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Unit - I

Wave Motion and its Applications

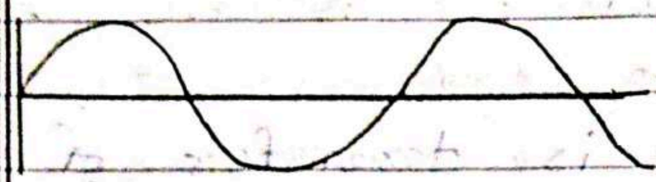
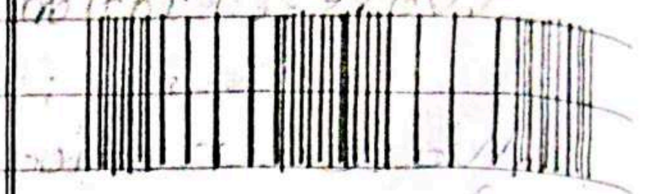
Wave Motion:

Wave motion is transfer of energy from one point to another without the transfer of mass.

Wave

A wave is a disturbance that transfers energy from one point to another in a medium without transferring mass.

Types of wave : Mechanical waves
Electromegnetic waves

	Transverse wave	Longitudinal Wave
1.		
2.	Particles vibrate in a direction perpendi-cular to the direction of propo-gation of wave	Particle vibrate in direction parall to the direction of propogation of wave
3.	The wave travel in form of crests and troughs	The wave travel in form of compression and rarefraction
4.	Formed on solid and liquids	Formed in solid liquid and gas
5.	May be elastic or non elastic wave	Only elastic wave
6.	Examples: light wave, radio wave	Sound wave, Seismic wave

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Wave velocity :

The distance travelled by the wave per unit time is defined as wave velocity.

$$v = \frac{\lambda}{T}$$

where v = wave velocity
λ = wave length
T = Time period

Amplitude :

It is maximum displacement of a particle from its mean position

Wavelength:

The distance between two consecutive crests or troughs is called wavelength.

Unit - metres

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Time Period:

It is defined as the time taken by a wave to complete one cycle.

$$T = \frac{1}{f}$$

Unit : second

Frequency:

The number of vibration made by a wave in one second is called frequency.

It can be also defined as reciprocal of Time period.

$$f = \frac{1}{T}$$

Unit : Hertz

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Phase:

Phase of particle tells position of a particle at that instant It is measured by the fraction of angle. It is denoted by Φ

Unit : radian

Phase difference:

The difference in phase between two points on the wave.

$$\phi = \frac{2\pi}{\lambda} \times \text{path difference}$$

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Relation between Wave Velocity, Wavelength and Frequency

We know that : wave velocity = $\frac{\text{distance}}{\text{time}}$

$$V = \frac{\lambda}{T}$$

Time period $T = \frac{1}{f}$

$$f = \frac{1}{T}$$

$$\boxed{V = \lambda f}$$

Properties of Sound Wave.

1. Sound wave require medium to travel.

2. In air sound wave are longitudinal.

3. Sound wave is ~~machine~~ mechanical wave

4. Velocity of sound wave in air ~~340 / m~~ 340 m/s

through a surface $\frac{1}{60} \times 9$ relation betw

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Properties of Light wave.

1. Light wave can travel in vaccum as well as medium also.

2. Light waves are transverse in nature

3. Light waves are electromagnetic wave.

4. Velocity of light wave is 3×10^8 m/s in vaccum.

Principle of Super position of wave:

When two or more waves cross at a point the displacement at that point is equal to the sum of displacement of waves.

$$\vec{y} = \vec{y_1} + \vec{y_2}$$

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Beat formation:

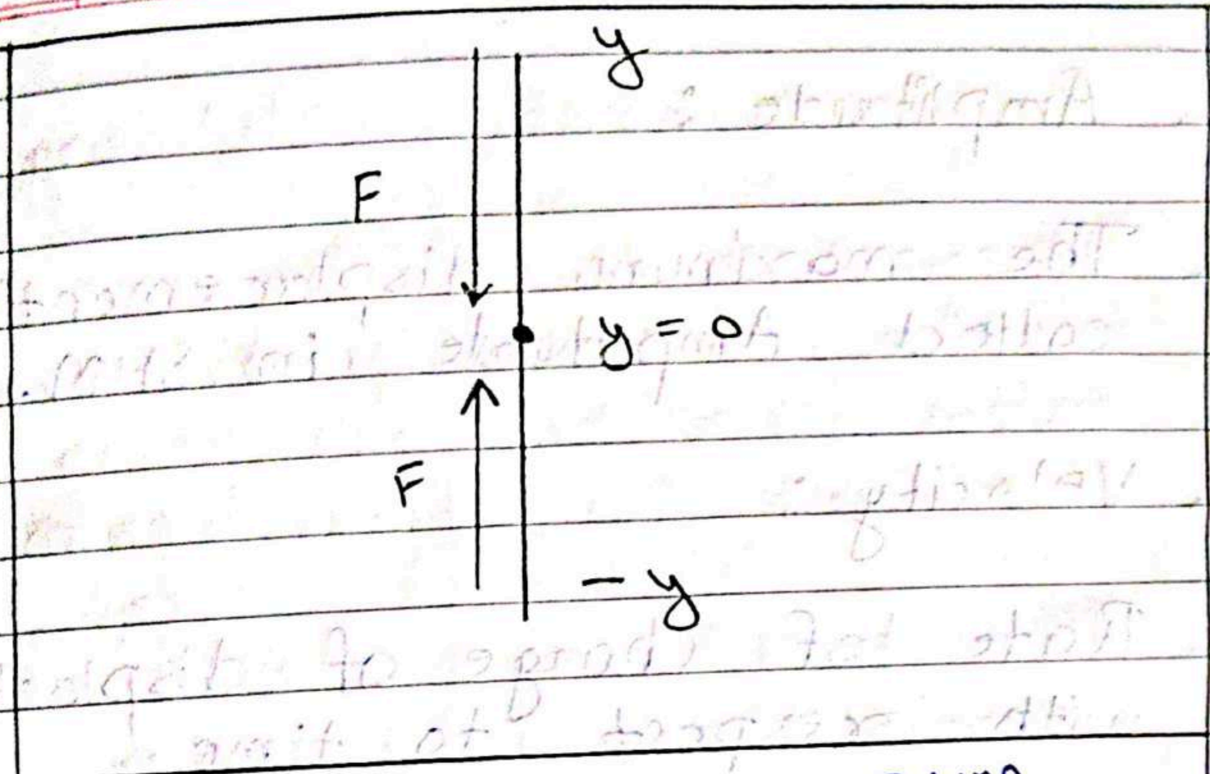
Beat formation or beats is a phenomenon that occurs when two sound waves with differe frequencies overlap and create a new wave. The beat frequ is difference of frequency between two waves.

$$f_0 = |f_1 - f_2|$$

Simple Harmonic Motion (SHM)

Simple Harmonic Motion or SHM is defined as a motion in which the restoring force is directly proportional to the displac-ent of body from its mean position.

The direction of restoring force is always toward mean position



Particle executing SHM

Expression for displacement velocity, acceleration, time period and frequency in SHM

1. Displacement:

The displacement is shift or movement of particle from its equilibrium position.

$$y = A \sin(\omega t)$$

2. Amplitude :

The maximum displacement is called Amplitude in SHM.

3. Velocity :

Rate of change of displacement with respect to time

$$v = A\omega\cos(\omega t)$$

4. Acceleration :

Rate of change of velocity is called acceleration.

$$a = -A\omega^2\sin(\omega t)$$

5. ~~Th~~ Frequency:

The frequency is number of oscillations per unit Time.

$$f = \frac{1}{2}\pi \sqrt{\frac{k}{m}}$$

unit - Hertz

6. Time Period:

It is reciprocal of frequency or it is time taken to complete one oscillation

$$T = 2\pi \sqrt{\frac{m}{k}}$$

Where,

A = Amplitude
ω = Angular frequency
a = Acceleration
T = Time period
f = frequency
m = mass

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Progressive wave	Stationary wave
1. No particle of medium is permanently at rest	The medium particles at node are permanently at rest.
2. The disturbance travels forward with constant velocity.	The disturbance remains confined to its region of production
3. All particles oscillate at same frequency	All particle oscillate at same frequency expect those at nodes
4. Energy is transferred along the wave	Energy is stored not transferred
5. Does not have nodes or anti nodes	Has nodes and anti node.

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Echo:

Direct sound and its reflection produced from the source and that arrives at the listner with an time interval is known as Echo.

Reverberation:

The direct sound and its multiple reflection with decreasing intensity reaches to listner in very less time interval. This phenomenon is known as Reverbration.

Reverbration Time:

The time required for the sound to "fade away" or decay by 60 dB.

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Coefficient of absorbtion of sound

The ratio of sound energy absorbed by surface to the total sound energy incident on a surface is called coefficient of absorbtion of sound.

$$a = \frac{\text{absorbed sound by surface}}{\text{Total sound incident on surface}}$$

Unit = (O.W.U) open window Unit

Its maximum value is 1

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Methods to Control Reverbration Time

1. Curtains
2. Open windows
3. Good number of audience
4 Carpets
5 False ceiling.

Sabine Formula :

The sabine formula is used to calculate reverbration Time

$$RT_{60} = \frac{0.165V}{Sa}$$

RT_{60} Reverbration time to decay by 60 Db

V = volume of room

S = Surface area

a = average absorbtion coefficie

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Ultrasonic Waves :

The sound waves having frequen more than 20 KHz are called ultrasonics.

Properties / Characteristics of Ultrasonic waves

1. They undergo reflection & refraction

2. They produce heat when passed through objects

3. They are longitudinal waves.

4. They work as a catalyst for chemical reaction.

5. They have smaller wavelength.

6. They cannot travel through vaccum.

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Engineering and Medical application of ultrasonic waves.

1. Ultrasound Scanning (Sonography):

It is majorly used for diagnosis of organs and scan. It is based on reflection of ultrasonic waves from the hard boundaries of organs. The sonography machine operates ~~at~~ in the frequency range of 2 to 18 megahertz.

