INTERMEDIATE STAGE PHYSICS

BOOK TWO

FOR CLASS XII

For

Sindh Textbook Board, Jamshoro.

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Chapter 11

HEAT

HEAT:

Heat is a form of physics. The sum of all the microscopic energies of all molecules in a body is called as heat. Heat is a form of physics.

UNIT:

Joule

TEMPERATURE:

The degree of hotness and coldness in a body is called as temperature.

SCALES OF TEMPERATURE:

There are three main scales of measuring the temperature.

- Celsius
- Fahrenheit
- absolute scale or Kelvin scale

We know that,

- The melting point of ice is 0 oC.
- The boiling point of water is 100 oC.
- Fahrenheit scale's highest temperature is 212 F and the lowest temperature is 32 F
- Lowest temperature for Kelvin or absolute scale is -273 oC

To convert Fahrenheit scale into Celsius scale we use formula

C= 5/9 (F-32)

To convert Celsius scale into Fahrenheit scale we use formula

F = 9/5 (C+32)

To convert the Celsius scale into Kelvin scale we use formula

K = C+273

THERMOMETER:

An instrument that is used to measure the temperature of a body is called as thermometer**.**

THERMAL EQULLIBRIUM:

The state at which the temperature of two different bpdies becomes equal is called as thermal equilibrium.

THERMOMETRIC PROPERTY:

The uniform change in a body when the heat is passes through the body then this type of property is called as thermometric property.

Heat causes following type of expansions.

1. Linear expansion or longitudinal expansion
2. Volumetric expansion

LINEAR EXPANSION OR LONGITUDNAL EXPANSION:

The expansion in length in a body that cause due to the heat is called as linear expansion.

DERIVATION:

The increase in length of a longitudinal bar is directly proportional to its original length.

$\Delta L \alpha L1 - - - - - - - - - - - - 1$

The increase in length is directly proportional to the change in temperature.

$\Delta L \alpha \Delta T - - - - - - - - - - - - 2$

Combining equation 1 and 2

$\Delta L \alpha L1 \Delta T$

$\Delta L = \alpha L1 \Delta T$

$\alpha =$ coefficient of linear expansion of solid.

COEFFICIENT OF LINEAR EXPANSION:

The change in length per unit length per degree rise in temperature is called as coefficient of linear expansion. Value of alpha is different for different materials.

VOLUMETRIC EXPANSION:

Increase in volume of a body cause due to the heat supply is called as volumetric expansion.

DERIVATION:

The increase in volume of a body is directly proportional to its original volume.

$\Delta V \alpha V1 - - - - - - - - - - - - 1$

The increase in volume of a body is directly proportional to the change in temperature.

$\Delta V \alpha \Delta T - - - - - - - - - - - - 2$

Combining relation 1 and 2

$\Delta V \alpha V1 \Delta T$

$\Delta V = \beta V1 \Delta T$ $\alpha =/ \beta$

$\beta =$ coefficient of volumetric expansion of solid.

RELATION BETWEEN ALPHA AND BETA:

Coefficient of volumetric expansion is three times of coefficient of linear expansion.

$\beta = 3\alpha$

BIMETALLIC STRIPS:

When two strips of different materials (brass and iron) are joined together then this type of device is called as bimetallic strips.

1. Bimetallic strips are used in electric thermostat.
2. It can be used in making fire alarm.
3. We can use it to make electric iron.

ANOMOLUOS EXPANSION OF WATER:

We know that water expands on heating. It contracts when the heat ranges to 0 C to 4C. And it expands when it reaches to the range 4C to 0C instead of contracting. This principle is called as anomalous expansion of water.

USE OF ANOMALOUS EXPANSION OF WATER:

Marine life survives because of this property of water because if the temperature decreases the water will expand otherwise the oceans and lake water will become ice.

DISADVANTAGE OF ANOMALOUS EXPANSION OF WATER:

When temperature falls below to 0C in winter the water expands and pipe lines bursts.

THERMAL CONDUCTIVITY:

The amount of heat conducted in one second through cubic meter of a substance is called as thermal conductivity.

OR

The ability of a substance to conduct heat energy is called as thermal conductivity.

FORMULA:

$$\Delta Q = \frac{KA.T\Delta t}{\Delta L}$$

Where,
K = thermal conductivity
A = Area of cross section
T = time interval
Δt = change in temperature
ΔL = change in length.

S.I UNIT:

J/sec.m C

TRANSFER OF HEAT:

We can transfer the heat energy by these three methods.

- **CONDUCTION:**

This is the type transfer method in which heat is transfer through one atom to another without change in the shape of substance.

- **CONVECTION:**

This is the type of heat transfer method in which heat is transferred due to the movement of molecules from one point to another.

- **RADIATION:**

This is the type of heat transfer method in which there is no medium is required for transference of heat.
For example the heat from sun transfers to the earth without any medium.

GAS LAWS:

BOYLE'S LAW:

Boyle's law states that;
The volume of a given mass of a gas is inversely proportional applied pressure and temperature remains constant.

Mathematically,
According to Boyle's law

$$V \alpha \frac{1}{P}$$

$$V = const \frac{1}{P}$$

$$PV = \text{constant}$$

P1V1=constant

p2V2=constant

P1V1= P2V2

VERIFY BOYLE'S LAW WITH THE HELP OF K.M.T:

According to Boyle's law at constant temperature, pressure & volume of a gas are related as:

PV = constant

According to Kinetic theory, pressure of a gas is

$P = 1/3 r\overline{V}^2$

$mN/V = r$

$P = 1/3(mN/V)\overline{V}^2$

$PV = 1/3(mN)\overline{V}^2$

Multiply and divide by 2 on R.H.S

PV=2/3N(1/2m$\overline{V}^2$)

We know that 1/2m$\overline{V}^2 = (K.E)_{av}$

$PV = 2/3N(K.E)_{av}$

We know that K.E. is proportional to temperature. Since temperature is constant therefore K.E. will also be constant and 2N/3 is also a constant factor. Thus the factor $2/3N(K.E)_{av}$ is constant

PV=constant
That's according to Boyle's law.

CHARLES'S LAW:

Charles's law states that,
The volume of a gas is directly proportional to the absolute temperature at constant pressure.

Mathematically,
According to charle's law,
$V \alpha T$
V= constant T
V/T = constant
V1/T=constant
V2/T2= constant

V1T1=V2T2

VERIFY BOYLE'S LAW WITH THE HELP OF K.M.T:

According to Charles law at constant pressure, absolute temperature & volume of a gas are related as:

V/T = constant

According to Kinetic theory, pressure of a gas is

P=(2/3)(N/V)(1/2m$\overline{V}^2$)

Since, 1/2 m$\overline{V}^2 = (K.E)_{av}$

$V = (2N/3P)(K.E)_{av}$

Since, K.E is directly proportional to the temperature therefore, we can replace K.E by T
V=(2N/3P)T

As 2N/3P is a constant factor
V=constant T
V/T=constant
That's according to Charles's law

IDEAL GAS EQUATION:

According to Boyle's law
The volume of a given mass of a gas is inversely proportional applied pressure and temperature remains constant.

$$V \alpha \frac{1}{P} --------i$$

According to Charles's law

The volume of a gas is directly proportional to the absolute temperature at constant pressure.

$V \alpha T$---------ii

According to Avogadro's law

Volume of a gas is directly proportional to the number of moles.

$V \alpha n$--------iii

Combining eq i, ii and iii
$V \alpha Tn 1/p$

$V \alpha \text{constant n} \frac{T}{P}$

$PV/nT = \text{constant}$

here constant is R

Pv/nT=R

or

$PV = nRT$

This is the equation of state of a gas or idea das equation.

R= universal gas constant

R=8.314

KINETIC THEORY OF GASSES:

The gas has following properties on the basis of kinetic theory of matter.

- The gas consists of small tiny particles called as molecules.
- All the molecules of gas are in stable state continuous and random motion
- Molecules are separated at large distance.
- They constantly collide with each other.
- It has macroscopic properties such as pressure, temperature, viscosity and volume e.t.c.

- There is no attractive or repulsive force between the molecules.
- The average kinetic energy of the gas particles depends only on the absolute temperature of the system. The kinetic theory has its own definition of temperature, not identical with the thermodynamic definition.
- At S.T.P 3* 10^{25} molecules are in cubic meter.

