also receives thermal radiations emitted by the surroundings.

BLACK BODY

We define a perfectly black body which components absorbs radiation incident on it depend on wavelength.

The emitted radiations from a black body are independent of the nature of the body and only depend upon the temp. Of the black body. These radiations are known as black body radiations.

Absorbing Power:

The absorbing power of a body is defined as the ratio of the amount of heat energy absorbed to the total amount of heat energy incident on it.

$$A=Q1/Q2$$

Q amount heat falling on the body per sec. And of this Q_1 amount of heat is absorbed by the body.

LAWS OF BLACK BODY RADIATIONS:

(a) KIRCHHOFF'S LAW:

This law states that ratio of the emissive power (e) to the absorptive power (a) from a given wavelength at a given temp. Remits the same for all bodies and its is eq. To the emissive power of the perfectly black body (E), at the same given temp.

e/a =E=Constant ,emissive power of a perfect black body is constant.

(b) STEFAN'S LAW: This law states that the amount of heat energy (E) radiated per unit are per unit time by a perfectly black body is directly proportioned to fourth power of its absolute temperature (T).

Numerically, $E \alpha T^4$

$C= \text{Constant}\alpha \ T^4$

$E=\sigma T^4$ ……… (i)

Where, Stefan's Constant =5.67 X 10-8 wm-2k-4

(i) When the black body is observed at 2 different temp. T_1 and T_2 we can write

$E_1 = \sigma T_1^{4}$ and $E_2 = \sigma T_2^{4}$

$$\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4$$

(ii) $E^1 = e\sigma T^4$ when the body is not a perfectly black body, it has some emissive e. (for perfect black body e=1).

(iii) $E_{net} = \sigma (T^4 - T_0^{4})$ ....(iv)

If a perfect black body operating at temp. Equally black surrounding at temp T0, then not loss or gain of heat per unit area per unit time by the black body surrounds T.

In case of any other set of a body and surrounding, having exissivity e,

$E_{net} = e\sigma (T^4 - T_0^{4})$ .... (v)

(iv) Amount of heat emitted ($\Delta\theta$)

$$E = \frac{\text{Amount of heat emitted } (\Delta\theta)}{\text{Area (A) X time interval } (\Delta t)}$$

$\Delta Q = EA\,\Delta t$

From Eqn (i) $E = \sigma T^4$

$\Delta Q = \sigma A T^4\,\Delta t$

<u>(C) WIEN'S Law</u>: It states that wavelength (hm) corresponding to the maximum energy emitted is inversely X to the absolve temp. of the black body

$\lambda m \;\alpha\; 1/T$

λmT= constant

Where it is the wavelength of the mast intense radiation and T is the temp. of the black body. The value of this cons ford is 2892 X $10-^{2}$ m.k. This is known as Wien's law.

Unique Technical Institute
H.O.: Shopping Complex, New Housing Board Colony, Barnala Road, Sirsa
B.O.: H.O OPP .SIHAG HOSPITAL HISAR ROAD SIRSA
==

WORK POWER ENERGY

<u>Work</u>: Work is said to be done by a force when it moves a body through a certain distance. It is measured as the scalar product of the force and the distance. Work done = Force× displacement

$$\boxed{W = FS \cos\theta}$$

TYPES OF WORK

1. Positive work: A work is said to be positive work when angle between force and displacement is 0 °. It means that they are parallel to each other

$$W = F.S \cos O° = FS$$

Eg. I) when a horse pulls a cart on a level road, it is +ve (Positive)

2 NEGATIVE WORK: A work is said to be negative work when applied force and distance are anti-parallel.

$$W = FS \cos 180° = -FS$$

$$\boxed{W = -FS}$$

Eg. Work done against gravity

3. ZERO WORK: A Zero work is said to be that when force and distance are perpendicular to each other:

$$W = FS \cos 90°$$

W= O

UNIT: In S.I. unit of work is joule. One joule is said to be when one Newton force is applied on a body and it moves 1 M CGS, unit of work is erg.

FRICTION: It is the opposing force, which comes into play when a body tends to slide over another surface of body.

LAW OF FRICTION:1. The force of friction always act in a direction opposite to the direction of motion.

2. The force of Limiting friction is directly proportional to the normal reaction i.e. $F \times R$.

3. It depends upon material and nature of surface

$F = \mu R$, $\mu = F/R$.

Where it is coefficient of friction.

Work done in moving an object on horizontal:

Consider a body moving over a distance 'S',

By applied force P. The various force act upon

The body

I. Weight of the body acting downward.

II. Normal reaction (R) upward

III Pulling Force P

IV Force of friction F acting in opposite direction

R = MG

If the full displaces the body B to a position B' by a distance 'S

,

W= PS

W= URS

$\boxed{\text{W=umgs}}$

(b) <u>When a body move in inclined planes</u>:

Consider a body of mass 'm' lying on inclined plane AB with angle "Q"

the various forces acting.