2. SONAR:

SONAR is an application used by submarines to detect the nearby ships, submarines and other obstacles. An ultrasonic signal is sent by submarine when it is beneath the surface and it receives echo of the same signal.

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3. Drilling:

Ultrasonic is high frequency and high energy wave so they can be used in applications involving high amount of energy.

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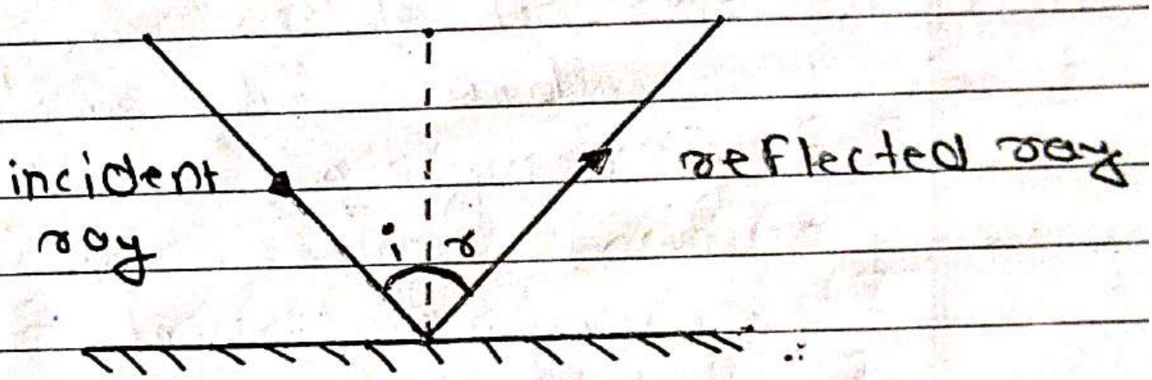
Unit - II
Optics

Laws of Reflection :

The phenomena of bouncing back of light after striking at a polished surface is called as reflection



Laws :

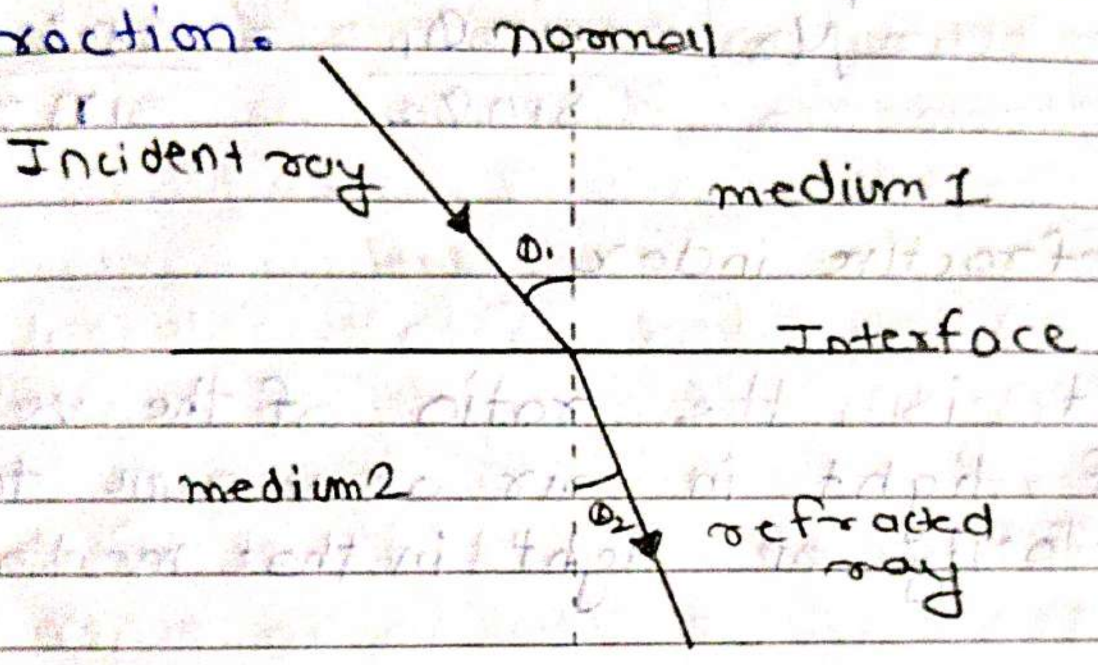
1. The incident ray, reflected ray and the normal all lie in same plane.

2. The angle of incidence is always equal to angle of ~~refraction~~ reflection

$$\theta_i = \theta_r$$

Refraction:

The phenomenon of bending of light rays from their original path while passing from one medium to another is called ref- -raction.



Laws

1. The incident ray, the refracted ray and the normal all lie in same plane.

2. The ratio of sine of angle of incidence (θ_1) to the sine of

refracted angle (θ_2) is a constant for that pair of media and is equal to the refractive index of the media. This is also known as Snell's law.

$$ {}^1\mu_2 = \frac{\sin\theta_1}{\sin\theta_2} = \frac{\sin i}{\sin r} $$

Refractive index

It is the ratio of the velocity of light in air or vacuum to the velocity of light in that medium.

$$ \mu = \frac{c}{v} $$

where c = speed of light in air
v = speed of light in medium
μ = refractive index

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Lens formula

The lens formula gives relation between focal length (f) object distance (u) and image distance (v) as

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

Power of lens

The ability of lens to converge or diverge the light rays is called as power of lens.

$$P = \frac{1}{f}$$

Unit - Dioptre

Power of convex lens positive
concave negative

Total Internal Reflection

When light is goes from denser medium to rare medium and the angle of incidence is greater than critical angle, the light get completely reflection in the same medium. This phenomenon is known as total internal reflection.

Conditions for Total Internal Reflection

1. The light should travel from a denser medium to a rarer medium.

2. The angle of incidence in the denser medim should be greater than the critical angle.

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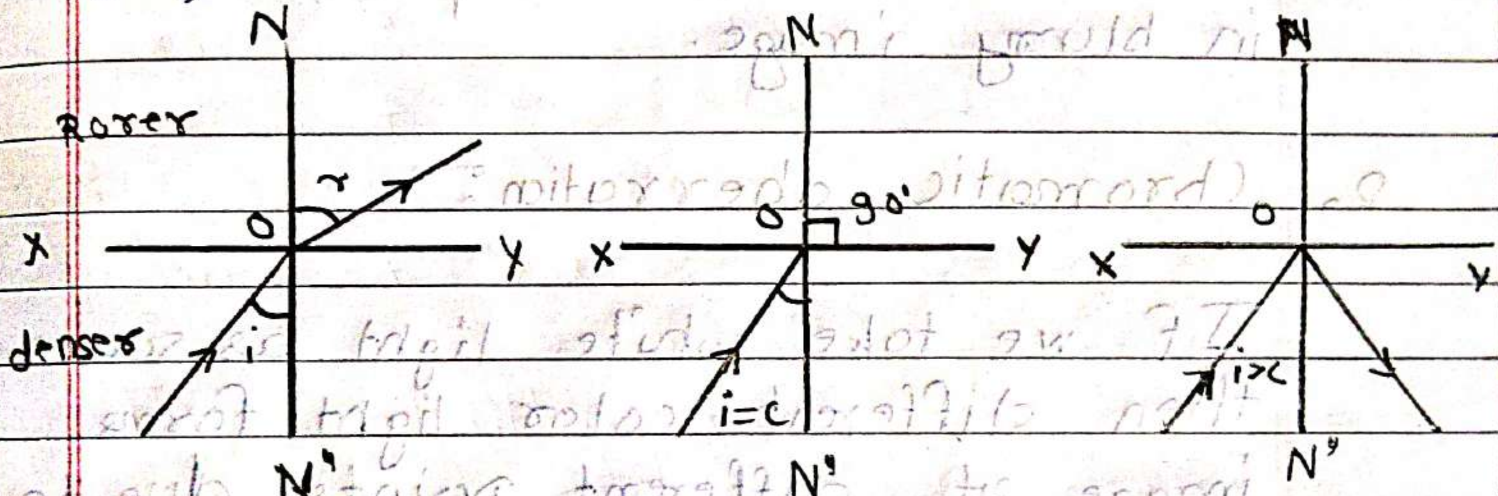
Critical Angle:

The angle of incidence for which the angle of refraction becomes 90° is called as critical angle (θ_c).



Total Internal Reflection

Magnification:

The ratio of the size of image to the size of object is known as magnification

$$m = \frac{-v}{u}$$

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Defects See Diagram

1. Spherical Aberration:

This occur when the curvature of lens or mirror cause rays to focus at different points resulting in blurry image.

2. Chromatic aberration:

If we take white light as source then different color light forms image at different points due to wave length difference as white light consists of several color wavelength.

3. Coma

If the light rays coming from object is not parallel to principal axis and spherical aberration is applied to such rays result in coma.

...spherical aberration.

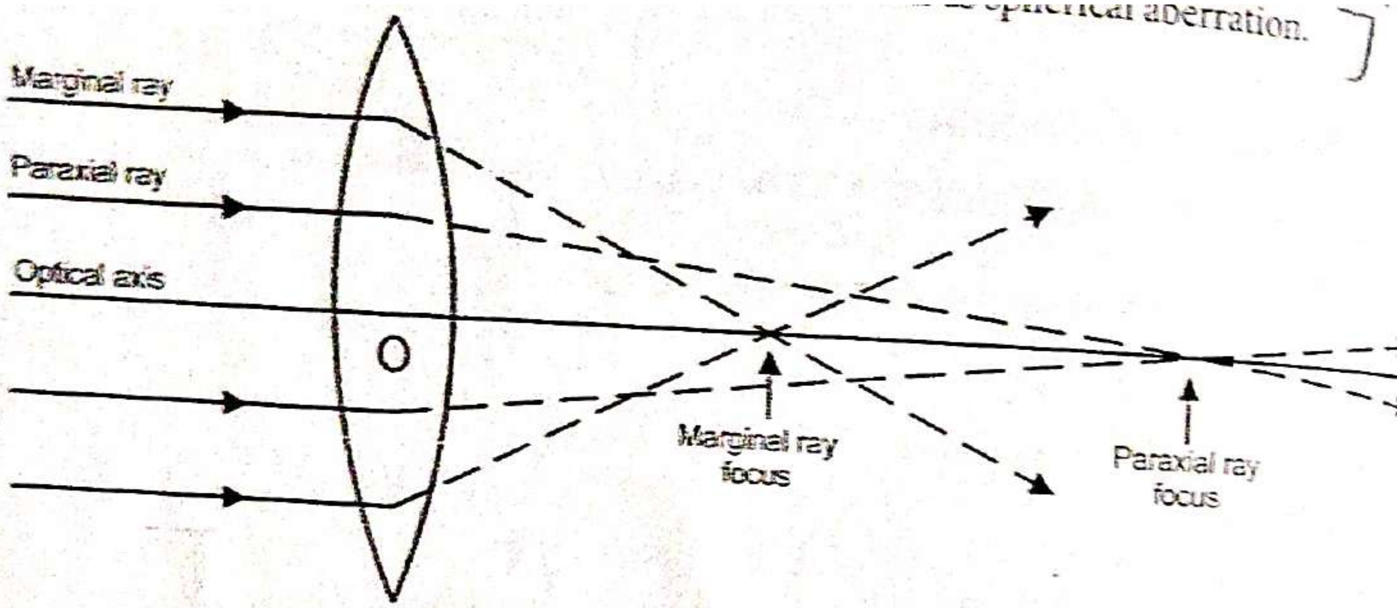


Fig. 2.5 Spherical aberration

Effect: out of focus image, or focus is not sharp point.