PRESSURE OF GAS:

The pressure exerted by the molecule moving with average velocity v is

$$P = \frac{1}{3}\rho V^2$$

ROOT MEAN SQUARE VELOCITY:

$$Vrms = \sqrt{\frac{3P}{\rho}} \quad \text{or} \quad Vrms = \sqrt{\frac{3KT}{m}}$$

Starting from the expression P = ρ 1/3 $\overline{V^2}$ show that the Average translational kinetic energy of the molecules of a gas is directly proportional to absolute temperature.

According to the kinetic equation of pressure of a gas:

$$P = r\frac{1}{3}\overline{V^2}$$

r= density of gas
density of gas = mass of gas /volume of gas
r= mN/V
putting the value of r in equation

$$P = (\frac{mN}{V})\frac{1}{3}\overline{V^2}$$

$$P = \frac{1}{3}(\frac{mN}{V})\overline{V^2}$$

$$PV = \frac{1}{3}mN\overline{V^2}$$

We know that,
PV=nRT
Putting the value of PV in above equation

$$nRT = \frac{1}{3}mN\overline{V^2}$$

Here,
n= molecules/avogadro's number

$$n = N / N_A$$

Therefore,

$$[N / N_A]RT = 1/3(mN)\overline{V^2}$$

$$N_A RT = 1/3(m)\overline{V^2}$$

$$3[N_A R]T = \mathrm{m}\overline{V^2}$$

Boltzman's constant= K=$[N_A R]$

$3\text{KT} = \text{m}\overline{V^2}$

Multiplying both sides by ½

$3/2\,\text{KT} = (1/2)\,\text{m}\overline{V^2}$

here,

$(1/2)\,\text{m}\overline{V^2} = K.E_{av}$

Therefore,

$3/2\,\text{K} = const$

$K.E_{av} = constT$

$K.E_{av} \alpha T$

SHOW THAT: $P = N_v KT$

PROOF:

ρ = **mass / volume**

ρ = **mN / V**

Putting the value of **"ρ"** in equation (1)

P = 1/3 mN/V v2

P = 1/3 N/V mv2……………(2)

But N/V = no of molecules per unit volume
i.e.

N/V = Nv

Putting the value of N/V in eq (2)

P = 1/3 Nv mv2

Multiply and dividing by 2 on R.H.S

P = 2/3 Nv (1/2mv2)

P = 2/3 Nv 3/2 KT [$1/2mv^2$ = 3/2 KT]

P = Nv KT

THERMODYNAMICS:

It is the branch of science that deals with the conversion of heat energy into mec
energy and mechanical energy into heat energy.

FIRST LAW OF THERMODYNAMICS:

First law states that,
Energy can neither be created nor be destroyed by it can converted from one form to another.

OR

The surroundings and total energy of a system remains constant during the process of a machine.

MATHEMATICAL REPRESENTATION:

Suppose that system is absorbing Q amount of heat energy When the system will absorb the heat energy internal energy change to U1 to U2 and work done is w
Increase in internal energy can be written as
Q=U1-U2
According to the first law of thermodynamics.
W= Q+w

APPLICATIONS OF FIRST LAW OF THERMODYNAMICS:

Thermodynamics system can be used under the following conditions.

1. Isobaric system
2. Isochoric system
3. Isothermal system
4. Adiabatic system.

ISOBARIC SYSTEM:

The system in which pressure remains constant during the continuous supply of heat energy is called as isobaric system.

EXPLANATION:

Consider a cylinder with piston on it. This piston can be easily move up and down. When we enter the ideal gas in cylinder.
The initial volume of a system is V1 and initial energy is U1. And the amount of heat energy Qp is entered. In final U1 will increase to U2. Volume of a system increase to V1 to V2 and temperature will increase to T1 to T2.

$$\Delta Q = \Delta U + \Delta V$$
$$\Delta w = P\Delta V$$
$$\Delta Qp = \Delta U + P(V2 - V1)$$

ISOCHORIC SYSTEM:

The system in which volume of a system remains constant during the continuous supply of heat energy is called as isochoric system.

EXPLANATION:

Consider a cylinder with fitted piston on it. The delta Q amount of heat is given to the cylinder internal energy increases to U1 to U2. Volume of a system remains constant to V and temperature will increase to T1 to T2. Pressure will also increase from P1 to P2. No work is performed during the all process.
According to the first law of thermodynamics
$$\Delta Q = \Delta U + \Delta W$$

$$\Delta Q = \Delta U + \Delta W$$
$$\Delta W = P\Delta V$$
$$\Delta V = 0$$
$$\Delta Q = \Delta U + P(0)$$
$$\Delta Q = \Delta U$$

ISOTHERMAL PROCESS:

The system in which temperature of a system remains constant during the continuous supply of heat energy is called as isothermal system.

EXPLANATION:

Consider a cylinder heat conducting base and fitted piston on it. Ideal gas is entered into the system.
According to the first law of thermodynamics
$$\Delta Q = \Delta U + \Delta W$$
Since, temperature is constant so there is no change in internal energy.
$$\Delta U = 0$$
As the work is done on the system so the work done is negative
$$\Delta Q = 0 + (-\Delta W)$$
$$\Delta Q = -\Delta W$$

ADIABATIC PROCESS:

The process in which heat does not transfer into and out of the system is called as adiabatic process.

EXPLANATION:

During this process the system is completely isolated because there is no change in the system.
$$\Delta Q = 0$$
Here there is no work done and no change in energy
$$\Delta U = \Delta W = 0$$
$$-\Delta U = \Delta W$$
We can say that it cause change in internal energy of the system.

2ND LAW OF THERMODYNAMICS:

This law states that it is impossible to design a system which can supply a continuous work by taking heat from a source without losing some part of it into sink.

OR

This law states that it is impossible to design a system which can transfer heat from low temperature to high temperature without any expenditure of energy.

CARNOT ENGINE:

It is an ideal engine, it has maximum possible efficiency. It consists of hot body of infinite thermal capacity, a similar cold body and a perfect heat insulator, a cylinder with working substance. It is a reversible engine.

The efficiency of engine can be calculated by following formula.

E= output/input=W/Q=Q1-Q2/1= 1-Q2/Q1
Here,
Q2 is heat rejected to sink
Q1 is heat supplied by a source
OR
E=1-T2/T1

ENTROPY:

The measure of molecular disorder is called as entropy,
During the process the entropy may be increase or remains constant that's is called as disorder increase or remains constant.

2nd law of thermodynamics states that
When an isolated system undergoes change, the disorder in the system is increase.
We can calculate it as,
$\Delta S = \Delta Q / T$

Chapter 12

ELECTROSTATICS

ELECTROSTATICS:

It is the branch of physics that deals with the static charges called as electrostatic.

CHARGE:

The force of attraction and repulsion is called as charge of a particle.

UNIT:

Coulomb

COULOMB'S LAW:

This law states that,

"The force of attraction and repulsion between two charges is directly proportional to the product of their charges and inversely proportional to the square of a distance between their centers."

$$F \alpha q_1 q_2$$

$$F \alpha r^2$$

combining both relation we get

$$F \alpha \frac{q_1 q_2}{r^2}$$

$$F = const \frac{q_1 q_2}{r^2} \qquad const=K$$

$$F = K \frac{q_1 q_2}{r^2}$$

This is the required relation.

OTHER FORM OF

$$K = \frac{1}{4\pi \in_o} = 9*10^9 = n.m^2/c^2$$

$$\in_o = 8.85*10^{-12}$$

ELECTRIC FIELD:

The area at which a charge can act according to its nature is called as electric field.

$$E = \frac{F}{q_o}$$

ELECTRIC LINES OF FORCES:

The lines may be straight or curved, so that the tangent at any point to it gives the direction of the electric field intensity at that point are called as electric lines of forces.

ELECTRIC FLUX:

The number of electrical lines of forces passes in a unit area or 1cm is called as electric flux.
The flux is positive when $\theta < 90$
The flux is negative when $\theta > 90$
The flux is zero when $\theta = 90$
The flux is maximum when $\theta = 0$

$\Delta\varnothing = E.\Delta A$

GAUSS'S LAW:

Gauss's law states that
"The total outward flux over any closed hypothetical surface is equal to the $1/\epsilon_o$ times to the total charge enclosed in it."

APPLICATIONS OF GAUSS'S LAW:

This law can be used to calculate the electric field only in case of charge distributions which are so symmetrical that by proper choice of a Gaussian surface the flux on it may possibly be evaluated. The following are few examples.

ELECTRIC INTENSITY DUE TO A SHEET OF CHARGES:

Consider an infinite sheet having uniform positive charges spread.
Let us consider that the total charges on sheet must be equal to q
The total area of sheet become A
The formula for charge density (σ) will be = q/A
Take two points p and p' near the sheet. Draw a cylinder from P to P'. Take this cylinder as a Gaussian surface. Consider a closed surface in front of cylinder such that p lies at one of its end faces.