(i) Weight (mg) of the body acting vertically down ward.

(ii) Normal reaction (R) acting perpendicular to plane AB

(iii) Force of friction (F), acting down the plane AB. The weight mg can be resolved into two rectangular component

(i) mg Cos θ Opposite to R.

(ii) mg sin θ which is parallel to plane AB.

In Equilibrium $R = mg \cos\theta$

$$P = mg \sin\theta + F \qquad , \text{as } F = UR.$$

If W is work done

$$W = P.s.$$

$$= (mg \sin\theta + F)S$$

$$W = (mg \sin\theta + \mu R)\, S$$

$$\boxed{W = (mg \sin\theta + \mu mg \cos\theta)\, S\,.}$$

POWER:

The rate at which is done is called power. If a force does work ‘w’ in a time ‘t’. The power delivered by the force is P=W/T=F.V

It is product of force and velocity.

UNIT: In C.g.s. system, the unit of power is erg/sec. In S.I., the unit of power is joule/sec. It is also called watt

1 HP = 746 watt.

ENERGY: It is defined as the capacity of to do work.

UNIT: It is also same unit of work as joule. There are two types of energy.

Kinetic Energy: It is defined as the type of energy which is due to its motion for e.g. A flying bird, A running man.

Expression: Consider a body of mass ‘M’ moving with velocity ‘V’ with with an acceleration ‘a’ and covered a distance ‘s’.

Force applied on body = ma.

Work = energy = F.S.

According to position velocity relation

$V^{-2} - u^2 = 2as$

As initial velocity = o= u

$V^2 = 2as$

KE=1/2 mv2

Potential Energy: The energy that is due to its position e.g. A lifted weight, water stared in dam.

Expression: consider a body of mass 'm' moved with acceleration due to gravity 'g' at a height 'h'

Force applied on body = mg.

Work = Potential energy= Force X distance

PE = mgh.

LAW OF CONSERVATION OF ENERGY:

Energy can neither be created nor be destroyed

Proof: Consider a body of mass 'm' at a point 'A'

At a height ‘h’ above the ground

Let X = distance of point ‘B’ from ‘A’

V_1= velocity of body at B

V_2 = velocity of body at C.

g = Acceleration due to gravity

Total energy= Potential energy + Kinetic energy

At A

Potential energy = mgh

Kinetic energy = o

Total energy = mgh+0 – mgh.

At B

BC = h-x

Potential energy = mg (h-x)

$$K.E. = \frac{1}{2} m v_1^2$$

$v_1^2 - u^2 = 2$ as => $V_1^2 = 2gx$.

$$K.E. = \frac{1}{2} mX(2\ gx) \qquad = V_1^2 = 2\ gx$$

Total energy = mgh – mgx + mgx = mgh

AT C

When the body reaches the point C, h = o

potential energy = mg x 0 = 0

$$K.E. = \frac{1}{2} m v_2^2$$

$V_2^2 - u^2 = 2as \Rightarrow V_1^2 = 2gh$

K.E. at 'C' = mgh

Total energy = mgh + x = mgh

Q: 1. Define work and its types.

2. Define unit of work

3. Explain and prove law of conservation of energy.

4. Define the power and its unit.

Unique Technical Institute
H.O.: Shopping Complex, New Housing Board Colony, Barnala Road, Sirsa

Unit 4

Stress Strain Curve:-

(i) When the deforming force is small the

Wire completely regain and original length Deformed. The wire is said to elastic. TheStraight line portion OA represents the Elastic behavior. When the deforming Force is increased, a limit is reached beyond which, it the applied force is removed.Its known as elastic Limit.

ii) If the wire is stretched beyond elastic Limit, the strain increased much more rapidly. The graph is not straight line but a curved from 'A' to 'C' some permanent increase is length takes plate; which is called permanent set OO.

iii) Beyond the point B, the deformation of the body may continue under the weight of body. The point 'B' at which the wire yields to the applied stress and begin to flow is called yield point and breaking point C is known as plastic range.

Unit-7

Newton's Law of Gravition::-

It states that; The gravitational force of attraction between any two particle is directly proportional to product of masses and inversely proportional to the square of distance between them

$F \alpha\ m1\ m2$

$F \alpha\ 1/r^2$

$F\ \alpha\ m1\ m2/r2$

Where G is gravitational constant. The value of G is 6.67 X 10^{-11} NM^2 Kg^{-2}. The dimensional formula of G is $[M^{-1} L^3 T^{--2}]$

Kepler's Law: Ist Law: All the Planet move in an elliptical orbit with the sun.

Kepler's 2nd Law: The line joining from sun to the planet sweeps equal area in equal interval of time.

<u>Third Law</u>: The square of limit Period of revolution of a planet around Sun is proportional to the cube of semi Circle axes.