2.1.7.3 Coma

In spherical aberration the light rays coming from the object are parallel to principal axis. If the p... object is away from principal axis, the light rays coming from the point not parallel to principal axis spherical aberration applied to such rays results in defects known as Coma. Unequal magnification... the image formed due to different zones of lens. The circular image of point will be formed perpend... ular to principal axis.

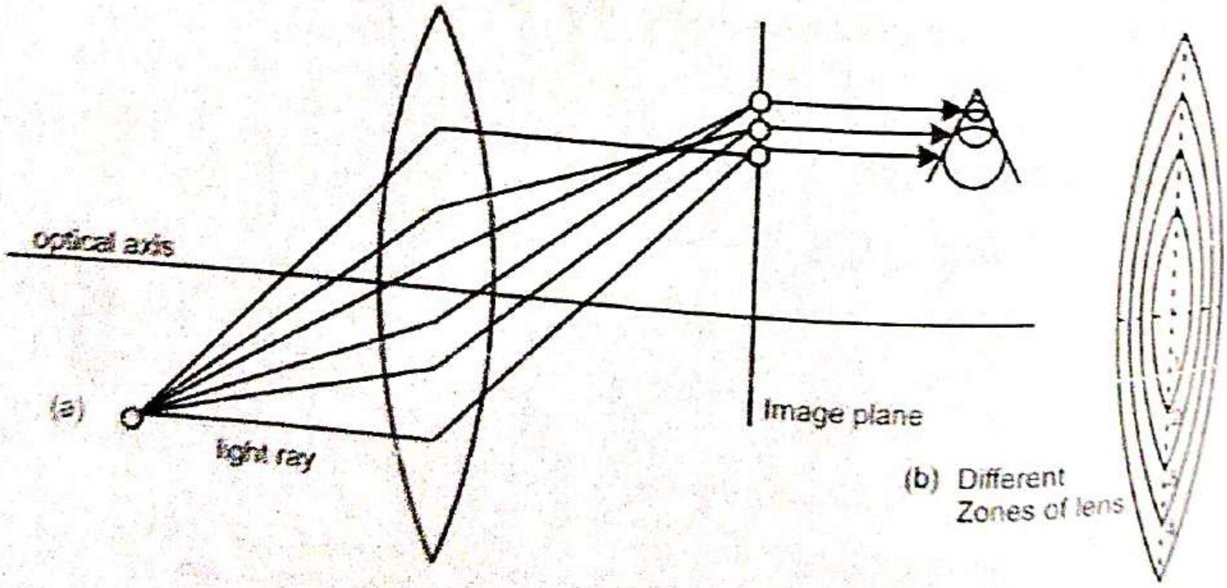


Fig. 2.6 Coma

Effect: Image is sharped in center but blurred towards the edges.

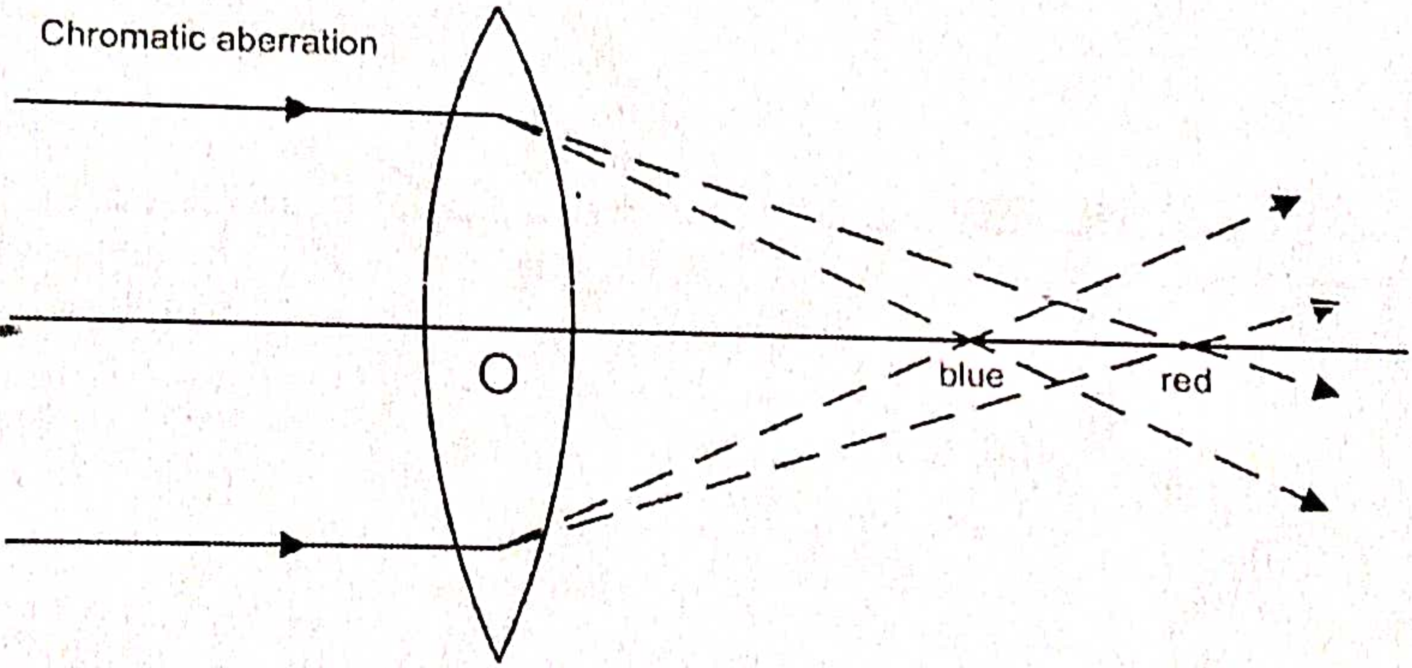


Fig. 2.4 Chromatic aberration

2.2 OPTICAL INSTRUMENTS

Optical Instruments are the instruments based on the principle of optics and uses optical devices such as lens or mirror to measure the physical quantities or to observe objects. In the present topic, some of the optical instruments based on ray optics are explained in detail with applications. Every instrument needs source of energy to observe the objects, the instruments that uses light source as energy provider are known as optical instrument.

Example: Human eye, spectrometer, periscope, microscope, telescope, projector

2.2.1 Simple and compound microscope

A microscope is an optical instrument used to magnify small objects. It is made up of lens or combination of lenses. The magnifying power of microscope depends upon the parameters of lens used for making microscope and the wavelength of source of light used. The meaning of micro is small, and scope is to see, hence the name suggest that microscope is used to observe small objects. The two basic types of microscope are

- Simple microscope
- Compound microscope

Simple microscope

As from table 2.3, when an object kept between focus and optical center of convex lens its virtual and enlarged image is formed. This property of convex lens is used in designing simple microscope. The following is the ray diagram of simple microscope. It consists of one convex lens. (The details of actual microscope is given in the video link). The object is observed by keeping eye close to convex lens and the image is clearly seen when it forms at distance of distinct vision, which is 25 cm for human eye.

Let 'b' is the angle which eye made with image formed at v = D and 'a 'is the angle which eye (without lens) made with object kept at distance of distinct vision. The magnification is calculated as ratio of the angle 'b' with 'a'.

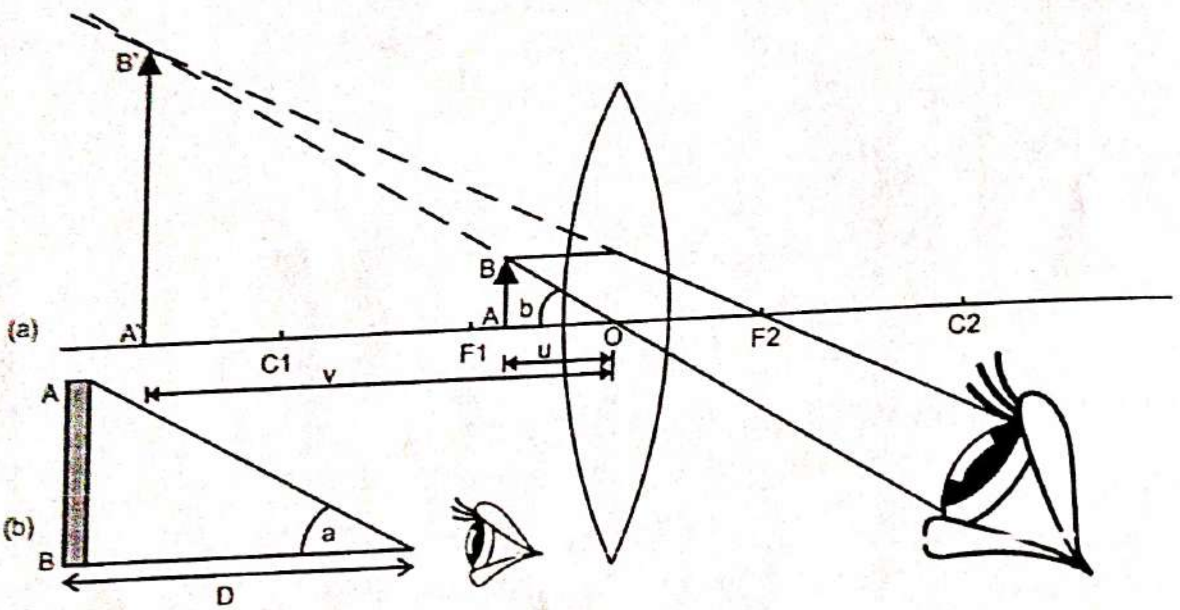


Fig. 2.10 Simple microscope

Magnifying power, $m = b/a$

In ΔA'B'O in Fig. 2.10 a, $tan(b)=A'B'/D$ and ΔABO in Fig. 2.10 b, $tan(a)= AB/D$ if a and b are very small then ...(2.11)