The angle between **E** and to the cylindrical surface is 90 .So the flux through the Cylindrical surface will become:

$\varnothing = E\,A\cos\theta$
$\varnothing = E\,A\cos 90$
$\varnothing = E\,A(0)$
$\varnothing = 0$

The angle between **E** with the end of the surface P and P' is 0.hence the flux through P will become:
$\varnothing_1 = E\,A\cos\theta$
$\varnothing_1 = E\,A\cos 0$
$\varnothing_1 = E\,A\,(1)$
$\varnothing_1 = E\,A$
The flux through P' will write as:
$\varnothing_2 = E\,A$

As we know that electric flux is a scalar quantity, therefore, total flux through both surfaces is:
$Ø_t = \Delta Ø1 + \Delta Ø2$
$Ø_t = E A + E A$
$Ø_t = 2EA$ ....(i)

According to gauss's law :
Total flux through a closed surface is $1/ \varepsilon_o x q$

$Ø_t = 1/ \varepsilon_o x q$.............(ii)

Now Comparing equations (i) and (ii)

$2EA = 1/ \varepsilon_o x q$

$E = q/ \varepsilon_o x 1/2A$

or

$E = q/ \varepsilon_o 2A$

$E = (q/A) \times 1/2 \varepsilon_o$

But $q/A = \sigma$, therefore,

$E= \sigma/2 \varepsilon_o$

ELECTRIC INTENSITY BETWEEN TWO OPPOSITELY CHARGES PARTICLE:

Let us consider two oppositely charged plates that are placed parallel to each other. Suppose that these plates are separated by a small distance d.
Charge density on each plate is '☐' .The electric lines of force are parallel except near the edges, each plate may be regarded as a sheet of charges.
Electric intensity at a point between the plates due to positive charged plate will become:
$E1= \sigma/2 \varepsilon_o$
Electric intensity at a point between the plates due to negative charged plate will become:

$E2= \sigma/2 \varepsilon_o$
We know that both intensities are directed from positive to negative plate So, total intensity between the plates Will become:
$E= E1+E2$

$E= \sigma/2 \varepsilon_o+\sigma/2 \varepsilon_o$

$E=2\sigma/2 \varepsilon_o$

Canceling 2

$E=\sigma/ \varepsilon_o$

FIELD OF UNIFORM SPEHERICAL SURFACE CHARGE AT A DISTANCE r FROM ITS CENTER:

Consider a sphere that is uniformly charged at a distance r from the center O.

ELECTRIC POTENTIAL:

When the charge experience some at all points in a electric field and work is also done by some external forces then this is called as electric potential.

RELATION BETWEEN ELECTRIC FIELD AND POTENTIAL:

Consider two points A and B that are separated by small distance S. If a small test charge q moved from point a to B and we can say that work is done by the field on test charge.

Work done by the field

$$\Delta w = -F\Delta S = q_o E\Delta S$$

Potential difference between point A and B

$$\Delta v = \frac{\Delta w}{q_o} = E\Delta S$$

$$E = -\frac{\Delta V}{\Delta S}$$

$\frac{\Delta V}{\Delta S}$ is the rate of change of potential with respect to the distance and it is called potential gradient.

EQUIPOTENTIAL SURFACES:

The potential has the same values at all points of a plate this system is called as equipotential surfaces..

CAPACITANCE OF A CAPACITOR:

The potential of a conductor is directly proportional to the charge

$$q \alpha V$$

$$q = CV$$

C is constant for a given conductor.
C=q/V

$$C = q / \text{V} = \frac{q}{\frac{1}{4\pi \in_o}\frac{q}{r}}$$

PARALLEL PLATE CAPACITORS:

It is a type of capacitors in which two plates are parallel to each other and oppositely charges.
The charges on these plates are uniformly distributed they are oppositely charges so they have attraction.

$$E = \frac{\sigma}{\in_o}$$

$$V = ED = E = \frac{\sigma}{\in_o} d$$

There is the d distance between these plates.

$$C = \frac{q}{v} = \frac{A\sigma}{\sigma / \in_o d}$$

$$C = \frac{\in_o A}{d}$$

Where A is the area of the plates
If an insulating material completely fills the space between these plates.

$$C = \frac{\in_o A}{d} = \frac{\in_r \in_o A}{d}$$

COMBINATIONS OF CAPACITORS:

SERIES COMBINATION:

The type of combination in which all the capacitors are connected in the series and there is only one place to flow the current then these type of combinations are called as series combination.

V=V1+V2+V3
V=q/C
q/C= q/C1+ q/C2+ q/C3
1/C=1/C1+1/C2+1/C3

PARALLEL COMBINATION:

The type of combination in which all the capacitors are connected in the parallel to one another is called as parallel combination.
Q=q1+q2+q3
CV=C1V+ C2V+ C3V
C=C1+C2+C3

CAPACITANCE IN THE PRESENCE OF DIELECTRIC:

<u>When dielectric is completely filled between the plates:</u>

Suppose that space between the plates of capacitor is filled with a dielectric of relative permittivity εr.
The presence of dielectric reduces the electric intensity by εr times and thus the capacitance increases by εr time.

<u>When dielectric is partially filled between the plates:</u>

- Electric field without electric
  $E1=\sigma/ \varepsilon_o$

- Electric field with dielectric
  $E2=\sigma/ \varepsilon_o$

The potential difference between plates
V=V1+V2 V=Ed
V=E1d1+E2d2
$V= \sigma/ \varepsilon_o(d-t)+ \sigma/ \varepsilon_\rho\varepsilon_o t$
$V=\sigma/ \varepsilon_o(d-t+t/\varepsilon_\rho)$

$$v = \frac{\sigma}{\varepsilon_o}\{d + t(\frac{1}{\varepsilon_r} - 1)\}$$

$$v = \frac{q}{\varepsilon_o A}\{d + t(\frac{1}{\varepsilon_r} - 1)\}$$

$$\text{v} = \frac{CV}{A\varepsilon_o}\{d + t(\frac{1}{\varepsilon_r} - 1)\}$$

$$C = \frac{A\varepsilon_o}{\{d + t(\frac{1}{\varepsilon_r} - 1)\}}$$

CONCLUSION:

1. Capacitance of a capacitor is directly proportional to the Area so we can say that the capacitance can be increased by increasing the dimension of the plates.
   $C \alpha A$

2. Capacitance of a capacitor is inversely proportional to the distance between plates so we can say that capacitance can be increased by decreasing the separation between the plates.
   $C \alpha 1/d$

3. Capacitance of a capacitor is directly proportional to the dielectric medium between the plates so we can say that capacitance can be increases by the presence of dielectric medium between the plates.
   $C \alpha \varepsilon_r$

Chapter 13

CURRENT ELECTRICITY

ELECTRIC CURRENT:

The amount of electric charge that is passing through area of cross section is called as electric current.

OR

The rate of flow of electric charge through the area of cross section is called as electric current.

Mathematically,
I=Q/t

UNIT:
Ampere

AMPERE:

If one coulomb of electric charge is passed through any area in a unit time or 1 second is called as ampere.

DIRECTION OF CURRENT

ELECTRIC CURRENT: It flows from positive to negative.
CONVENTIONAL CURRENT: This current flows from higher potential to the lower potential.

RESISTANCE:

The opposing force produce during the flow of electric current is called as resistance.
The resistance of a conductor is caused due to the free flowing electron in the conductor.

FACTORS ON WHICH RESISTANCE DEPENDS:

1. **LENGTH OF CONDUCTOR:**
The resistance of a conductor is directly proportional to the length of conductor.

$$R \alpha L$$

2. **AREA OF CROOS SECTION:**
The resistance of a conductor is inversely proportional to the area of cross section.

$$R \alpha 1/A$$

Combing relation A and B

$$R \alpha \frac{L}{A}$$

$$R \alpha \rho \frac{L}{A}$$

ρ=resistivity of material

RESISTIVITY OF A MATERIAL:

Resistance of a material of unit length or 1 meter or area of 1 meter is called as resistivity.

RESISTANCE AND TEMPERATURE RELATION:

Resistance of a conductor is directly proportional to the temperature.

VARIATION IN RESISTANCE OF A MATERIAL:

(1) Increase in resistance of a conductor is directly proportional to original resistance.

$\Delta R \alpha R_1$.............(a)

(2) Change in resistance is directly proportional to change in temperature.