$T^{2\alpha} R^{3} \Rightarrow (T^{2} = KR^{3})$

<u>Escape Velocity</u>: It is defined as the minimum velocity with which it is to be projected so that. It escapes from the gravitational field of the earth.

Consider earth of perfect sphere M1 radius R

Gravitational force of attraction of body at P

$$\boxed{W = \frac{GMm}{R}}$$

If Ve is velocity of body for escape

1

K.E. of body = 1/2mv2

Vc= 2gR

The value of escape velocity is 11.2 km/sec.

Unique Technical Institute
H.O.: Shopping Complex, New Housing Board Colony, Barnala Road, Sirsa
B.O OPP.Sihag Hospital ,Hisar road Sirsa-125055

Unit-Heat & Temperature

Scale of Temperature:

(i) Faurnahieght Scale: In this scale, melting point of a mixture of ice with common satt was first reference point and boiling point of water is second reference point. The first is 32°F and last is 212 F° ‘, that is equally divided.

(ii) Reumer scale: The first reference point was 0° R and steam point was 80°R

(iii) Celsius Scale : The scale have first on 0° C and last on 100°C, is equally divided in 100 part

Relation: $$\frac{C}{5} = \frac{F-32}{9} = \frac{K-273}{5}$$

Bimetallic Thermo-meter: These thermo-meter are based on principle that solid shows thermal expansion.

Principle: A bimetallic thermo meter is based upon the principle that linear expansion depend upon the same increase in temperature of different material.

Theory: A bimetallic strip of two metal copper and iron are riveted together at several point. These are tightly contact. At room temp, the strip remains straight but when it is heated, copper shows more expansion than iron.

Copper remains on the outer side because it has linear expansion for same rise in temp.

When temperature increases the inner and outer layer shows different extension. The spiral winds up and deflect the point. A calibrated scale is provided to display the reading.

Uses: The range of bimetallic thermometer is 50° to 550°C

Platinum Resistance Thermometer.

Principle: The electrical resistance of a solid changes with a change in temperature

$$Rt = R_0 (1 + \alpha t)$$

Where α is temperature co-efficient of thermometer.

Construction: It consist of platinum wire of resistance about 10 ohm at 0°c, wounded on a strip.

The Platinum wire is doubled to avoid the effect of self inductance. It ends are connected to copper leads having resistance R_1 which emerge from tube passing through mica discs

<u>Working:</u> The leads C_1, C_2 are Connected the arm AD while the Leads P_1, P_2 are connected to the Arm CD. A wire of Length 2yAnd resistance r ohm/cm is put AD and CD. The opposite point A and C are joined together through a cell and key. The resistance R_0 and R_{100} are found by immersing the platinum wire in Ice and boiling point.

Calculation: $R\,T = R_0\,(1+\alpha t) = Ro + Ro\,\alpha t$

$R\,T = R0 = Ro\,Xt$

If t= 100°c, $R_{100} = RO = Ro\,X - 100$

$$T = \frac{Rt - Ro}{R_{100} - R0} X\,100$$

Merits : It performs well in a range 250°C to 1600°C

It reading is very accurate upto 0°. 01 C

It is standard thermometer.

Demerits (i) It takes a long time to read the temperature

(ii) It cannot measure the changing temperature

Pyrometer:

Principle: A Pyrometer is based on the Principle of radiation of not body. Types:

(i) Total radiation pyrometer: In this Pyrometer, the a valuable radiation of a hot body is focused at a point. A thermocouple is used to determine the temperature.

Construction: It have parabolic mirror to focus the radiation coming from hot body. A thermocouple is fitted in such a way that is junction is right at focal point of mirror. A galvanometer is used to interpret the output of thermocouple.

Working: This pyrometer turned to the object. The hot objects do emit a good amount of visible radiation as well. The image formed just as the top of thermocouple. The temperature is displayed on milivot meter.

Applied Physics

Note: Attempt any ten questions from this section:

2 X 20

1. (a) Define a Cantilever.

(b) Write any four sources of conventional energy.

(c) What is a satellite?

(d) Define heat on the basis of kinetic theory.

(e) Define thermal conductivity.

(f) What is a horse power?

(g) Define centrifugal force.

(h) Write SI unit of energy.

(i) Define escape velocity.

(j) Define temperature.

(k) Define a vector quantity with example.

(l) Give an example of zero work.

Section-B

Note: Attempt any five questions from this section.

5 X 6 = 30

2. Explain resonant vibration with examples.

3. Explain the three modes of transfer of heat.

4. Define potential energy and derive a relation for it.

5. Define transverse and longitudinal waves with examples.
6. Explain kepler's laws of planetary motion.
7. Explain different scales of temperature.

Section-C

Note: Attempt all questions from this section 5 X 10= 50

8. Derive a relation for time period of simple pendulum using method of dimensions.
9. Define a projectile. Derive a relation for time of flight and horizontal range in case of a projectile projected at an angle θ with horizontal.

