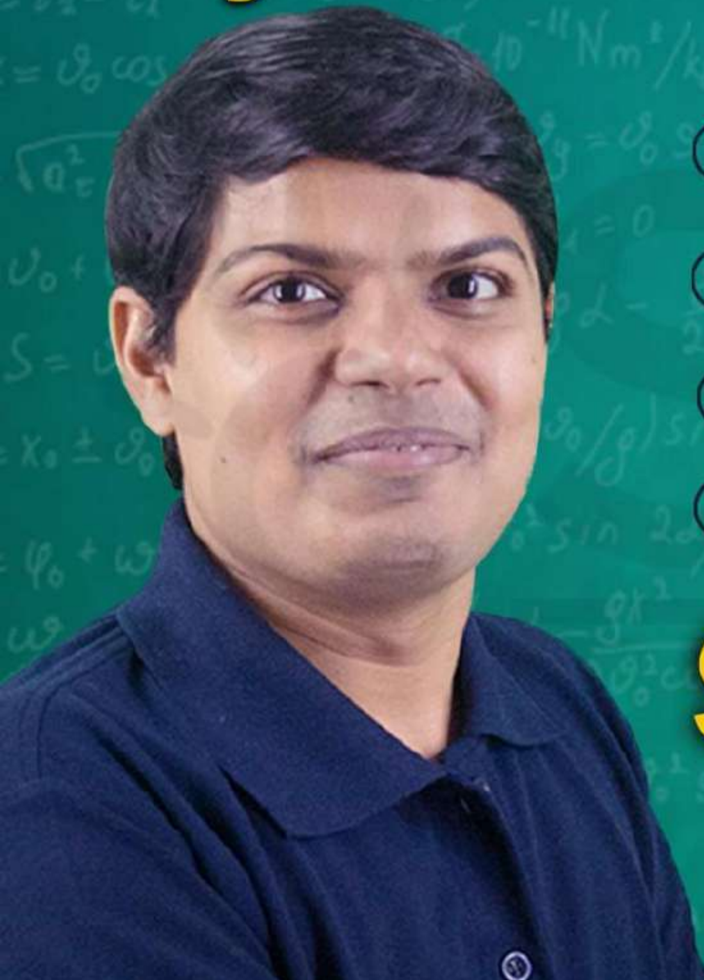
Physics Mega Revision #5



- Ray Optics
- EM Waves
- Wave Optics
- Optical Instruments
- Errors

Superfast Revision

🔥 Welcome Students 🔥

Complete Physics Mega Revision Timetable

15 Feb
- Electrostatics
- Current electricity
- Capacitor
- 🎁 Surprise Gift 🎁

16 Feb
- Calorimetry
- Elasticity
- Thermal Expansion
- Heat Transfer
- KTG
- Thermodynamics
- Fluid Mechanics

17 Feb
- Magnetic effect of current
- Magnetism and matter
- Emi
- AC

18 Feb
- UD
- Vector
- Kinematics 1D
- Kinematics 2D
- NLM
- Friction
- Circular motion
- Work power energy
- COM

19 Feb
- Ray optics
- Optical Instruments
- Wave optics
- EM Waves
- Errors in measurement

20 Feb
- Rotation motion
- Gravitation
- SHM
- Wave on string
- Sound wave

21 Feb
- Atomic structure
- Dual nature of radiation
- X-rays
- Nuclear physics
- Radioactivity
- Semi conductor
- Communication system

Faculty of the Series

Saransh Gupta Sir

eSaral Physics HoD

- **IIT Bombay**, CS
- **AIR-41** IIT-JEE
- **Air-71** AIEEE (JEE Main)
- **AIR-4** NSO
- **1%** In Top INPHO
- **8+** Years of Teaching Experience
- **Mentored** Lakhs of Students

Master Planners & Faculties

Prateek Gupta Sir
eSaral Chemistry Faculty

- **IIT Bombay,** Metallurgy
- **Online** Creativity & Visualization Expert
- **Mentored** Lakhs of Students

Master Planners & Faculties

N.K. Gupta Sir

eSaral Math Faculty & Master Planner

- **IIT Kanpur**, Mechanical
- Ex **Vice President & Academic Head**, Allen, Kota
- Mentored many of **Rank 1** & **Top 100** Students
- **30+ years** of Teaching Experience
- **Mentored** over 3,00,000 Students

Master Planners & Faculties

Dr. Anshuman Agarwal

eSaral Biology Faculty

- **MBBS, MD, FIPM**
- **AIR-196**, AIPMT(NEET)
- **ARR-46**, RPMT
- **NTSE Scholar**
- **Ex HoD Biology**, Resonance, Kota
- **10+ years** of Teaching Experience
- **Mentored** over thousands of doctors

Master Planners & Faculties

Dr. Kushika Taneja
eSaral Biology Faculty

- **Ex-HoD Biology,** Pace IIT and Medical, Indore
- Biology faculty at Rao Academy, Kota
- **7+ years** of Teaching Experience
- **Mentored** over thousands of doctors

★ Today's Session Highlights ★

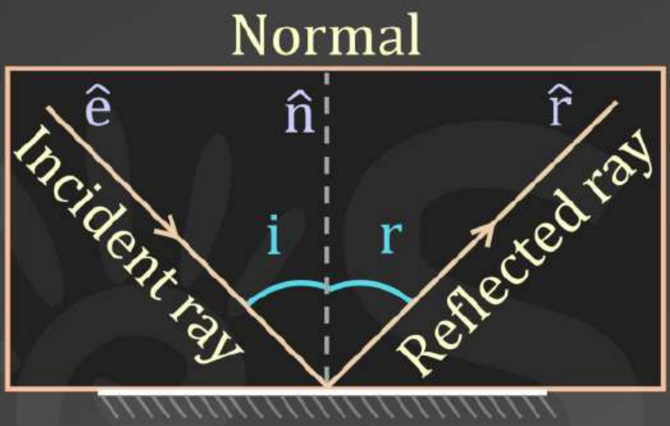
- Admit Card Information
- Frequently Asked Topics of Each Chapter
- Quiz after each Topic

Will a Donkey look like Zebra if Strips are put in front of Camera ?