$\Delta R \alpha \Delta T$............(b)

Combining (a) and (b)

$\Delta R\ R_1 \Delta T$

$\Delta R = (\text{constant})\ R_1 \Delta T$

Here constant = α

$\Delta R = \alpha R_1 \Delta T$

Where α = temperature coefficient

As $\Delta R = R_2 - R_1$

and

$\Delta T = T_2 - T_1$

We get

$R_2 - R_1 = \alpha R_1 (T_2 - T_1)$

$R_2 = R_1 + \alpha R_1 (T_2 - T_1)$

$R_2 = R_1 \{1 + \alpha T_2 - T_1)\}$

When $T_1 = 0$ and $T_2 = t$

$R_t = R_0 [1 + \alpha((t - 0)]$

$$R_t = R_0 \{1 + \alpha t\}$$

TEMPERATURE COEFFICIENT:

Change in resistance per unit resistance per degree change in temperature is called as temperature coefficient.

$\Delta R = \alpha R_1 \Delta T$

$\alpha = \Delta R / R_1 \Delta T$

OHM'S LAW:

Ohm's law states that,

The electric current passing through a conductor is directly proportional to the potential difference between ends of conductor.

$I \alpha V$

According to the Ohm's law,

$I \alpha V$

$I = kV$

K = constant

$V = I/K$

Or $V = I * 1/K$

$1/K = R$

$V = I * R$

SERIES COMBINATION OF RESISTANCE:

There is one path for the flow of electric current.
Potential difference across each resistor is different.
Equivalent resistance of circuit is greater then the connected circuit.

DISADVANTAGES OF SERIES COMBINATION:

In this combination, if one resistance will damage whole system will stop working.

EQUIVALENT RESISTANCE OF CIRCUIT:

Consider three resistors R1 R2 and R3 connected in series.
Let the circuit is connected with V and electric current I is passing through circuit.
V=V1+V2+V3
V=IR
IRe= IR1+ IR2+ IR3
R=R1+R2+R3

PARALLEL COMBINATION OF RESISTANCE:

In this combination there is more than one path to flow electric current.
In parallel combination of resistance the electric current flow in the resistor is different from one another.
Potential difference across each resistor is the same.
The equivalent resistance is smaller then the connected resistance.

ADVANTAGES OF PARALLEL:

In parallel combination, if one resistor is damaged then whole system work properly.

EQUIVALENT RESISTANCE OF CIRCUIT:

Consider three resistance R1,R2 and R3 connected parallel in circuit.
Circuit is connected to the voltage V and electric current I is passing through the circuit.
The sum of three currents is
I=I1+I2+I3
According to Ohm's law
I=V/R
Putting the value of I we get,
V/Re=V/R1+V/R2+V/R3
V/Re=V[1/R1+1/R2+1/R3]
Canceling V both sides
1/Re=1/R1+1/R2+1/R3

POWER DISSIPATION IN RESISTORS:

When an electric current passes through a conductor, some useful electrical energy is converted in the form of heat energy. The loss of electrical energy during the conversion into heat energy is due to the collision of charges with the atoms of conductor. This loss f power in a unit time or 1 second is called as power dissipation in resistor.

RELATION FOR POWER DISSIPATION IN RESISTOR:
Consider that the amount of q passed through the conductor in a unit time is

I=q/t
Q=I*t
Energy loss=q*V
Put the value of q
Energy loss =I*t*V
Energy loss/t=VI
Power =VI

POWER LOSS IN TERMS OF CURRENT:

According to the ohm's law
V=IR
Put the value of V in the above relation
Power = VI
Power=IR*I
Power=I2R

POWER LOSS IN TERMS OF POTENTIAL DIFFERENCE:
According to Ohm's law
I=V/R

Put the value of I in the above relation
Power = VI
Power=V* V/R
Power=V2/R

ELECTROMOTIVE FORCE:

When electric current is passed through a conductor, energy is converted in the form of heat energy. To maintain the steady state of current the continuous supply of energy is required.
To get the continuous supply of energy the source is connected to the resistance that maintains potential difference through out the time.
These devices are dry cell, battery or electric generator .The force required for this system is called as electromotive force.emf.

EMF=w/q

EMF AND TERMINAL POTENTIAL DIFFERENCE

Let us consider a source of emf connected with a resistor"R" through which a current "I" flows through out the circuit.
Here, the emf of source is E
Potential difference across resistance R is V
We know that
Let the internal resistance of the source is "r"
Potential drop across emf source = V_r
E=V+Vr
or
V=E-Vr
Vr=Ir
V=E-Ir

Chapter 14

MAGNITISM AND ELECTROMAGNITISM

MAGNETIC FIELD OF CURRENT:

This field was introduced by Oersted in 1819.
We know that statics electric charges only have electrostatic force between them. But when the charges moved then they do not only contain electrostatic force but also magnetic force between both of them.

MAGNITIC LINES OF FORCES:

These are the lines that are in proper concentric circle around current carrying wires with center at the wire is called as magnetic lines of forces.
Two parallel wires always attract each other if the current flows in same direction. If the current is carrying in opposite directions then they repel each other.

MAGNITIC FIELD:

An area where a magnet can act is called as magnetic field.
This force depends upon the

- Magnitude of charge
- Speed of charge
- Magnetic field of induction

MAGNITIC FORCE ON A MOVING CHARGE:

The direction of motion is perpendicular to the direction of charge and motion and direction of B.
When the angle is 90 then there is maximum force. The unit of magnetic induction is called as tesla.

MAGNITIC FORCE ON A CURRENT CARRYING CONDUCTOR:

Consider a conductor of length L and the force F is exerted on it. And the uniform magnetic field is B So we can write our relation as

$$q = nA\ell e$$

where A is the area and the ℓ *isthe* cross section of conductor.

$$F = q(\vartheta * \overline{B}) = nA\ell e(\vartheta * \overline{B})$$

$$F = nA\ell e(a\,\vartheta * \overline{B})$$

$$F = nAev(a\ell * \overline{B})$$

$$F = nAe\vartheta(\vec{\ell} * \vec{B})$$

$\vartheta = \frac{\ell}{t}$ Where t is the time taken by the q to cross the length of the conductor.

$$F = \frac{nAe\ell}{t}(\vec{\ell} * \vec{B}) = \frac{q}{t}(\vec{\ell} * \vec{B})$$

$$F = I(\vec{\ell} * \vec{B})$$

TORQUE ON A CURRENT CARRYING RECTANGLE PLACED IN A MAGNITIC FIELD:

Consider a rectangular coil that is suspended in a uniform magnitc field. And the plane of the coil is the parallel to the field. Let us consider that the current I is following round the coil. At that point the coil is experienced a perpendicular force so that there perpendicular force can be expressed as

$\tau = Fb$

$F = BI\ell \sin 90 = BI\ell$

Where l is the length of each vertical side of the coil

$\tau = Fb$

$F = BI\ell \sin 90 = BI\ell$

$\tau = BI\ell b = BIA$ where A is the area of coil

For a coild havinf n turns.

$\tau = BIAN$

We can write this relation as

$\tau = BIAN \cos\alpha$

MAGNITIC FLUX AND FLUX DENSITY:

MAGNITIC FLUX:

The number of magnetic lines of forces in an area A is called as magnetic flux.

FORMULA:

$$\Delta\phi_m = \vec{B} * \overrightarrow{\Delta A}$$

FLUX DENSITY:

The number of lines passing per unit area is called as flux density.

FORMULA:

$$B = \frac{\Delta\phi_m}{\overrightarrow{\Delta A_n}}$$

e/m RATIO OF ELECTRON:

APPARATUS:

It consists of a highly evacuated glass tube that is fitted with electrodes. Electrons are produced by heating a tungsten filament electrically. Electrons form a beam by passing through discs A and B. They are passed through electric and magnetic field. Finally they fall on zinc sulphide screen.

PRINCIPLE OF WORKING:

Let us consider that the narrow beam of charged particles are projected at constant speed (v) across a magnetic field in a direction perpendicular to the field, the beam of particles experiences a force, that allows them move in a circular path.

DERIVATION:

Fm=evB--------1
Here magnetic field is equal to the centripetal force
Fm=Fc
evB=mv2/r
eB=mv/r
e/m=v/Br
This is the required relation.

DETERMINATION OF VELOCITY:

The electrons are accelerated by applying a potential (V)
K.E = V.e K.E=1/2mv2
Or
1/2mv2 = Ve
v = (2Ve/m)1/2
Putting the value of v in eq. (2)
e/m = v/Br
e/m = (2Ve/m)1/2/Br
taking Square on both sides
e2/m2 = 2Ve/m/B2r2
or
e/m = 2Ve/B2r2

value of e/m =1.75888*10^11C/kg

AMPERE'S LAW:

Ampere's law states that
The sum of products of tangential component of **B** and length element Δl of a closed curve is μ_o times the current enclosed.
μ_o = permeability of free space.