10- Define surface tension and derive a relation for height of liquid column by capillary rise method.

11. (a) Derive a relation for rotational kinetic energy of a rigid body.

(b) State theorems of parallel and perpendicular axes.

12. Write notes on any two of following:

(a) Modulus of elasticity.

(b) Geo-stationary satellites.

(c) Properties of heat radiations.

(d) CHEMISTRY

(e) FRADAY'S LAW OF ELECTROLYSIS:-

FIRST LAW :- It states that "mass of any substance is directly proportional to the quantity of electricity passed through it . It W is the mass of substance liberated on passing Q coulombs of charge

$W \alpha Q$

$W = ZQ$

where Z is electrochemical equivalent

As $Q = IT$

charge = Current x time

$W = ZIT$

If $I = 1A$, $t = 1sec$, then $W = Z$

Electrochemical equivalent is defined as the amount of mass when

1Ampere current is passed in 1 sec ; Z=**E/96500**

where E is equivalent mass , 96500 is constant

compare of 1st law & 2nd law

From 1st law :- m α E

M1/M2 =E1/E2---------(1)

from 1st law ,where Q constant

m α Z

M1/M2 = Z1/Z2 ---------(2)

From E1/E2 = Z1/Z2

E α Z

$\boxed{E=FZ}$

Where F is Faraday's Constant

ELECTOLYSIS

Electrolysis = The phenomenon of chemical decomposition of large molecule in to smaller molecule by passing electric current.

Electrode = A metallic or non-metallic rod conducting electrons on passing current.

Anode = A electrode which contains positive charge oxidation take place.

Cathode = The electrode or which reduction take place contain negative charge.

Cations = Which have positively charge ion.

Anion = Which have negatively charge ion.

Electrolytes = The substance which can be split up in to cation and anion in equal is solution.

ELECTROLYSIS = The process of chemical decomposition of the electrolyte on passing electric current is called electrolysis. It is carried out in electrolytic tank. Electrolytes is dissolved in some suitable solvent . Two metallic strips i.e. electrodes are immersed in electrolytes; knows as anode and cathode .A electric current(D.C) is passed through the electrolyte with the help of these electrode . During electrolysis, cations move towards cathode and anion move towards anode.This is occurs due to loss and gain of electrons.

IMPORTANT 1.It help in finding E.C.E.

(2) The second law help in determine the eqvivalent weight.

(3) It also helps in determine the quantity of electricity.

Applications of Electrolysis

(1)Electrometallargy =: Sodium, chromium, Aluminums, Iron metals are extracted from their over by electrolysis.

(2)Electro- refining = Various metals like iron,cu,fe,cr,zn,Pb are purified by the prosses electrolysis. Impure metal is mode anode and pure metal act as cathode. Anode and Cathod are suspended in electrolytic cell containing salt of an electrolyte of the same salt cation move towards cathode and anion move towards anode.

Electroplating :- It is technique in which superior metals layer is deposited over inferior metal's layer with the help of electrolysis corrosion. That can be reduce by corrosion .

Equivalent Weight :- With the help of 2nd law of faraday we can easily calculate equivalent weight

$$\frac{\text{Weight (Wt) of metal A deposited}}{\text{wt.of metal B deposited}} = \frac{\text{Eq wt.of A.}}{\text{Eq wt.of B}}$$

(5) Manufacturing of chemical in Industries :- Chlorine , sodium, hydroxide , Nacl,D2O(heavy water) are manufacture with the help of electrolysis.

(6) Preparation of alloys :- High class alloys can be prepared by the process of electrolysis Brass, which is alloys of Zn & Cu .

LEAD ACID BATTERY :- It consist lead (Pb) which act as anode and PbO2 act as cathode . When "external circuit is completed .

Discharging :- At Anode :-

lead lasses electrons and change in Pb(+2) ion

Pb(s) ------------- Pb(+2) +2e-

which will combine with SO42- ions of electrolyte that produce lead sulphate (PbSO4)

Pb2+ + SO4- -------------- PbSO4

At cathode :- PbO2(S) + 4H+ + 2e- ---------- Pb2 + 2H2O

Then again Pb^{2+} combine with SO_4^{-2} to give lead sulphate

$PbO_2 + SO_4^{2-}$ ------------- $PbSO_4(s)$

$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq)$ --------------- $2PbSO_4(s) + 2H_2O$

Recharging :- It can be recharged by passing electric current at a suitable voltage in opposite direction

$PbSO_4(S) + 2e^-$ --------- $Pb(S)SO_4^{2-}(aq)$

$PbSO_4 + 2H_2O$------------- $PbO_2 + SO_4^{-2} + 4H^+ + 2e$

$2PbSO_4(S) + 2H_2O$---------- $Pb(S) + PbO_2 + 4H^+ + 2SO^{-2}$

NICKLE CADMIUM BATTERY :- It is also called Ni-Cd battery.