$$tan(b)/tan(a) = b/a = A'B'/AB$$

As from Fig. 2.10 (a) ΔA'B'O and ΔABO are similar triangles then ...(2.12)

$$A'B'/AB = -v/-u = D/u$$

$$m = D/u$$

From Lens Equation

$$1/v - 1/u = 1/f$$

$$(1/-D) - (1/-u) = 1/f$$

$$1/u = 1/D + 1/f$$

Multiply D both sides

$$D/u = 1 + D/f \text{ hence } m = \{1 + D/f\} \quad ...(2.13)$$

This equation gives magnification of simple microscope. If we decrease the focal length of lens the magnification of microscope increases.

Compound microscope

A simple microscope has a limitation of magnification, for larger magnification a combination of two lens microscope or compound microscope is used Fig. 2.11 shows the ray diagram for compound microscope. The lens which is near to object is objective lens and the lens from which, the image is observed is eye piece. The focal length of objective and eyepiece is f_0 and f_e respectively.

The object AB is kept at distance slightly greater than f_0 such that real and inverted magnified Image A'B' is formed on other side of objective. The A'B' is formed between the focal length and Optical center of Eyepiece. The enlarged virtual erected image A"B" of A'B' is seen through eyepiece.

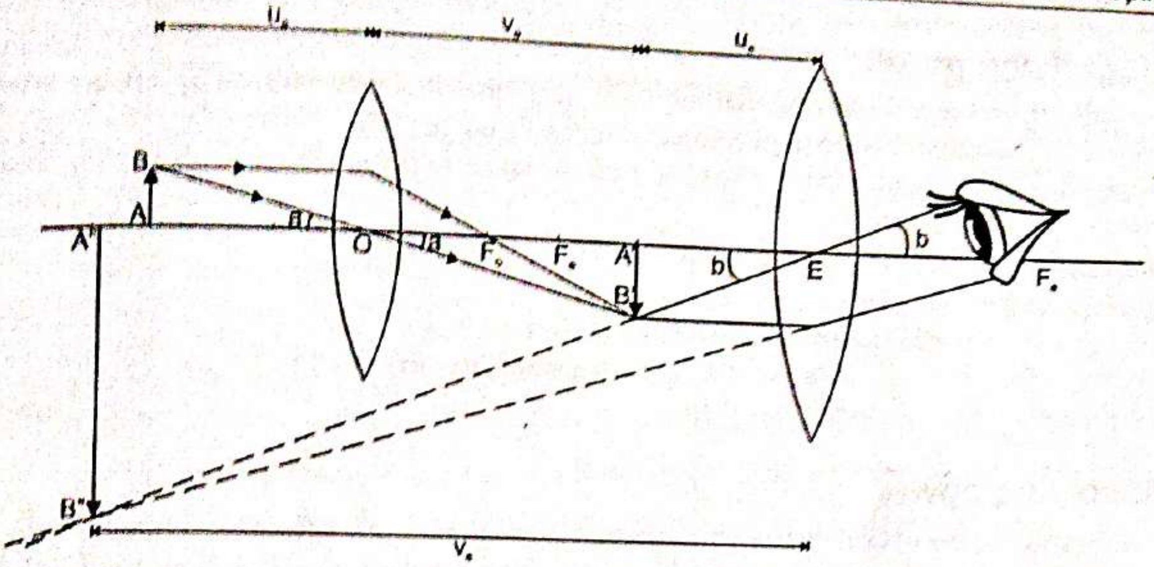


Fig. 2.11 Compound microscope

The magnifying power of compound microscope is product of the magnification by two lenses.
Magnifying power of compound microscope is = $m_o \times m_e$

$$= (-v_o/u_o)[1+D/f_e] \quad ...(2.14)$$

2.2.2 Astronomical telescope in normal Adjustment A Digram ,

The meaning of 'tele' is 'distant' or 'far', hence as the name suggest that telescope is used to observe distant objects such as astronomical objects or terrestrial objects. The simple astronomical telescope consists of two lenses as given in ray diagram of astronomical telescope in Fig. 2.10. The objective is a convex lens of long focal length and with large aperture. The real image of the distant object forms at the focus of objective lens. The eyepiece is convex lens of small focal length. The optical system of telescope is like microscope. The objective lens forms real and diminished image AB of the object. The eyepiece enlarges the image AB (which is object for eyepiece) and forms magnified virtual image.

In normal adjustment the image AB is formed at the focus of eyepiece and its magnified and enlarged virtual image is formed at infinity. If the final image formed by the by the eyepiece lies at infinity. The distance between the objective and eyepiece is the sum of their focal length, $f_o + f_e$

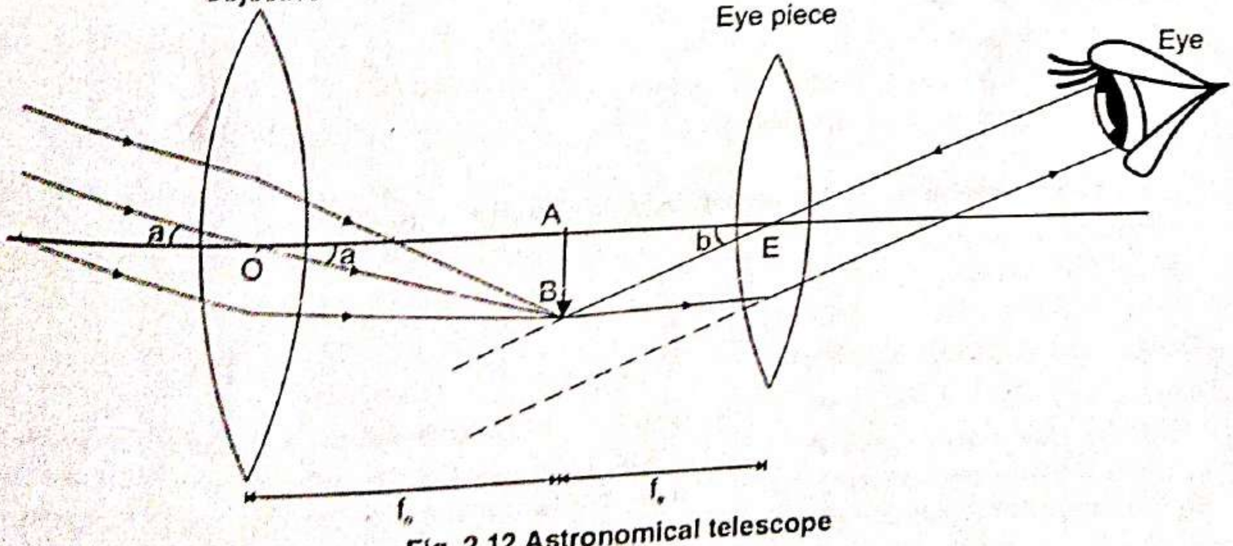


Fig. 2.12 Astronomical telescope

2.2.3 Magnifying power

To find magnifying power it is assumed that the eye is very close to the eyepiece. The distance between the objective and eyepiece is very small as compared to the distance of the objective from the object. The angle 'a' subtended at the unaided eye by the object can be taken as the angle subtended by the object at the objective.

Magnifying power,

$$|m| = b/a \qquad ...(2.15)$$

In ΔABO and ΔABE of Fig. 2.12

$$\tan(b)/\tan(a) = (AB/BE)/(AB/OB)$$

$$b/a = OB/BE \quad \text{[if a and b are very small]} \qquad ...(2.16)$$

$$|m| = f_o/f_e$$

2.2.4 Resolving power

The resolving power of any optical instrument, whether it's a microscope, telescope or human eye, is the ability of instrument to resolve any two near objects and form separate image of those nearby objects. In case of telescope the resolving power is the ability to form separable images of two distant objects or astronomical object. In case of microscope the two smaller nearby objects are resolved. Our eye is also an optical instrument. It is seen by experiment that if the angle subtended by two objects on eye is less then 1' (1 minute) then the objects will not be separate. This angle is called the 'resolving limit of the eye'.

Similarly, every optical instrument has a limit to form separate images of two objects and is called as the limit of resolution of that optical instrument. Smaller the limit of resolution of an optical instrument, greater is said to be its resolving power.

The resolving power of telescope = $d/1.22\,\lambda$

Where, d is the diameter of objective lens and λ is the wave length of light used.

The resolving power of microscope = $2n\sin(\theta)/\lambda$

Where, n is the refractive index between specimen and lens

θ is the half of the angle subtended by objective lens on object,

λ is the wave length of light used.

2.2.5 Uses of microscope and telescope

Microscope

- Analysis of soil particles
- Find out various skin diseases.
- In microbiology to study samples of algae, fungi.
- To magnify the fine parts of the jewelry.

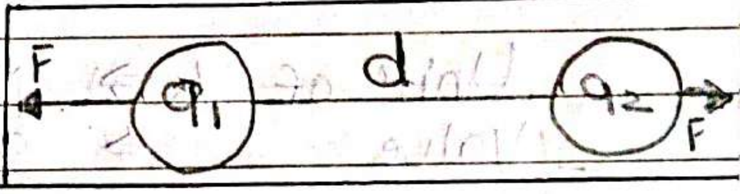
Telescope

- View astronomical objects such as planets, galaxy, natural satellite of planet.
- Solar and lunar eclipse.
- Observe Moon surface.