Its value is $\mathbf{4\pi*10^{-7}}$.

Its unit is Henry/m^2.

$$B \alpha \frac{2l}{r}$$

$$B = \frac{\mu_o}{4\pi} * \frac{2l}{r}$$

$$B = \frac{\mu_o l}{2\pi r}$$

Again consider that the circle is divided into small elements and each length is L. Multiply the length of elements by the tangential component of field which is in the direction of L

$$B\cos 0\Delta\ell = \vec{B}.\overrightarrow{\Delta\ell}$$
$$\sum \vec{B}.\overrightarrow{\Delta\ell} = \sum B\cos 0\overrightarrow{\Delta\ell} = \sum B\Delta\ell = B\sum \Delta\ell$$

$$\sum \vec{B}.\overrightarrow{\Delta\ell} = \frac{\mu_o l}{2\pi r} * 2\pi r = \mu_o l$$

This is the relation of ampere's law.

SOLENOIDAL FIELD:

The type of a coil that's is insulated of copper wire and wound on a cylinder with close turns is called as solenoid field.

$$B = \mu_o nI$$

TOROIDAL FIELD:

The type of a coil that's is insulated of copper wire and wound on a cylinder with close turns is called as solenoid field.

DERIVATION:

When a current is passed, circular strong uniform magnetic field is setup inside the coil. The field outside the turns of toroid is zero.
EXPRESSION FOR B
To compute B, consider a circular loop of radius 'r'. Let the length of loop be divided in to a number of very small elements

$$B2\pi r = 0$$
$$B = 0$$
$$B2\pi r = \mu NI$$
$$B = \frac{\mu NI}{2\pi r}$$

ELECTROMAGNITIC INDUCTION:

An E.M.F. is setup in a coil placed in a magnetic field whenever the flux through the coil changes. The effect produces is called as electromagnetic Induction.

FARADAY'S LAW OF ELECTROMEGNITIC INDUCTION:

Farady's law states that,
When magnetic flux changes through a circuit, an E.M.F is induced in it which remain long as the change in the magnetic flux through the circuit continues.

We can say that the E.M.F is directly proportional to the rate of change of magnetic flux through the coil.

Flux linkage = N ϕ

LENZ'S LAW:

Lenz's law states that, the induced current always flows in such a direction as to oppose the change which is giving rise to it. This is why the negative equation is used equation.

SELF INDUCTION:

A coil through which a current is flowing has an associated magnetic field. If for any changes the current changes so does the E.M.F has been induced in the coil. Since this emf has been induced the coil by a change in a current through the same coil. This process is called as self induction.

MUTUAL INDUCTION:

If two coils are closed together. Then a changing coil set up changing magnetic field in the other and so induces an emf in it. This is called as mutual induction.

NON INDUCTIVE WINDING:

To minimize self inductance, coils are tightly wound as to set up extremely small magnetic fields. The wire is doubled wound on itself before coiling up this type of winding is called as non-inductive winding.

MOTIONAL E.M.F:

When a conductor is moved across a magnetic field the potential difference appears at it ends this type of potential difference is called as motional e.m.f

FORMULA:

$$\varepsilon = VBL\sin\theta$$

ALTERNATING CURRENT GENERATOR:

The device that is used to convert the mechanical energy into electrical energy is called as alternating current generator.

WORKING PRINCIPLE:

This device work on the principle that the emf is induced in the coil due to the changing magnetic flux linkage when it is rotated between the poles of magnet. The essential parts of this device are

- **Field magnet:**

It is strong and permanent horse shoe magnet that produces strong and uniform magnetic field. Of induction between its poles.

- **Armature:**

It is a small iron cylinder that is mounted on the axle. It rotates on ball bearing thus rotating the cylinder between the poles of the magnet.

- **Slip rings and collecting brushes:**

The ends of are joined to separate copper rings fixed on the axle. Two carbon brushes remain presses against each of the rings which form the terminals of the external circuit.

DERIVATION:

$$v = \frac{b}{2}\omega$$

$$\xi = 2BN\ell \sin \omega t$$

$$\xi = (b\ell)NB\omega \sin \omega t$$

$$\xi = ANB\omega \sin \omega t$$

$$\xi = \xi_o \sin \omega t$$

It is the peak value of emf which depends on the area and number of turns on the coil.

DC GENERATOR:

When the generator is modified to direct current through external circuit then it is called as DC generator.

ELECTRIC MOTOR:

A device which convert electrical energy into mechanical energy is called as electric motor.

TRANSFORMER:

A device used mutual induction for stepping up or down an alternating emf is called as transformer.

Efficiency of transformer can be calculated as

Efficiency= power output/power input

Chapter 15

ELECTRICAL MEASURING INSTRUMENTS

MEASURING INSRUMENTS:

The devices that are used to measure different things are called as measuring instruments.

MOVING COIL GALVANOMETER:

The electromechanical instrument that is used for the detection of electric current is called as moving coil galvanometer.

WORKING PRINCIPLE:

This device works on a principle of conversion electrical energy into mechanical energy. When current flows in magnetic direction it experience magnetic torque.

PARTS OF GALVANOMETER:

These are important parts of galvanometer:

U shaped permanent magnet
A flat rectangular coil
A soft iron cylinder
A sharp pointer or needle
A measuring scale

CONSTRUCTION:

The flat rectangular coil that is made by the thin wire wound on a nonmetallic frame that is suspended cylindrically between concave poles of magnet by a thin phosphor bronze strip. One end of the wire of the coil is soldered to strip. The other end of
the strip is fixed to the frame of the galvanometer and connected to an external terminal. It serves as one current lead through which the current enters or leaves the coil. The other end of the wire of the coil is soldered to a loose and soft spiral of wire connected to another external terminal. The soft spiral of a wire serves as the other current lead. A soft-iron cylinder, coaxial with the pole pieces, is placed within the frame of the coil and is fixed to the body of the galvanometer. In the space between it and the pole pieces, where the coil moves freely, the soft iron cylinder makes the magnetic field stronger and radial such that into whatever position the coil rotates, the magnetic field is always parallel to its plane.

WORKING:

When a current passes through the galvanometer coil, it experiences a magnetic deflecting torque, which tends to rotate it from its rest position. As the coil rotates it produces a twist in the suspension strip. The twist in the strip produces an electric restoring torque. The coil rotates until the elastic restoring torque due to the strip does not equal and cancels the deflecting magnetic torque, then it attains equilibrium and stops rotating any further.

DERIVATION:

Deflecting magnetic torque = BINA Cosα
B = Strength of the magnetic field.
I = Current in the coil.
A = Area of the coil.
N = Number of turns in the coil.
α = The angle of deflection of the coil.
The restoring elastic torque is proportional to the angle of twist of the suspension strip According to Hook's Law
Restoring elastic torque = C θ
Where
θ = Angle of twist.
C = torque per unit twist.
BINA Cos $\alpha = C\theta$
I = Cθ /BNA Cosα ----->(ι)
I= Cθ /BAN Cosα

AMMETER:

The device that is used to measure electric current through the circuit is called as ammeter.

CONVERSION OF GALVANOMETER INTO AMMETER:

To convert a galvanometer into ammeter a very low resistance known as "shunt" resistance is connected in parallel series to galvanometer.

$$V_g = I_g R_g \text{----------} i$$

$$I_s = (I - I_g)$$

$$V_s = I_s R_s$$

$$V_s = (I - I_g) R_s \text{------------} ii$$

$$V_s = V_g$$

$$(I - I_g) R_s = I_g R_g$$

$$R_s = \frac{I_g}{I - I_g} R_g$$

VOLTMETER:

The device that is used to measure the potential difference between two points is called as voltmeter.

CONVERSION OF GALVANOMETER INTO VOLTMETER:

To convert a galvanometer into voltmeter a very high resistance called as series resistance is connected in series to galvanometer.

Resistance of galvanometer = Rg
Resistance Rx
combined resistance = (Rg + Rx).

V = Ig (Rg + Rx)

$V = I_gR_g + I_gR_x$
$V - I_gR_g = I_gR_x$
$R_x = (V - I_gR_g)/I_g$
$R_x = V/I_g - R_g$

WHEAT STONE BRIDGE:

It is an electrical circuit. There are four resistance R1, R2, R3 and R4 respectively. This resistance is connected end to end with each other to form a closed loop. A sensitive galvanometer "G"connected between one pair of opposite junctions. This type of device is called as wheat stone bridge.