It have cadium anode and NiO_2 act as cathode. This solution of electrolytic is

$Cd(S) + 2OH^- (aq)$ -------------- $Cd(OH)_2 + 2e^-$

$NiO_2(s) + 2H_2O(l) + 2e^-$ ----------- $Ni(OH)_2 + 2OH^-$

$Cd(S) + NiO_2(s) + 2H_2O(l)$ ----------- $Cd(OH)_2 + Ni(OH)_2$

After discharging they formed as solid reaction can be revers by charging

Advantage :- 1) It has longer life.

2) It is much lighter in wt.

3) It is compact and portable.

ATOMIC STRUCTURE

DALTON'S ATOMIC THEORY:-In 1808, Dalton gives a theory about structure of atom.

(1) Matter is made of extremely small invisible particle called atoms.

(2) Atom of same element are similar in all respect.

(3) Atoms are different element have different weight.

(4) Atoms of different elements combine in simple but fixed ratio to form compound atoms.

(5) Atoms can neither be created nor be destroyed.

RUTHERFORD'S SCATTERING EXPERIMENT :- According to Rutherford.

(i) Most of alfa- particle passed straight through the gold foil.

(ii) Some of rays were deflected by small angles .

(iii) A very few alfa-particle suffered major deflected by more than 90 angle and even came back in same direction . It means that

(iv) Most of the atom is hollow .

(v) The central proton of the atom carries positive change which repels the positively charged alfa-particles .

(vi) The central portion of atoms is solid .

(vii) But , It fails to explain as to why electrons donot fall in to positively charged nucleus due to matual forces .

<u>BHOR'S MODEL OF ATOM</u> :- An atom consist of small heavy positively charged nucleus the center and electron revolve around certain paths .

(2) As long as an electron revolve around the nucleus, It does not lose or gain energy but If it remains in particles orbit .

(3) Only those orbits are permissible in which angular momentum of electron is multiple of <u>h/2Л</u>

(4) An electron continues to move in a particular energy level without losing energy.

(5) Energy is emitted or absorbed only when the electron jumps one orbit to the other.

<u>MASS NUMBER</u> :- The sum of protons and neutron present in the nucleus of an atom is called mass number.

<u>ATOMIC NUMBER</u> :- It is equal to number of proton or no. of electron of atom.

<u>ISOTOPES</u> :- The atoms of an element which have same atomic number but different mass number are called isotopes.

ISOBARS :- Atoms of different element which possess the same mass number but different atomic number are called isobars .

ORBIT :- It is a well defined path traced by electron and two dimensional representation .It is always circular. The path of electron can be extractly followed .The number of electrons is 2n.

ATOMIC STRUCTURE

ORBITALS :- It is region or space where probability of finding the electron is maximum. It has three dimension representation. The no. of electron is two in a orbital.

SHAPES OF S AND P ORBITALS :-

S – ORBITALS :- The shapes of s-orbital is spherical .Its probability of finding the electron is identical. in all direction. The no. of spherical nodal surfaces the S-orbital of any energy level is equal to n-1. Where n is principal quantum number.

p-orbital :- The p-orbital has dumb-bell shape. Depends on directions px ,py,pz are lobes of o-orbital.

QUANTUM :- It is defined as the number which determines energy of electron , angular momentum and shape of electrons and direction of orbit , spin of electron. There are four quantum numbers.

1) PRINCIPLE QUANTUM NUMBER :- It determines energy of electrons. of hydrogen atom E_n = -1312/n2Kjmol-1.The number of electron in an atom having same principle quantum number is 2n2 , where n is principle quantum no.

AZIMUTHAL QUANTUM :- It is also called angular quantum number. It determines the shape of electron's orbit . It is denoted by l . The value of l is o to n-1 value of i.e. ----- o = s

1 = p

2 =d

3 = f

4 = g

5 = H

The number of sublevel present in an energy level is equal to principal quantum number .

MAGNETIC QUANTUM :- It describes the behavior of electron in magnetic field . Due to magnetic field .The electron revolves and it is denoted by m. = -l to +l . including zero . Total number of orbital in an energy level are equal to square of principle quantum number(n^2)

SPIN QUANTUM NUMBER :- It is denoted by S and it is not related by l,n,m. This is due to spinning of electron .

n = give size and energy in orbital

l = shapes of orbital

m =orientation of orbital

s = spin of electrons

AUFBAU PRINCIPLE :- According to this ,electron tend to occupy orbital to minimum energy in ground state of atom

n+l rule :- This tell about sublevel of which has lower energy ; An energy level of which (n+l) lower energy . If(n+l) has same level then compare n.

1S orbital (1+ 0) = 1,2s---- 2+0=2

HUND,S RULE OF MAXIMUM MULTIPLICITY :- It states that pairing of electron does not take place. in orbital of same energy until all the orbital contain at least one electron each.