Physics Notes Unit - III
Electrostatics

** Coulomb's law

Coulomb's law states that the force of attraction or repulsion between two point charges is directly proportional to the product of the magnitude of charges and inversely proportional to the square of distance between them.



$$F \propto q_1 \times q_2$$

$$F \propto \frac{1}{d^2}$$

$$F \propto \frac{q_1 q_2}{d^2}$$

$$F = k \frac{q_1 q_2}{d^2}$$

where k is constant of proportionality and called as electrostatic constant.

When two charges kept in free space

$$k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \ Nm^2/C^2$$

Where ϵ_0 is permitting of free space

$$F = \frac{1}{4\pi\epsilon_0} \times \frac{q_1 q_2}{d^2}$$

Unit of $k \Rightarrow Nm^2/C^2$
Volue $\Rightarrow 9 \times 10^9 \ Nm^2/C^2$

Charge

Charge is the physical property of matter that causes it to experience a force when placed in an electro-magnetic field.

Unit $\Rightarrow$ Coulomb (C)

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Electric field Intensity / strength

Electric field intensity is a measure of the strength of an electric field at a given point. It is equal to the electric force per unit charge experienced by a test charge at that point.

Formula ⇒ $E = \frac{F}{q}$

Unit ⇒ Newton per coulomb (N/C)

Electric lines of force and properties

Electric lines of force also known as electric field lines are a visual representation of electric field around charged objects. They illustrate the direction and strength of the electric field.

Properties : ~~of~~ (Any 4) Easy

1. The field lines never intersect each other.

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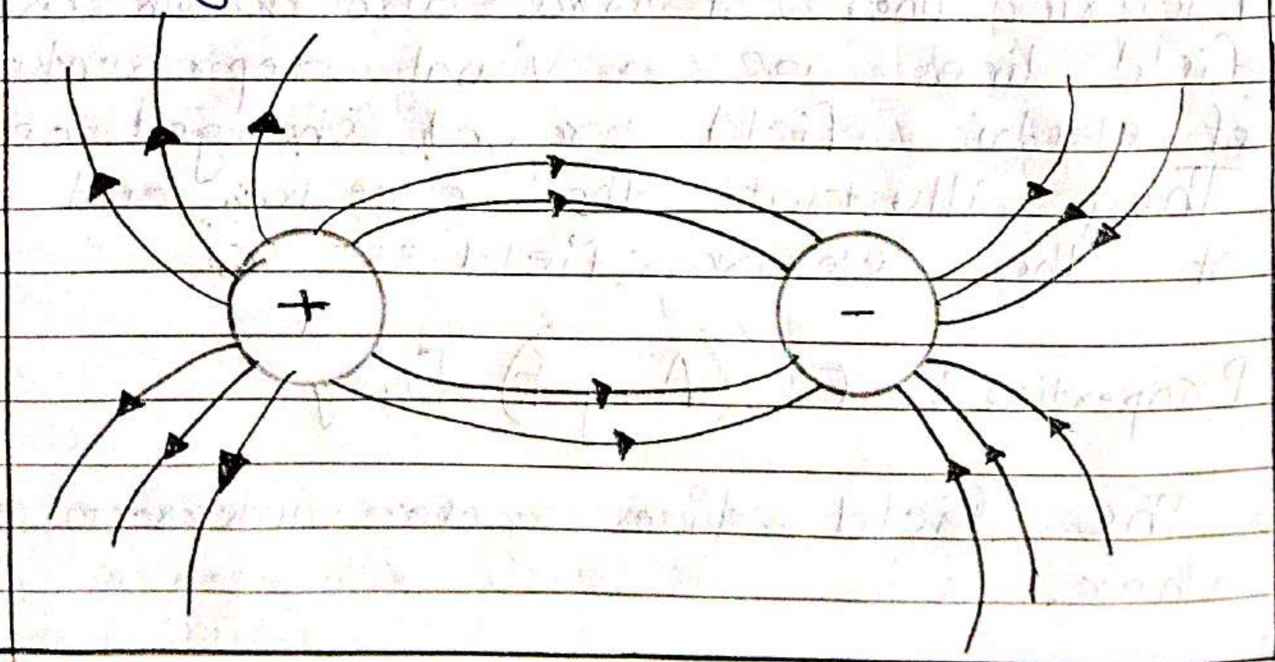
2. Electric field lines start from positive charge and end on negative charge.

3. The density of the field lines indicate the strength of the electric field.
A higer density of lines corresponds to a stronger electric field.

4. Electric lines of force are always perpendicular to surface of charge.

5. Electric field lines never form closed loops

6. The electric lines of force do not pass through the conductor.



Electric lines of force

Electric flux (ϕ)

The total number of electric lines of force passing through a specific area inside an electric field is a measure of the electric flux through that area.

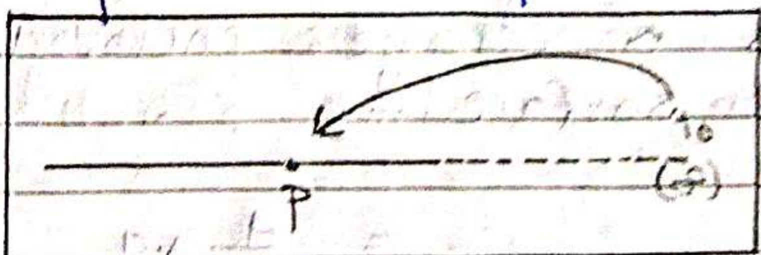
Formula

$$\phi_E = E S \cos\theta$$

Unit = Nm^2/C

Electric potential (V)

The amount of work done in moving a unit positive test charge from infinity to a point P against the electric field is electric potential at point P.



$$V = \frac{W}{q_0}$$

Unit - Volt

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Potential Difference (Voltage)

The amount of work done to move a unit positive charge q_0 from one point to another point inside the electric field is known as electric potential difference.

$$V = \frac{W}{Q}$$

unit ⇒ Volt

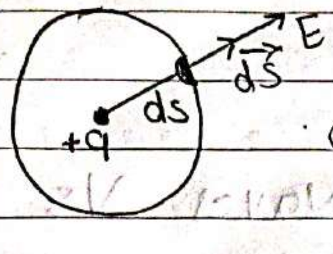
Gauss Law

The total electric flux (ϕ) passing through any closed surface is $\frac{1}{\epsilon_0}$ times of charge enclosed by the surface

$$\phi_E = \frac{1}{\epsilon_0} \times q$$

Guass theorem gives relation between charge and flux

Proof



$\phi = 0°$

We know that

$$\phi_E = \oint \vec{E} \cdot \vec{ds}$$

$$\phi_E = \oint E\, ds \cos\phi$$

$$\phi_E = \oint E\, ds \cos 0$$

$$\phi_E = \oint E\, ds$$

$$\phi_E = E \oint ds$$

$$\phi_E = E \cdot 4\pi r^2$$ [Area of sphere

$$\phi_E = \frac{1}{\cancel{4\pi}\epsilon_0} \cdot \frac{q}{\cancel{r^2}} \times \cancel{4\pi r^2}$$

$$\left[E = \frac{1}{4\pi\epsilon_0} \times \frac{q}{r^2} \right]$$

$$\phi_E = \frac{1}{\epsilon_0} \times q$$

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Applications of Gauss Law

1. Straight charged conductor:
Electric field at a distance r from an infinitely long charged conductor with linear charge density λ

$$E = \frac{\lambda}{2\pi\epsilon_0 r}$$

2. Plane charged sheet:

Electric field near an infinite plane sheet of charge with surface density σ:

$$E = \frac{\sigma}{2\epsilon_0}$$

3. Charged sphere:

Outside the sphere

$$E = \frac{Qr}{4\pi\epsilon_0 r^2}$$

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Inside the sphere

$$E = \frac{Qr}{4\pi \epsilon_0 R^3}$$

Capacitor :

A capacitor is an electronic component that is used to store charge in form of potential difference between its plates.

Capacitance

Capacitance is the ability of a material to store electrical charge

$$C = \frac{Q}{V}$$

unit = Farad

Types of Capacitor

(a) Types of capacitor on basis of shape of electrodes

Parallel plate , spherical , cylindrical

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(b) Material between electrodes

Dielectric . Electrolytic

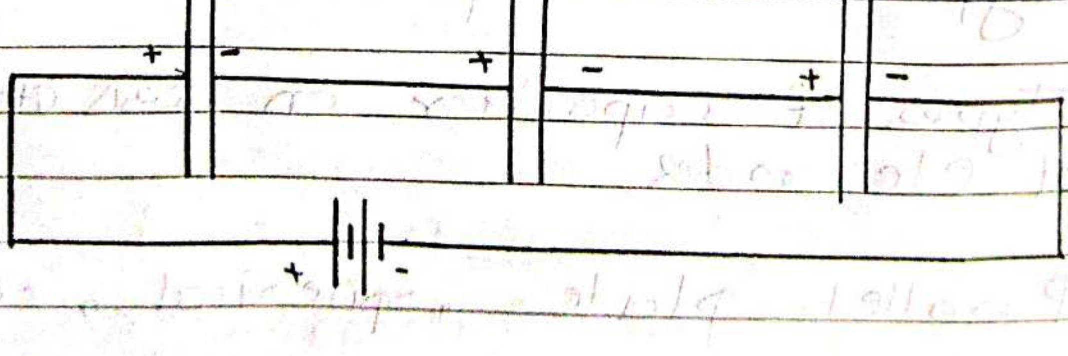
(c) Capacitance

Fixed and variable capacitor

Series and parallel combination of capacitor

① Series

When negative plate of one capacitor is connected to positive plate of second and negative of second to the positive of third and so on the capacitor is said to be connected in series.