There are many devices that worked on the same principle.

- Meter bridge
- Post office box
- Potentiometer
- Ohmmeter

Chapter 16

ELECTROMAGNITIC WAVES AND ELECTRONICS

ELECTRONICS:

Electronics is the branch of science that deals with the control and flow of electric current is known as electronics.

P TYPE SUBSTANCE:

If A trivalent element such as Gallium or Indium is sandwiched between germanium o silicon to form covalent bonds. This type of structure is called as p type substance.

n- TYPE SUBSTANCE:

If a pentavalent element such as Antimony (Sb) is added to pure geranium (Ge) or silicone (Si), then four electrons of (Sb) will form covalent bonds with four (Ge) or (Si) atoms. The fifth electron of 'Sb' is free to move which makes (Ge) or (Si) a good conductor. This type of material is called n-type substance.

RECTIFIER:

The device that is used to convert alternating current into direct current is called as rectifier.
The PN junction diode is used as a rectifier.

RECTIFICATION:

The process of converting alternating current into direct current is called as rectification.

FORWARD BIASING:

When n-type substance is connected to negative terminal of pn junction diode and p-type substance with positive terminal of a (DC) supply, then the height of potential barrier reduces and provides easy flow of electric charge that is pn-junction conducts electricity. In this condition pn-junction is said to be forward biased.

REVERSE BIASING:

When p-type substance is connected to the negative terminal and n-type substance with positive terminal of a (DC) supply, Then height of potential barrier increases to maximum and the flow of electric charge across the junction will become zero. In this condition a pn-junction diode is called Reverse Biasing.

DOPING:

Addition of an element of group IIIrd-A or Vth-A to Ge or Si crystals to convert them into semiconductor substance (p-type or n-type) is called Doping. Normally impurity is in very small quantity. There are two types of impurities that are added to geranium or silicon

WORKING OF PN JUNCTION DIODE:

A p-type substance has excess positive charge and n-type substance has an excess of negative charge or electrons, the electrons from n-type and holes from p-type sections flow across the junction and combine. In this way a layer of positive charges is formed on the n-type and a layer of negative charges on p-type material. Due to induction of these layers a potential barrier is now developed across the junction and further flow of charges is prevented from one side to the other.

TRANSISTOR:

A three terminal semiconductor electronic device is called transistor. Transistors are widely used in electronic appliances such as computers, radio, audio video equipment, bio medical instrument etc.

CONSTRUCTION:

A transistor is a three layer semiconductor which consist a very thin central layer of one type of semiconductor material sandwiched between two relatively thick layer of second type.

TYPE OF TRANSISTOR:

pnp TRANSISTOR:

In this type of transistors n-type semi-conductor piece is sandwiched between two piece of ptype semiconductor layers then this complete structure is called as pnp transistor.

npn TRANSISTOR:

In this type of transistors p-type semi conductor piece is sandwiched between two piece of n-type semiconductor layers.

PARTS OF TRANSISTOR:

There are three essential parts of transistor.
Base: It is the central layer denoted by b
Emitter: It is the outer layer that is denoted by e
Collector: It is an outer layer that is denoted by c

WORKING:

Consider a pnp-transistor Let the two p-end are connected to two batteries. The forward bias causes the holes in the p-type emitter to flow towards the base which constituent current. These holes cross into the n-type base, they try to combine with electrons but the base is lightly doped and is very thin. Therefore only few holes combine with electrons and the remaining holes cross into the collector and generates collector current Ic. In this way almost the entire emitter current flows in the collector circuit. From the above description it is clear that:

Ie = Ib + Ic

Thus there are two current paths through a transistor. One is the base-emitter path or input and the other is the collector-emitter path or output.

Chapter 17

ADVENT OF MODERN PHYSICS

PAIR PRODUCTION:

When a photon strikes to a heavy nucleus, it disintegrates and produces a pair of an electron and a positron. Electron and positron always move in opposite directions so that the momentum is conserved. This phenomenon is called pair production.

POSITRON:

An antiparticle of an electron is called as positron. It is also called as positive electron.

POLES OF NUCLEUS:

The role of the nucleus is just to share some energy and momentum in order to conserve the two quantities.

FRAME OF REFERENCE:

The regular set of coordinates that are used to specify relative position of a body in space is called as frame of reference.

INTERNAL FRAME OF REFERENCE:

The frame reference that is moving with constant velocity or is at rest is called as internal frame of reference.

PRINCIPLE OF RELATIVITY:

All the inertial laws are equivalent to the statements and physical laws is called as principle of relativity.
There are following points that define the relativity.

- The speed of light in vacuum is constant. It is independent of the motion of the source or the observer.
- All the laws of physics will remain same in the inertial frame of reference. For example Newton's laws as well as the Maxwell's electromagnetic laws.

MASS VARIATION:

According to the theory of relativity the mass of object in a frame of reference at rest is called as m_o If the observer is moving with the constant speed v If the mass is comparable to the c the relation become

$$m = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}}$$

LENGTH CONTRACTION:

According to the theory of relativity the length of object in a frame of reference at rest is called as L_o. If the observer is moving with the constant speed v If the mass is comparable to the c the relation become

$$L = \frac{L_o}{\sqrt{1 - \frac{v^2}{c^2}}}$$

TIME DILATION:

The time interval between two events taking place at the same point in space is timed with a clock at rest and that time is called as proper time interval

Then according to the special relativity theory the time are related by the formula.

$$T = \frac{T_o}{\sqrt{1 - \frac{v^2}{c^2}}}$$

MASS ENERGY RELATION:

According to this relation when an object moves with speed of light its mass is converted into equivalent energy.
The relation become E=mc^2

BLACK BODY RADIATION AND QUANTUM THOERY:

An object that has the power to absorb all the energy in itself is called as black body.

WEIN'S DISPLACEMENT LAW:

This law states that,
The wave length for maximum radiation is inversely proportional to the absolute temperature of black body.

$$T \alpha \frac{1}{\lambda_{\max}}$$

STAFEN-BOLTZMAN LAW:

According to stafen-Boltzman law:
The total amount of energy radiated per second per unit to black body is directly proportional to the fourth power of absolute temperature.

$$E \alpha T^4$$

RAYLEIGH-JEANS LAW:

This law states that the energy that is associated to the particular wavelength is inversely proportional to the fourth power of wavelength.

$$E = \frac{const}{\lambda^4}$$

PLANCK'S LAW QUANTUM THEORY:

Plank proposed that radiant energy comes out in discreete amount or quanta of energy the energy content of each quantum is directly proportional to the frequency.

$E = \frac{hc}{\lambda}$ c is the velocity of light; h is the plank's constant.

PHOTON:

A particle that has no charge and no mass is called as photon. It can interact with all charged particle as well as neutral ones. It is electromagnetic radiation and carrier of electromagnetic force.

FORMULAE:

$$E = h\upsilon$$

$$p = \frac{h\upsilon}{c}$$

THE PHOTO ELECTRIC EFFECT:

In 1887 Hertz experiments that when the ultra violet rays are allowed to fall on certain metals they the electrons are emitted. This phenomenon is called as photo electric effect.

It has three features.

- Increasing the intensity of source of light, increases the number of photo electrons but not the velocity with which they leave the surface of the metal.
- For each substance there is certain frequency called threshold frequency below which the effect does not occur.
- The higher the frequency of the incident light, the greater the kinetic energy of the photoelectrons.

EXPERIMENT:

A suitable light is allowed to fall on plate 'P', it will give out photo electrons. The photo electrons are attracted by the collector 'C' connected to the positive terminal of a battery. The glass tube is evacuated. When the collector 'C' is kept at positive potential, the photo electrons are attracted by it and a current flows in the circuit which is indicated by the galvanometer.

THRESHOLD FREQUENCY:

The minimum frequency of incident light which can cause photo electric emissions called as threshold frequency.

PHOTOCELLS:

The device that converts light energy into electrical energy is called as photocells. It is based on the principle of photo electric effect.
They are used to count vehicles passing the road, to open the doors of building automatically, the alarm for burglar.

CONSTRUCTION:

A photocell consists of an evacuated sealed glass tube containing a wire anode and a concave cathode of suitable emitting material such as Cesium (Cs) The material of cathode responds to a given frequency range.

WORKING:

When light of frequency greater than the threshold frequency of the cathode material falls on the cathode, photoelectrons are emitted. These electrons are collected by the anode and an electric current starts flowing in the external circuit. The current increases with the increase in the intensity of light. The current would stop, if the light does not fall on the cathode.