PAULI’S EXClUSION PRINCIPLE :- No. two electron in an atom can have all the four quantum number .

It can also be state as , An orbital cannot have more than two electron . Electron present in the same orbital have same values of three quantum number n,l,m but spin quantum no. must be different .That will be +1/2,-1/2.

HYBRIDIZATION :- It is process of intermixing of orbital of an atom of nearly equal energies for making new orbital equal in number to the mixing orbital and same energy and same shape.

CHARACTERSTICS OF HYBRIDIZATION :- 1) The number of hybridized orbital is equal to the number of orbital.

2) The hybridized orbital are always same in energy and shape.

3) The hybrid orbital are more effective in forming stable . bonds than the pure atomic orbital.

4) The hybridization takes place at the time of bond formation.

LANGUAGE OF CHEMISTRY

ATOMIC MASS :- Atomic mass of an element as defined as a average relative mass of an atom of the element as compared with an atom of carbon taken as 12a.m.u .

Valency :- It is combining capacity of an element for e.g. valency of hydrogen (h) is 1 and chlorine is I .

It is defined as the number of the hydrogen or chlorine atoms or twice the no. of oxygen atoms with which one atom of the element combines . These are two types of valency.

1) Electropositive valency

2) Electronegative valency

1)Electropositive valency :- Radicals contains +ve charging is called the +ve radical when 1, then monovalent ,when 2 then bivalent , when 3 , then trivalent , when 4 , then tetravalent .

when 1= H^+ ,Na^+ , K^+ etc.

when 2 =Fe^{++} , Pb^{+2} , Sn^{+2} etc.

when 3 = Ba^{+3} , Fe^{+3} etc.

when 4=C^{+4}

2) Electronegative valancy :- The –ve charge present on radical is called electronegative radical , CH_3COO^- , Br^-, Co^{2-} , Aso_3^{-3} , C^{-4}

FORMULA OF COMPOUND :- 1) Positive radical is written on the left side and –ve radical is written on right side .

2) The no. of atom is multiplied by valencies of opposite radicals.

e.g. 1) Ca^{+2}-------$2Cl_2$

========= $CaCl_2$

Cl^{-1} -------- 1xCa

2) Al^{+3} ------------ Cl_3

======== $AlCl_3$

TYPES OF FORMULA :-

Empirical formula :- That formula give the whole no. ratio between the atoms of various element present in one molecule of compound($C_6H_{12}O_6$) empirical formula CH_2O

2) Molecular formula :- It is defined in the formula which gives the actual no. of atoms present .

Steps :-

1) Calculate relative no. of moles of each element by dividing % of each element by its atomic mass .

2) Calculate simple ratio between the no. of moles of various element by dividing quantity by smallest of them .

3) To obtain the whole no, ratio by multiplying the fraction figure with integar .

4) Write the empirical formula .

E.G :- A sample of salt has following % age

Element	%age	At mass	Relative atom mass	simple ratio	Whole no. ratio	result
Fe	36.76	56	36.76/56=0.65	.65/65=1	1	1
S	21.11	32	21.11/32=0.65	1	1	1
O	42.14	16	42.14/16=2.63	4.05	4	4

=== $FeSo_4$

Chemical equation:- A chemical equation is represented by the chemical equation in which symbols and formula are used.

Steps :- 1) Reaction substance is represented as reactant , Produced substance is Product.

2) Check the no. of atoms of each element whether they are equal or not .

Reaction of chemical equation :- 1) It does not give information about physical state of matter.

2) This does not give information about temp. , pressure , catalyst.

3) Rate of chemical reaction and time taken to complete the chemical reaction are not know.

4) Mechanism of chemical reaction is not know by simple reaction .

5) It does not show precaution and presentations measures during explosive chemical reaction .

6) It does not tell , that reaction is exothermic or endothermic .

<u>Balancing a chemical equation</u> :-

<u>HIT and trial method</u> :- This method is useful to balancing method equation .The atom which occur at minimum no. of places on both sides should be selected first and one occurring maximum number of times should be taken last of all.

For example $Na + H_2O$ -------- $NaOH + H_2$

$2Na + 2H_2O$ -------- $2NaOH + H_2$

E.g. $KclO3$ ------------- $Kcl + O$

1) To equalize the no. of oxygen atoms on both sides multiply O by 3

$KClO3$ -------------- $KCl + 3O$

now multiple it to 2 to make molecule

$2KClO3$ ---------- $2KCl + 3O2$

E.g. $Na_2S_2O_3 + HCl$ ------------ $Nacl + SO_2 + S + H_2O$

To equalize Na atom multiply Nacl by 2

$Na_2S_2O_3$ + HCl --------- $2NaCl + SO_2 + S + H_2O$

To balance Cl multiply by (2) HCl

$Na_2S_2O_3 + 2HCl$ ------------ $2Nacl + SO_2 + S + H_2O$

WATER

There are two types of water

1) Soft water

2) Hard water

Soft water :- Water which form lather with small amount of soap solution is called soft water E.g. Rain water , distilled water.