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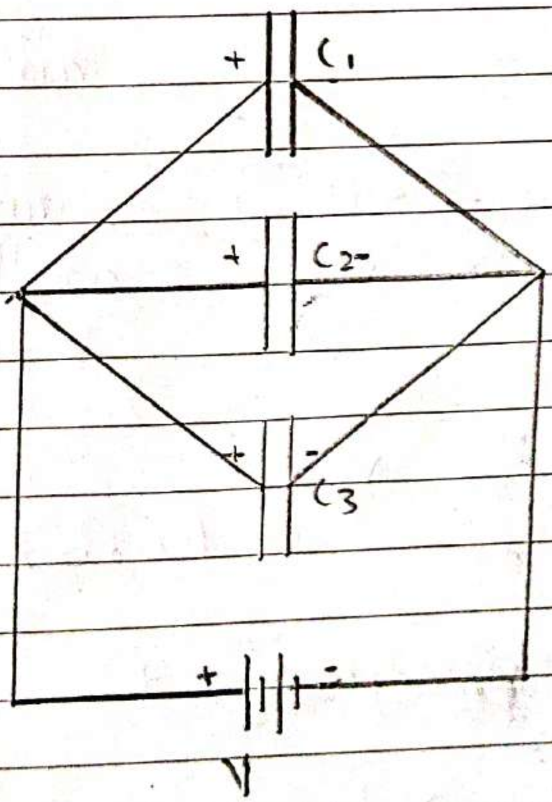
Total capacitance in series

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

② Parallel

When the positive of all capacitors is connected to one common point and negative plate to another common point The capacitor is said to connected in parallel.



Total capacitance in parallel

$$C = C_1 + C_2 + C_3$$

Dielectric breakdown:

Dielectric materials are electrical insulators they prevent the flow of current. Dielectric breakdown is the phenomenon of failure of an insulating material to prevent the flow of current.

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Chapter - IV
Current Electricity

Electric current:

Electric current is defined as the rate of flow of electric charge through a conductor.

$$I = \frac{Q}{t}$$

where I = Electric current
Q = charge in Coulomb
t = time in second

Unit = Ampere

Direct Current

Direct current in an electric wire flows in one direction only.

OR

The current which flows in one direction only is called Direct current.

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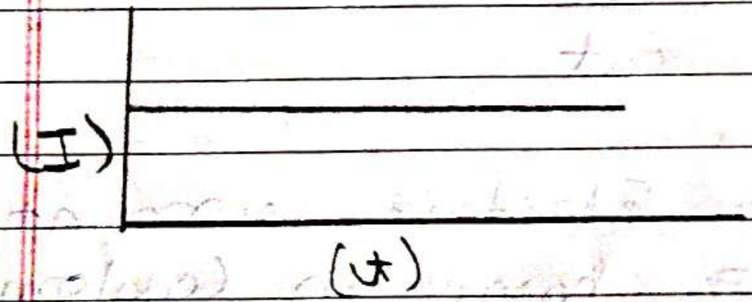
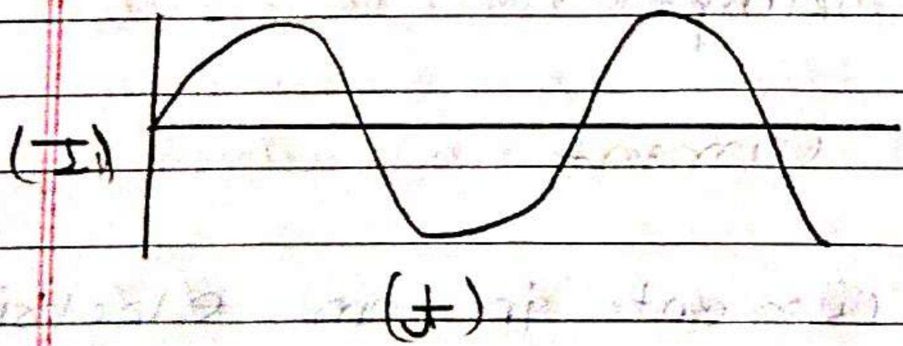
Alternating Current

When both magnitude and direction of current changes with such type of current is known as Alternating current.



Direct current



Alternating current.

Resistance :

The opposition to the flow of current in an electric circuit is called resistance

$$R = \frac{V}{I}$$

symbol

unit - Ohm (Ω)

Specific Resistance (Resistivity)

The specific resistance is resistance of a conductor having unit length and unit area of cross section. The specific resistance depends on following factors

1. It is directly proportional to its length

$$R \propto l \qquad -①$$

2. It is inversely proportional to area

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of cross section

$$R \propto \frac{1}{A} \quad \text{--- (2)}$$

Combining eq 1 and 2

$$R \propto \frac{l}{A}$$

$$R = \rho \frac{l}{A}$$

Where ρ is a constant and known as specific resistance

Conductance:

It is measure of ease with which the current flows through an object.

$$G = \frac{1}{R}$$

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Conductivity (Specific conductance)

It is degree to which an object conducts electricity. it is reciprocal of resistivity.

$$\sigma = \frac{1}{\rho}$$

Series and Parallel Combination of resistance

Series combination

The resistance are said to be connected in series if the same current passes through all the resistances and the potential difference is different across each resistance.

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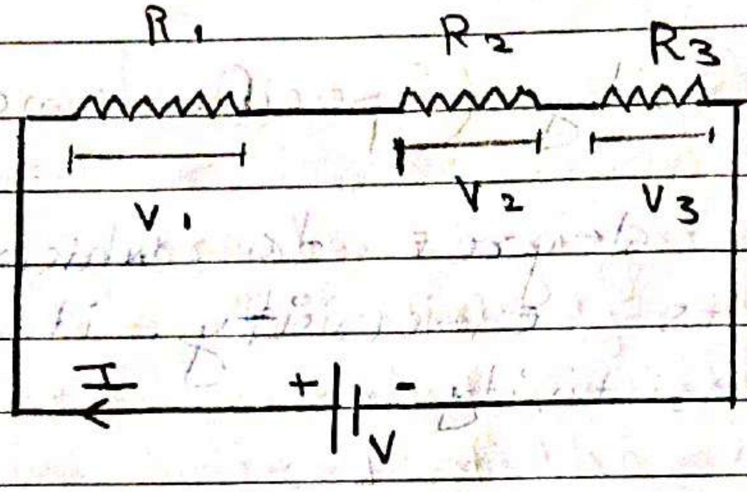
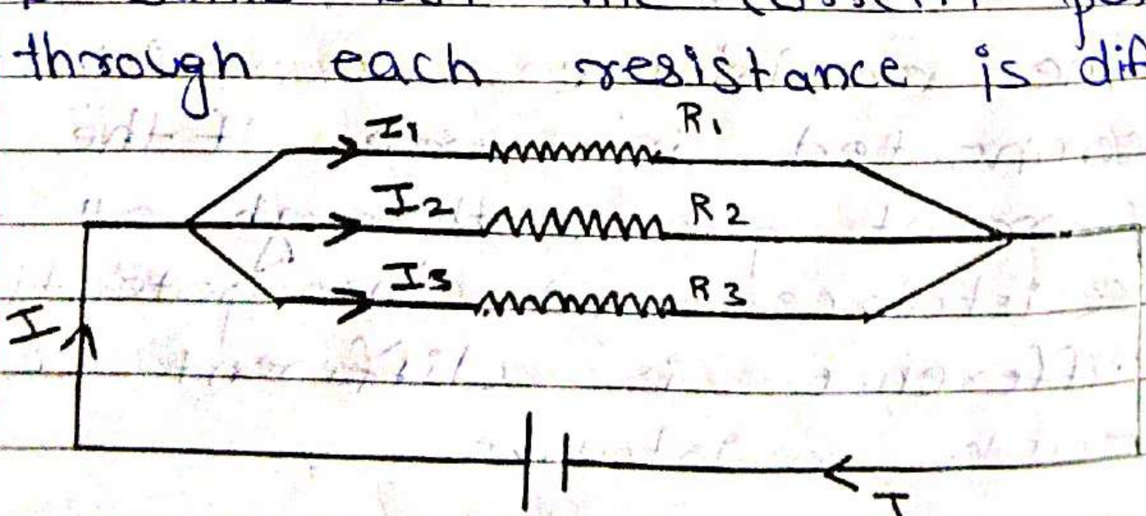


$$R = R_1 + R_2 + R_3$$

Parallel Combination

The resistances are said to be connected in parallel if the potential difference across each resistance is same but the current passing through each resistance is different.



$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

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Factors affecting Resistance of wire

1. Length : Length increases the resistance

$$R \propto l$$

2. Area of cross section increases resistance decreases

$$R \propto \frac{1}{A}$$

3. Temperature of conductor

4. Nature of material

[Color Coding Table Here]

Next Question

COLOUR (A, B)	INITIAL LETTER	Corresponding Digit or number	MULTIPLIER (C)	COLOUR (R)	Tolerance
Black	B	0	10^0	Gold	±5%
Brown	B	1	10^1	Silver	±10 %
Red	R	2	10^2	No colour	±20%
Orange	O	3	10^3		
Yellow	Y	4	10^4		
Green	G	5	10^5		
Blue	B	6	10^6		
Violet	V	7	10^7		
Grey	G	8	10^8		
White	W	9	10^9		
Gold			10^{-1}		
Silver			10^{-2}		

Table 4.1: Colour code of carbon resistors

To remember the value of colour coding used for carbon resistor, the following can be remembered **B B ROY** of Great Britain has Very Good Wife wearing Gold Silver necklace.