COMPTON EFFECT:

When X rays are scattered by an electron then the scattered X rays has the frequency less then its original frequency this phenomenon is called as Compton's effect.

FORMULA:

$$\lambda_2 - \lambda_1 - \frac{h}{m_o c}(1 - \cos\theta)$$

CONSTRUCTION:

Consider a photon of frequency υ**1** and wavelength λ**1** strikes a stationary electron of rest mass mo. After collision the photon is scattered at an angle of θ with its original line of action. While electron moves forward at an angle of ϕ with its original direction.

Energy of photon before collision = $E_1 = h\upsilon_1$
Energy of electron before collision = $E_2 = m_oc_2$
Energy of photon after collision = E1\` = $h\upsilon_2$
Energy of electron after collision = E2\` = mc_2
Since the collision between photon and electron is elastic. Therefore energy and momentum will be conserved.
Total energy before collision = Total energy after collision
E1 + E2 = E1\` + E2\`
hυ1 + moc2 = hυ2 + mc2
hυ1 - hυ2 = mc2 – moc2
h(υ1 - υ2) = c2(m – mo)………………(1)

MOMENTUM CONSERVATION:

Momentum of photon before collision = h /λ_1
Momentum of electron before collision = 0
Momentum of photon after collision = h / λ_2
Momentum of electron after collision = mv

MOMENTUM EQUATION:

$h/\lambda 1 + 0 = h/\lambda 2 Cos\theta + mvCos\phi$
$h/\lambda 1 = h/\lambda 2 Cos\theta + mvCos\phi$............(2)

MOMENTUM EQUATION:

$0 + 0 = h/\lambda_2 Sin\theta + (-mvSin\phi)$
$h/\lambda_2 Sin\theta - mvSin\phi = 0$..................(3)
Solving (1) , (2) and (3), we get the following result:
$1/\upsilon_2 - 1/\upsilon_1 = h/m_oc^2 (1- Cos\theta)$ ....(4)
$c(1/\upsilon_2 - 1/\upsilon_1) = hc/m_oc^2 (1- Cos\theta)$
$c/\upsilon_2 - c/\upsilon_1 = h/m_oc (1- Cos\theta)$
But $c/\upsilon = \lambda$, therefore,
$\lambda_2 - \lambda_1 = h/m_oc (1- Cos\theta)$
where $\lambda_2 - \lambda_1$ = Compton's shift in wavelength
h/m_oc is called Compton's wavelength and its value is 2.426×10^{-12} m.

RESULT:

Thus the frequency υ_2 of scattered photon after the collision will be less than the original frequency υ_1.

ANNIHILATION OF MATTER:

When an electron and positron are combine with each other this process is called as annihilation and their masses become as similar to the masses of two photons.

DEBROGLIE HYPOTHESIS:

According to this hypothesis,
If a photon has all the characteristics of particle nature, then a particle (electron) must possess all the characteristics of wave nature. It is also called as wave characteristics of particles.

We can calculate the wavelength of particle by using formula $\lambda = \frac{h}{m\upsilon}$

DAVISSION GERMER EXPERIMENT:

The theoretical prediction given to the DEBROGLIE was confirmed by this experiment.
A beam of electron is accelerated and strike to the nickel crystal. The measurements were made to count the number of electrons. It was noticed that electron reflected very strongly at certain angles at only and not at other direction.
They came to the conclusion that electrons behave as a wave.

UNCERTAINITY PRINCIPLE:

The devices that are used to measure things have some limitations for the accuracy with which the position and velocity of microscopic particle can be known as uncertainty principle.

Chapter 18

THE ATOMIC SPECTRA

BOHAR'S MODEL OF HYDROGEN ATOM:

Bohar's presented following postulates to develop quantitative theory of spectrum.

An electron moves only in circular orbits and its angular momentum L is an integral multiple of h/2^

The total energy of electron remains constant as long as it remains in the same orbit.

If the electron jumps from an initial orbit of energy to final orbit of energy.

$$\upsilon = \frac{E_i - E_f}{h}$$

According to bohar's postulates the hydrogen atom consists of a nucleus that consists of a neutron and a proton and the electron is revolving around the nucleus and the force that is holding the electron in the atom is called as coulomb's law.

So the relation becomes

$$F = \frac{1}{4\pi \in_o}$$

As we know that the electron is revolving in the circular path having radius r with the velocity v this coulomb's force is balanced by centripetal's force.

$$\frac{1}{4\pi \in_o}\frac{e^2}{r^2} = mv^2 r$$

The total energy of the atom is the sum of the kinetic energy and potential energy of electron it can be write as

T=1/2mv^2

$$\frac{e^2}{(4\pi \in_o)2r}$$

$$v = -\frac{e^2}{4\pi \in_o r}$$

The total energy of the system is

E=T+V

$$E = -\frac{e^2}{8\pi \in_o r}$$

E=-T

If L is the orbital angular momentum

$$L = n\, h/2\pi$$

L=mvr

mvr=nh

$$r = 4\pi \in_o \frac{n^2 h^2}{me^2}$$

$$r = \frac{4\pi \in_o h^2}{me^2}$$

Substituting these values we get 03053nm

This relation is called as Bohr radius.

XRAY SPECTRA:

When heavier atoms are bombarded by electrons that have accelerated through thousands of volts then the spectra formed is called as X ray spectra.

LASER:

Laser stands for light amplification by stimulated emission of radiation. This device is used to produce very intense, highly directional, coherent, mono chromatic beam of light.

Different types of lasers are used for different issues.

1. Solid state
2. Gas
3. Liquid

CONDITIONS FOR LASER:

There are following conditions that are required to produce laser.

1. The system must be meta stable
2. It must achieve population inversion
3. The photons that are emitting radiations must be confined.

PRINCIPLE OF LASER:

The laser light production is depends upon the atoms of a material that have numbers of energy levels and one of them must be at meta stable state. Consider a three level atomic system having energies E_1, E_2 and E_3 respectively. Consider that atoms are at ground state E_1 initially. When photons interact with an atom in ground state, the atom will absorbs the photon and reaches at the excited state E_3 . Here the excited state is an unstable state, therefore, electron must return back to ground state E1 but such transitions are not allowed and the electron first reaches the state E_2. Atoms in the state E3 which has much longer life time of about 10-8 sec decay spontaneously from state E3 to state E2 which is meta stable and has life time of 10-3sec . This means that the atoms reach state E2much faster than they leave state E2. This results in an increase in number of atoms in state E2, and hence population inversion is achieved.

APPLICATION OF LASER:

There are following applications of laser technology.

- Three dimensional images of objects are formed by using lasers in a process called as Holography.
- It is used as a surgical tool for welding detached retina.
- It is used to measures the lengths and precision surveying.
- It is used as a potential energy source for inducing nuclear fusion reactions
- It can be used in telephone communications along the optical fiber
- It is also used to cut the metals.

Chapter 19

THE ATOMIC NUCLEUS

ATOM:

The smallest particle of a substance is called as atom of that substance. An atom consist of three fundamental particles these are:

1. Electron
2. Proton
3. Neutrons

Electron is a negatively charged particle.

A proton is a positively charged particle

And a neutron is a neutral particle or having no charge. James Chadwick discovered the neutron in the nucleus.

Proton is the heaviest particle in the nucleus.

ATOMIC NUMBER:

The number of electrons in an atom is called as atomic number.

MASS NUMBER:

The sum of protons and the neutrons in an atom is called as mass number.

FORMULA:

$A=Z+N$

ISOTOPES:

The elements having same charge number but different mass number are called as isotopes.

ISOBARS:

The elements having same mass number but different charge number are called as isobars.

MASS DEFECT:

The mass of nucleus is less than that of sum of masses of the nucleons. This is called as mass defect.

BINDING ENERGY:

The energy required to keep nucleons together is called as binding energy.

RADIO ACTIVITY:

All the atoms having atomic masses greater than 82 are called as radioactive elements and this process is called as radioactivity.

RADIATIONS EMITTED BY RADIOACTIVE ELEMENTS:

There are three types of radiations emitted through the radioactive elements.

ALPHA RAYS:

Alpha particles are positive in nature. They are helium nuclei with double positive charge. They have low penetrating power. But they have high ionization power.

BETA RAYS:

These particles are negative in nature. They have high penetration power. They have low ionization power. They travel1/5th of the velocity of light.

GAMMA RAYS:

They are neutral in nature. They have very high penetrating power. They have very low ionizing power. They travel with the equal speed of light.