Hard water :- The water which does not form lather with small amount of solution is called Hard water E.g. Tap water , Sea water

Causes of hardness :- The causes of hardness due to following reasons

1) Calcium bicarbonate ------------- $Ca(HCO_3)_2$

Temporary

2) Magnesium bicarbonate ----------- $Mg(HCO_3)_2$

Calcium Chloride ------------------- $CaCl_2$

Magnesium Chloride --------------- $MgCl_2$

Calcium sulphate ------------- $CaSO_4$

Magnesium sulphate -------------- $MgSO_4$

Types of hardness :- These are two types

1) Temporary hardness

2) Permanent hardness

Temperary hardness :- Temperary hardness is that which can be removed by a simple method like boiling – due to bicarbonate.

Permanent hardness :- It is that hardness which can not be removed by using boiling due to chloride and sulphate .

Softening of Hard Water: - The process of removing hardness from water is called softening of water.

Boiling: - The temporary hardness can be removed by boiling .The CO_3 of Ca & Mg present in water is decomposed.

$Mg(HCO_3)_2$ --------------- $MgCO_3 + H_2O + CO_2$

$Ca(HCO_3)_2$ --------------- $CaCO_3 + H_2O + CO_2$

2) <u>BY CLARCK'S METHOD</u> :- The addition of lime convents soluble bicarbonates in to insoluble carbonate and hydroxide of Mg.

$Ca(HCO_3)_2 + Ca(OH)_2$ ----------- $2CaCO_3 + 2H_2O$

$Mg(HCO_3)_2 + Ca(OH)_2$ ----------- $MgCO_3 + CaCO_3 + 2H_2O$

$MgCO_3 + Ca(OH)_2$ -------------- $Mg(OH)_2 + CaCO_3$

3) <u>By adding Washing Soda :-</u> In this method temporary as well as permanent hard water is treated with washing soda.

<u>Temparary hardness</u> :-

$Ca(HCO_3)_2 + Na_2CO_3$ -------- $CaCO_3 + 2NaHCO_3$

$Mg(HCO_3)_2 + NaCO_3$ -------- $MgCO_3 + NaHCO_3$

<u>Permanent hardness</u> :-

$CaCl_2 + Na_2CO_3$ -------------- $MgCO_3 + Na_2SO_4$

<u>Permuit Process</u> :-It is technical name of Zeolite .It is obtained by fusing sodium carbonate , silica and alumina.

$Na_2CO_3 + 2SiO_2 + Al_2O_3$ -------------- $Na_2Al_2Si_2O_8 + CO_2$

The apparatus consist of cylindrical steel container packed with gravel sand and permutit it suspended particles are removed by passing the water thought bed of sand.

It is most method for removing temporary as permanent hardness .

After a continuous use permuitit gas exhausted In order to activate ,NaCl is added

1) Ion exchange method ;- These material are made from coal, wood and organic material by reaction with fuming sulpharic acid. There are two types.

1) Cation exchange 2) Anion exchange

2) <u>Cation exchange resins</u> :- It is represented by HX , Where x represents halogen group.

E.g. Cl ,Br , I It can be added in water to remove hardness.

$Ca(HCO_3)_2 + 2HX$ ---------- $CaX_2 + H_2CO_3$

$Mg(HCO_3)_2 + 2HX$ ------------- $MgX_2 + H_2CO_3$

$Ca(SO_4) + 2HX$ ------------ $CaX_2 + H_2SO_4$

1) <u>Anion exchange resine</u> :- It is represented by ROH where R is alkyl group .

<u>R=</u> C_nH_{2n+1}, OH = Hydroxy group.

these resins are capable of removing anion from water by replacing it with hydroxyl ion Normally water is passed first through a of cation exchange resin in order to remove Ca or Mg salt and then passed through anion exchange

$ROH + HCl$ ------------ $RCl + H_2O$

$2ROH + H_2SO_4$ --------- $R_2 SO_4 + H_2O$

Lime soda process: - In this method lime and soda are required to add in water.

a) Cold soda lime Process: - In this method water is agitated with a calculated amount of soda and lime to room temperate a small amount of co-agulants (Sodium aluminates) is also added so as to cause coagulation of the finally divided precipitates. It helps remove the silica as well as oil. If present in water.

Thus 106 part of Na2CO3 ------------ 111 parts of $CaCl_2$

b) $CaSO_4$ + Na_2CO_3 ------------ $CaCO_3$ + Na2 SO_4

136 ------------- 106

Thus 106 parts by lot of Na2CO3 are required to remove 136 of $CaSO_4$.

c) For $MgCl_2$, Both soda and lime are required.

Hot Lime Soda Process :- In this method , water is treated with chemical at 80-120^{0}c .Temperature is closed to boiling point of solution so reaction much process faster.