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Ohm's law

The current flowing through a conductor is directly proportional to the potential difference across the end of the conductor

$$I \propto V$$

$$V = RI$$

$$V = IR$$

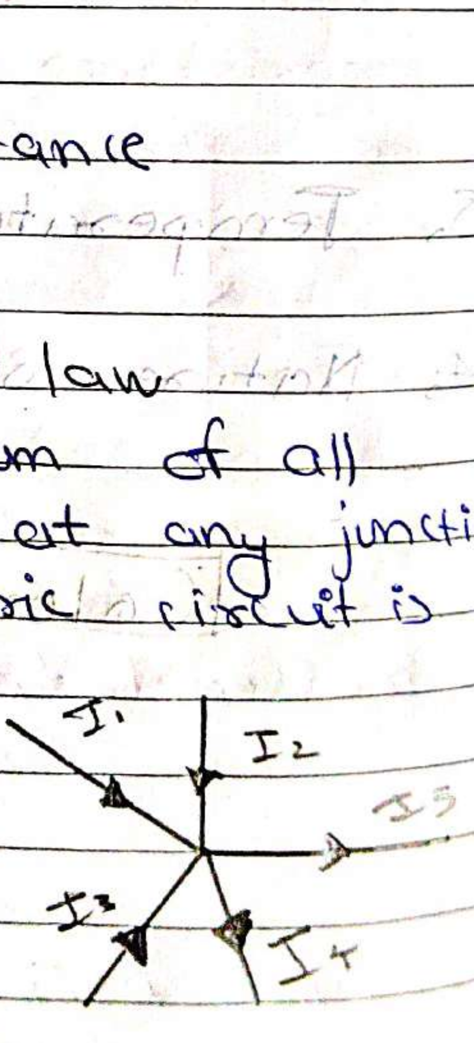
Where R is resistance

Kirchhoff's law

Kirchhoff's current law

The algebraic sum of all currents meeting at any junction point in an electric circuit is zero.

$$\sum I = 0$$



$$I_1 + I_2 + I_3 = I_4 + I_5$$

$$I_1 + I_2 + I_3 - I_4 - I_5 = 0$$

kirchhoffs voltage law.

The sum of all voltage changes in a closed-loop circuit is equal to zero.

$$\cancel{\sum V = \sum IR}$$

$$\sum V = 0$$

Wheatstone bridge

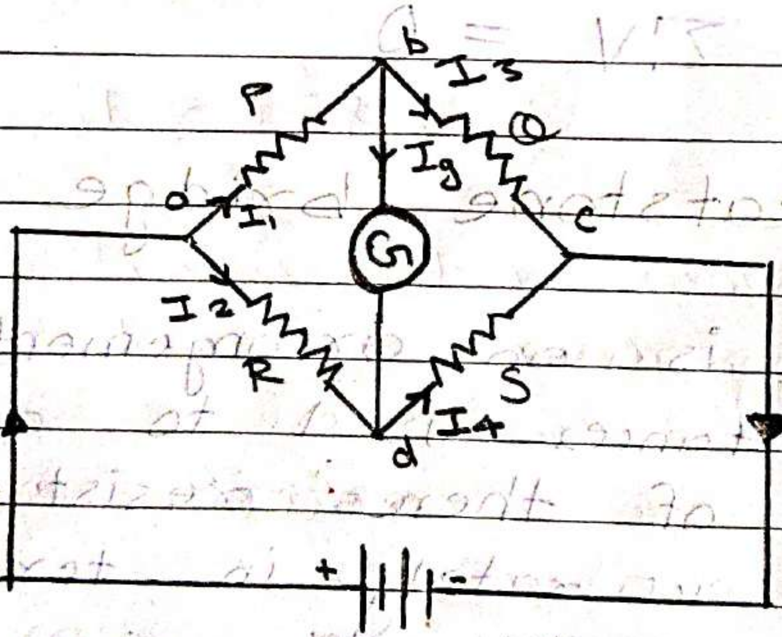
It is an arrangement of four resistances used to determine one of these resistances quickly and accurately in terms of remaining three resistance.

Advantages of wheatstone bridge

1. The unknown resistance can be measured with high accuracy

2. No involvment of current and voltage the characteristics of measuring instrument does not affect the measurment.

3. Simple and Reliable. The basic design of wheatstone bridge is very simple and reliable.



Wheatstone Bridge

Application of Wheatstone bridge

Slidewire bridge

A slidewire bridge is a simple

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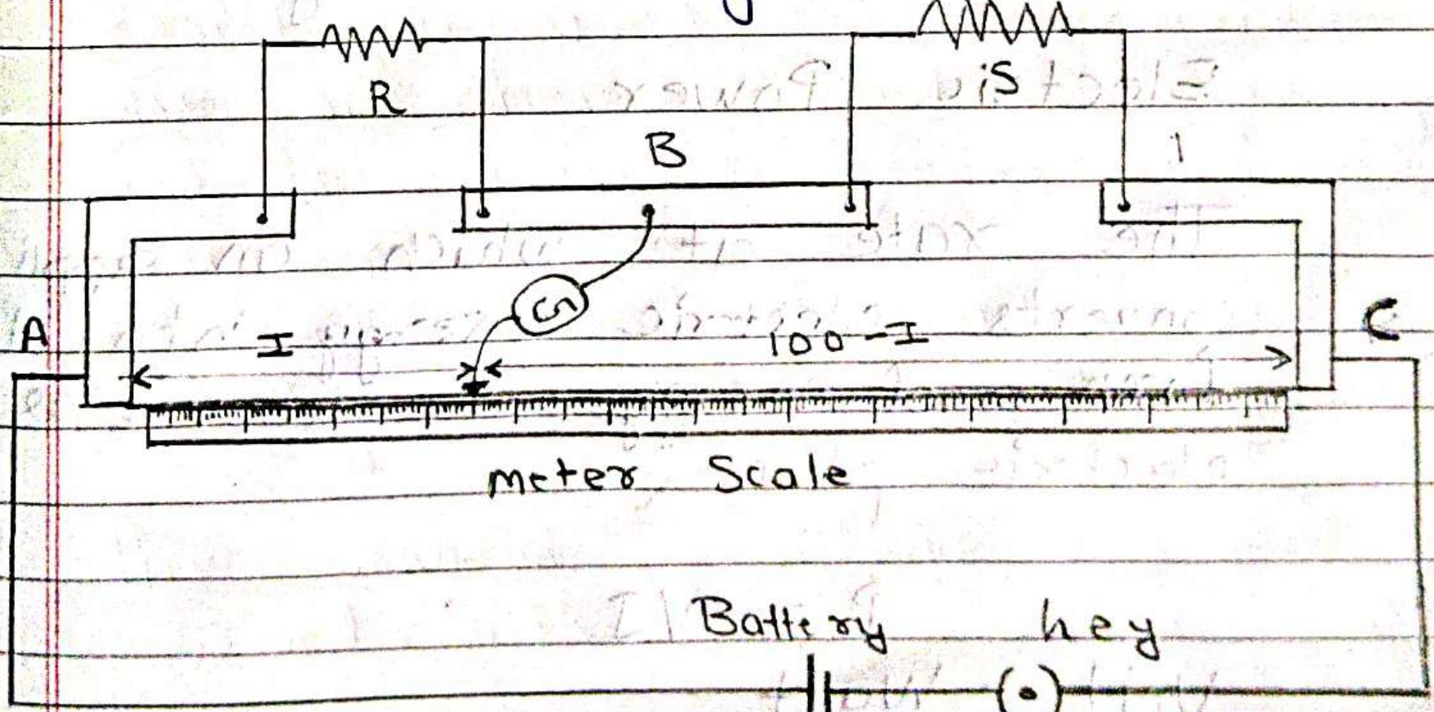
electrical device used to measure an unknown resistance. This method is based on principle of wheatstone bridge.

It consists of a wire streched along a scale with a sliding contact called jockey that moves along the wire. By adjusting the jockey until the galvanometer shows zero deflection, the unknown resistance can be determined using the ~~known~~ known resistances and the lengths of the wire segments.



Meter Bridge

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Heating effect of current

Whenever any electric current passes through a conductor the conductor becomes hot after some time and produces heat. This is called heating effect of electric current.

$$H = I^2 R t$$

Above law is also known as Joule law of heating.

Electric Power

The rate at which an appliance converts electric energy into other form of energy is known as electric power

$$P = VI$$

Unit - Watt

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Electric Energy

Electric energy is said to be one joule when one ampere of current flows through a circuit for one secon-d when the potential difference is one volt across it

$$E = QV$$

Unit - Joules
Board of Trade (BOT) = 3.6×10^6
1 kwh = 1 unit = 3.6×10^6 Joules

Advantages of Electrical Energy over other forms of energy.

1. Electrical energy can be easily converted into other forms of energy
2. Easily controllable through switches
3. Easily transported through wire
4. Efficient and Reliable.

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Unit - V
Electromagnetism

1. Diamagnetic materials:

Materials which are ~~[illegible]~~ weakly repelled by magnet. Do not retain magnetic properties when external field is removed.

Example: Antimony, Bismuth, copper, Gold, Silver, Quartz

2. Paramagnetic:

Materials which are weakly attracted by magnet. and do not retain magnetic properties when external field is removed.

Example: Aluminium, Chromium, Alkali Platinum

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3. Ferromagnetic :

Materials which are strongly attracted by a magnet and retain magnetic properties when external field is removed.

Example: Iron, Cobalt, Nickel

Magnetic field :

The magnetic field is a region around magnet in which the force of magnetism can be experienced.

Diagram

Unit: tesla

Magnetic Intensity :

Magnetic Intensity is a vector quantity that measures the strength of a magnetic field at a given point. It is represented by H.

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Unit: Ampere/meter (A/m)

Formula ⇒ $H = \frac{B}{\mu_0}$

Magnetic lines of force

Magnetic lines of force are imaginary lines that represent the direction of a magnetic field

Properties

1. Magnetic lines do not intersect each other.

2. They emerge from north pole

3. They merge at south pole.

4. Magnetic lines forms continuous closed loops.

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Magnetic flux

The number of magnetic field lines passing through unit area. Its unit is weber (Wb).

$$\phi = B A \cos\theta$$

ϕ = magnetic flux
B = magnetic field
A = Area

Electromagnetic Induction:

Electromagnetic Induction is the process where a changing magnetic field creates an electric current in a conductor. When a magnet moves near a coil of wire or the coil moves near a magnet electricity is generated in the wire.

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Faraday's law of Electromagnetic Induction

First law: When the magnetic field around a conductor changes. It induces EMF in the conductor. This happens if the conductor is part of a closed circuit. ~~causing~~

Second law: The amount of induced EMF is directly proportional to the rate of change of the magnetic field through the conductor.

$$\varepsilon = -N \frac{\Delta \phi}{\Delta t}$$

ε = induced voltage
N = Number of loops
$\Delta \phi$ = change in magnetic flux
Δt = change in time

Lorentz force

Lorentz force is defined as the combination of the magnetic and electric force on a point charge due to electromagnetic fields

$$F = q(E + v \times B)$$

where (Optional)

F is Force acting on a particle
q is electric charge of the particle
v is velocity
E is external field
B is magnetic field

Moving Coil Galvanometer

A moving coil galvanometer is an instrument used to detect and measure small electric currents. It operates on the principle of electromagnetic induction, where a current-carrying coil experiences a torque in a magnetic field.