DIFFERENCE BETWEEN ALPHA, BETA AND GAMMA:

ALPHA	BETA	GAMMA
They are fast moving helium nuclei	They are moving electrons.	They are just like photons
They are positive in nature	They are negative in nature	They are neutral in nature
They have highest ionizing power	They have moderate ionizing power	They have very low ionizing power
They travel at 1/20th of the speed of light.	They travel at almost the speed of light.	They travel1/5th of the velocity of light.
Thy have lowest penetration power	They high penetration power	They have highest penetration power

RADIOACTIVE DECAY:

The process by which a nucleus of an unstable atom loses energy by emitting ionization radiation is called as radioactive decay.

LAW OF RADIOACTIVE DECAY:

The number of nuclei decay in a certain time is directly proportional to the total number of nuclei present initially.

$\Delta N = -\lambda N \Delta t$ -----------i

Number of nuclei decay is directly proportional to time interval

$\Delta N \alpha \Delta t$..................(2)
Combining (1) and (2)
$\Delta N \alpha -N \Delta t$
OR

$\Delta N = -\lambda N \Delta t$

Where N = Number of nuclei initially present
ΔN = Number of nuclei decay
λ = Decay constant
$\Delta N / N = -\lambda \Delta t$

Integrating both sides

$\ln N = -\lambda t + C$...........(3)

when $t = 0$, $N = N_o$

$\ln N_o = -\lambda(0)$

$\ln N - \ln N_o = -\lambda t$
$\ln (N/N_o) = -lt$
$N/N_o = e^{-\lambda t}$
If $t = T1/2$, $N = N_o/2$
$N_o/2 / N_o = e^{-\lambda T1/2}$
$1/2 = 1/ e^{\lambda T1/2}$
$e^{\square T1/2} = 2$
$\lambda T_{1/2} = \ln 2$
$\lambda T_{1/2} = 0.693$
$A = \lambda N$
Where A = activity and N/N_o = relative activity

λ Is a decay constant and it depends the nature of the material but not on external conditions like temperature pressure.

HALF LIFE:

The time interval that is required by elements to convert into daughter elements are knows as half life of elements.

Half life varies from element to element. Half life of radium is 1590years. And Radon is only 3.825days

FORMULA:

$$T_{1/2} = \frac{0.693}{\Delta\lambda}$$

NUCLEAR FISSION:

The process of breaking up of heavy nucleus into daughter nuclei due to the release of energy is called as nuclear fission. Very high amount of energy is released during this process. It is self sustaining and controllable reaction.

NUCLEAR FUSION:

This is the process in which heavy nucleus is formed from two or more lighter nuclei. The energy released during is process is called as thermonuclear energy.

NUCLEAR REACTORS:

The system that is used to get the controlled amount of heat energy from nuclear fission is called as nuclear reactor.

MODERATORS:

The elements that are used to reduce the energy of neutrons are called as moderators. For example graphite beryllium

COOLANTS:

The elements that are used to absorb excess heat produced in reactor are called as coolants. Mercury and other organic compounds are the example of coolants.

CONTROL MATERIAL:

They are used to cease the fission at any instant. Boron and cadmium rods act as very good control material.

Chapter 20

NUCLEAR RADIATIONS

WILSON CLOUD CHAMBER:

The instrument that is used to detect atomic path is called as Wilson cloud chamber.

WORKING PRINCIPLE:

This device works on the principle of ionization in which supersaturated vapors or droplets are formed on the line and then particle is detected.

CONSTRUCTION:

This device consists of a closed cylindrical chamber having transparent glass top; there is a movable piston at the bottom of that chamber. Near the top, the cylinder having a glass window. A liquid of low boiling point is placed inside the cylinder. The whole system is air tight. A strong light source is used to illuminate the chamber during this process a picture is taken by the sensitive camera.

WORKING:

A low boiling point liquid for example methanol or ethanol is poured on the inner surface of the chamber. The piston is movable and moved up so that the air inside the chamber is cleaned and then piston moved down and the internal pressure is dropped and the air get vapors of the liquid and becomes supersaturated and a fog is observed in the chamber.
At that moment particles are allowed to enter into the chamber and a strong and intense beam of light is used to light the track of the particles and photos are taken by the sensitive camera.
If a resultant field is strong then their path is altered. By the study of path`s length, continuity or discontinuity, thickness and the influence of magnetic field the nature of particle is determined.

GEIGER'S COUNTER:

It is a portable device that is used to detect the ionizing particle or radiation.

CONSTRUCNTION:

This device consists of a hollow metallic cylinder. It one end is closed by an insulating cap. A stiff straight wire is placed at the center of the cap of cylinder. A thin glass disc is placed at other end that closes the other end. It allow the window for ionizing particles. This metallic cylinder contains a special mixture of air, argon, alcohol at a pressure of 50-100 mmHg.

WORKING:

A potential difference of the range of 1000V is maintained between the metallic cylinder and the axial wire through a suitable series resistor of 109 ohms through out the time. When an ionizing particle enters in the tube through the window, it ionizes some gas molecules in it. These ions are accelerated by the strong electric field producing more ions by collision which produces ionization current so a momentary current flows between the wire and the cylinder and also through the resistor R. The ends of "R" are connected to a loud speaker or an electronic counter.

COUNTING OF PARTICLES:

Each time a particle enters in the cylinder the counter and ionization current pulse is created that gives a click in the loud speaker or a count in a counter.
In the case of ionizing radiation, the numbers of counts register by the counter measures the intensity or ionizing power of incident radiation.

IMPORTANT TOPICS FOR 2ND YEAR PHYSICS:

- Linear expansion
- Entropy
- Temperature
- Second law of thermodynamics
- Heat engine
- Electric flux
- Electromagnetic waves
- Galvanometer
- Resistance
- Compton's effect
- P type n type semi conductor
- Laser
- Fission and fusion reaction
- Transformer
- Black body laws
- Radioactivity

SCIENTIFIC REASONS

Reason No 1: When a block with a hole is heated why does not material around the hole expand and make it small give scientific reason?

Answer: Thermal expansion of homogenous substance cause increase in all direction with the same linear thermal expansion. This increase in all direction effective magnification of an object.

Reason No 2: The pressure in gas cylinder containing hydrogen will leak more quickly then if this containing oxygen. Why?

This is so because the hydrogen molecules are lighter then the oxygen molecules and we know that molecular speed is inversely proportional to the molecular mass. Hence hydrogen will leak more quickly.

Reason No 3: Small gaps are left between two adjacent pieces of rails.

Materials expand on heating. Rails also expand as the temperature rises in summer days. To accommodate this expansion the gap between two pieces of rail is left.

Reason No 4: It is not possible to measure the alternating current with the help of moving coil galvanometer.

A moving coil galvanometer is used to measure the magnitude and direction of current. Alternating current changes its direction many times a second. If it is passed through a moving coil galvanometer, the needle will simply vibrate about its mean position because of magnetic effect. It is therefore not possible to measure alternating current with a moving coil galvanometer.

Reason No 5: A nail sinks in water but a heavy ship floats. Give scientific reason.

The nail sinks in water because the weight of the water displaced by it is less than the weight of it. The ship floats because it is so large and displaced large volume of water. The weight of the water displaced by the ship is greater than the weight of the ship.

Reason No 6: The energy of photoelectron is less than that of incident photon?

When a radiation or a photon strikes a metal it deposits some energy on electron in the absorbing surface. If the energy of the photon exceed by the energy required by the electron in work against the force binding it to the surface. It will be emitted by some energy.

Reason No 7: Why is soft iron core used in transformer?

Soft iron is ferromagnetic materials made of iron which can be magnetized and demagnetized easily. This is an advantage in transformers because in transformers, we're constantly varying magnetism of the core. This is important because without the change of magnetism of the core, there wouldn't be any voltage induced in the second circuit (the output)! Hence, using a soft iron would allow the magnetism of the core to be changed easily, lessening the amount of energy lost and increasing the efficiency of the transformer.

Reason No 8: Why Compton's affect is not observable with visible light

In Compton scattering it is necessary that the energy of the photon should be very much greater than binding energy of electro. binding energy is equal to work function of metal. In most of metals , the threshold frequency is equal to that of ultraviolet light .that is why we do not observe comption effect with visible light.

Reason No 9: Is it more difficult to start fusion reaction than fission and why?

Fission reactions start naturally if the proportion of U-235 is high enough; there is evidence this has happened in places in Africa in the distant past of Earth's history.
Fusion reactions require more heat and pressure than we really know how to provide so as to keep a reaction going.