Degree of Hardness: - It is used to measure the hardness of water. The hardness is always measured in terms of $CaCO_3$.

1gram molecule or 162gm of Ca $(HCO_3)_2$

1) = 1gm molecule of $CaCO_3$

2) = 1gm of 111gm of $CaCl_2$ = 100 gm of $CaCO_3$

3) 136gm of $CaSO_4$ = 100gm of $CaCO_3$

4) 146 gm Mg $(HCO_3)_2$ = 100gm of $CaSO_3$

5) 95 gm of $MgCl_2$ = 100gm of $CaCO_3$

6) 120gm of $MgSO_4$ = 100gm of $CaCO_3$

There are three units

1) Clarck's degree of Hardness

2) French degree of Hardness

3) Parts per millenium

1) Clarck's degree of Hardness: - It is no. of part by weight of hardness causing substances in terms of $CaCO_3$ per 10000 parts by weight of water It is represented by cl.

2) French degree of Hardness: - It is no. of parts by weight of hardness causing substance in terms of calcium carbonate present per 100000 parts by weight .It is represented by Fr^0

3) Parts per million (PPM):- It is no. of parts by weight of hardness causing substances in terms of $CaCO_3$ present per million parts by weight of water. It is represented as P.P.M.

Relationship: - 7^0 Clark = 10^0 French =100 P.P.M

E.D.T.A method: - E.D.T.A stands for ethylene diamine tetra acetate. This is modern method for estimation of hardness of water.

1) Standard solution of E.D.T.A

2) NaOH solution

3) Mur oxide (indication)

1) Determination of Hardness due to calcium ion: - A know volume of sample water is taken in the conical flacks .It is added by 5m.l of N/10 NaOH and two drop of peroxide . The solutions become pink. This is then

titrated against stand E.D.T.A. A solution is burrelete till colour changes from pink to .Let the volume of E.D.T.A used by v, ml.

1 ml of E.D.T.A = mg of $CaCO_3$

1 ml of E.D.T.A = mg of $CaCO_3$

Calculation: - v1 --------------- mv_1 of CaCO3

50ml of sample water = $mv_1/50 \times 100$

106 ml sample water = $mv_1/50 \times 106$

= $2mv_1 \times 10$gm of $caco_3$

DRINKING OF WATER :- It passes the following properties

1) It should be cloureless and tasteless.
2) It should be free from the suspended impurities.
3) It should be free from germs and bacteria.

2) Purification; - If water does not satisfy above properties. It cannot use for drinking purpose.

Rage: - Water is bept aside in big tanks most of the suspended impurities present in it, due to it their greater densities , settle down . Some germs and bacteria are killed due to sunlight.

2) Filteration: - In order to remove the fine suspended impurities the process of filtration is carried out.

a) Domestic filtration:-For domestic purification of water, are placed are placed one above the other in a wooden frame.

3) Formatting of scale or sludge: - When water is boiled in boiler was bicarbonate of Ca and Mg are precipitated as carbonates. Due to continuous use concentration of soluble salts increases and it is known as scale. When scales become soft, it is known as sludge. But it remains hard.

1) The scale is bad conductor

2) Heat due to this wastage of fuel.

3) Cracks may appears in scale due to non-uniform heating

2) Corrasion: - The constant eating up of the plates is called corrosion.

$MgCl_2 + H_2O$ -------- $Mg(OH)Cl + HCl$

$Fe + 2HCl$ -------- $FeCl_2 + H_2$

3) Priming Foaming: - Due to suspended impurities in fed water large amount of bubble on surface of bubbles are formed known as foaming.

4) Caustic embritile ment: - When the boiler material becomes brittle due to presence of caustic substance in water. Thus process is called caustic embritilement.

The upper three pitchers have small holes at their bottom powered red chemical gravel are placed in second and third .Now impure water is most put in the upper most pitcher holes of pitchers are plugged with cotton plugs .Impure water as it passes dropurise from of leaves its colouring Mattel and most of suspended impurities present in it, while discolors water passes through the third pitches .The pure water collected in fourth pitchers.

2) Laboratory :- A funnel is filled in a stand with filter paper .Impure water is poured on glass rod held slanted in

the filter paper funnel .This pure water is obtained from funnel.

3) Pasteur filtration: - The impure water is put in to the container and then is covered with the lid. There there are porceli tubes. Container .Impure water passes through tubes leaves the impurities in the container. Pure water is collected in receiver.

4) Town supply: - Impure water passes through different layer one by one. The impure water percolates down. These layer and leave the suspended particle impurities.

3) STERLIZATION: - The removes of bacteria and germs is known as sterilization.

1) Boiling

2) Oxidation & Coagatants

3) Chlorination

4) U.V (ultra –violet) ray

Boiler Water: - In industries water is largely used in boiler for the generation of stream.