Principle

The principle behind a moving coil galvanometer is based on the fact that when a current flows through a coil placed in a magnetic field, it experiences a torque proportional to the current. This torque causes the coil to rotate and the rotation is measured to determine the current.

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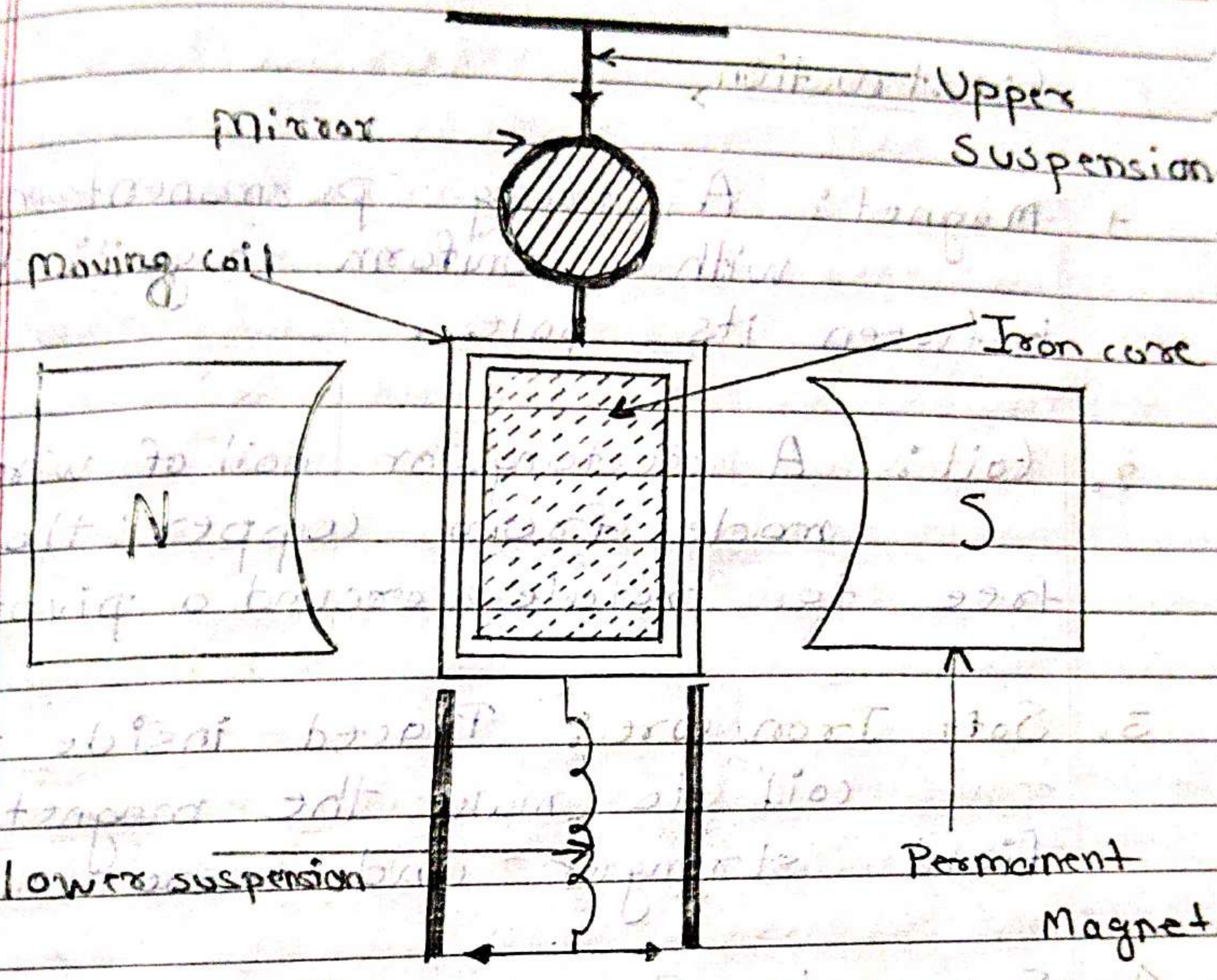

Moving Coil Galvanometer

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Construction

1. Magnet: A strong permanent magnet with a uniform magnetic field between its poles.

2. Coil: A rectangular coil of wire made from copper that is free to rotate around a pivot.

3. Soft Iron core: Placed inside the coil to make the magnetic field stronger and more uniform.

4. Suspension System: The coil is suspended by a fine phosphor - bronze strip or filament which also serves as one electrical connection to the coil. The bottom end of the coil is connected to a hair spring which provides the restoring torque and the other electrical connection.

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5. Pointer: Attached to the coil to indicate the deflection on a calibrated scale.

6. Scale: Graduated in units of current (amperes, miliamperes) or charge (coulombs).

Working

1. Current Flow: When an electric current flows through the coil it creates a magnetic field around it.

2. Torque Generation: The interaction between the magnetic field of the coil and the magnetic field of the permanent magnet generates a torque on the coil.

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3. Deflection: This torque causes the coil to rotate. The angle of rotation is proportional to the current flowing through the coil.

4. Restoring Force: The hair spring attached to the coil provides a restoring torque that opposes the rotation. The equilibrium position (where the restoring torque equals the magnetic torque) determines the coil deflection.

5. Measurment: The pointer attached to the coil moves over a calibrated scale indicating the currents' magnitude.

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Mathematical Expression

$$\theta = \frac{nBIA}{k}$$

where

θ = deflection
n = number of turns in coil
B = magnetic flux density
I = current through the coil
A = Area of coil

Conversion of Galvanometer into Ammeter and Voltmeter

A galvanometer can be converted into an ammeter or voltmeter by adding a resistor in either series or parallel.

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Ammeter

To convert a galvanometer into an ammeter connect a low resistance resistor called a shunt resistor in parallel to the galvanometer. The shunt resistance carries most of the current allowing the right amount of current to pass through the galvanometer.

Voltmeter

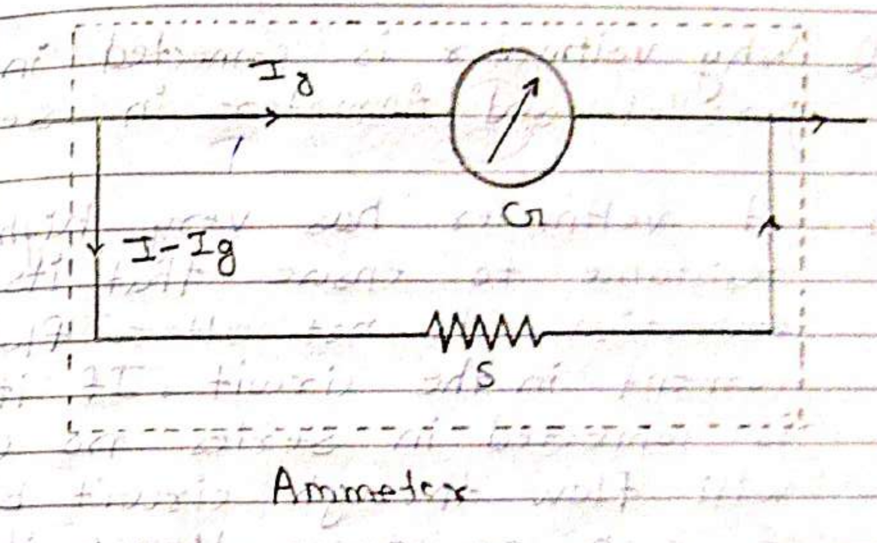
To convert a galvanometer into a voltmeter connect the galvanometer in series with a high resistance resistor. This increases the overall resistance of the device which is necessary for a voltmeter.

Ammeter

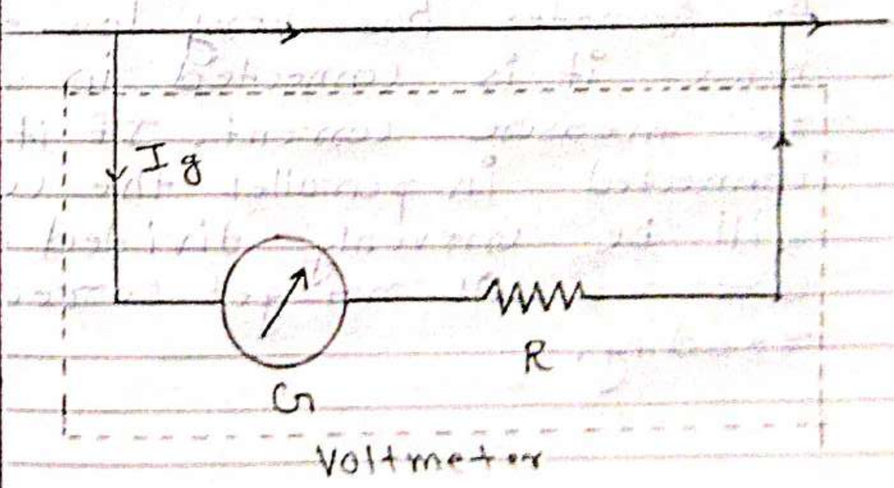
To convert a galvanometer into an ammeter connect a low resistance resistor called a shunt resistor in parallel to the galvanometer. The shunt resistance carries most of the current allowing the right amount of current to pass through the galvanometer.

Voltmeter

To convert a galvanometer into a voltmeter connect the galvanometer resistance in series with a high resistance resistor. This increases the overall resistance of the device which is necessary for a voltmeter.



Conversion of Galvanometer into Ammeter



Conversion of Galvanometer into Voltmeter

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Q Why voltmeter is connected in parallel and Ammeter in series?

Ans A voltmeter has very high resistance to ensure that its connection do not alter flow of current in the circuit. If it is connected in series no current will flow through circuit because of high resistance. Hence it is connected in parallel.

An Ammeter has very low resistance hence it is connected in series to measure current. If it is connected in parallel the current will be unevenly divided and ~~corre~~ we will not get correct reading.