NO. Donkey will be a Donkey but with less intensity.

Ray Optics
Superfast Revision

Laws of Reflection



Incident ray, reflected ray and normal lies in the same plane.

$$[\hat{e}\ \hat{r}\ \hat{n}] = 0$$

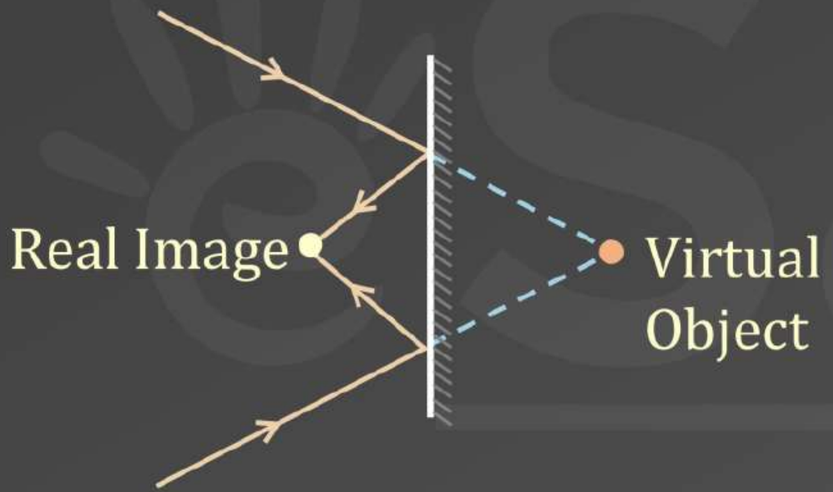
$$[\hat{e} \times \hat{r}] \cdot \hat{n} = 0$$

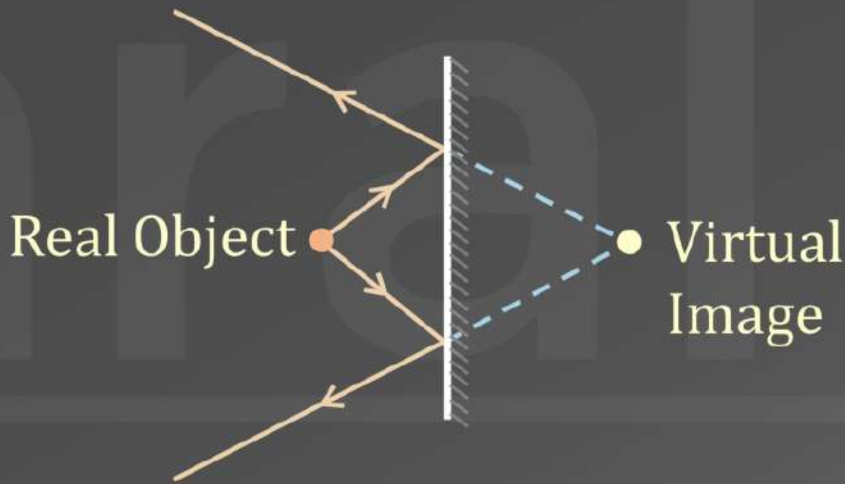
The angle of reflection is equal to the angle of incidence

$$\angle i = \angle r$$

Properties of Image Formed by a Plane Mirror

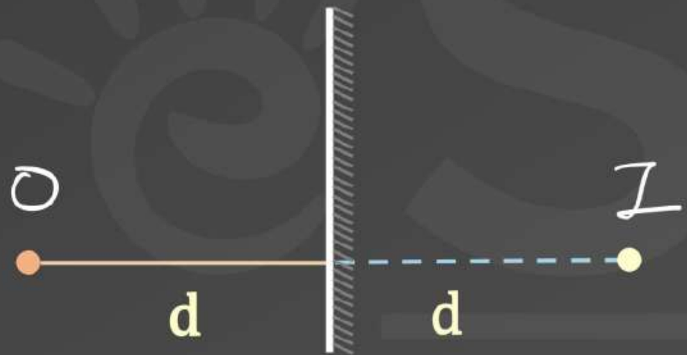
1. It forms Real Image of Virtual Object and Virtual Image of Real Object.





Properties of Image Formed by a Plane Mirror

2. The distance of object from mirror is equal to the distance of image from the mirror.

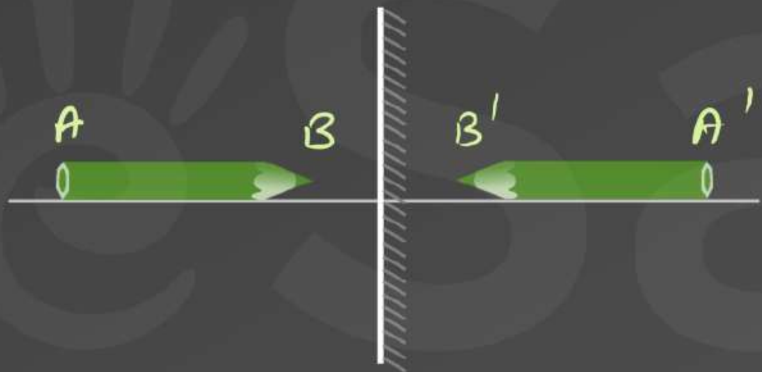


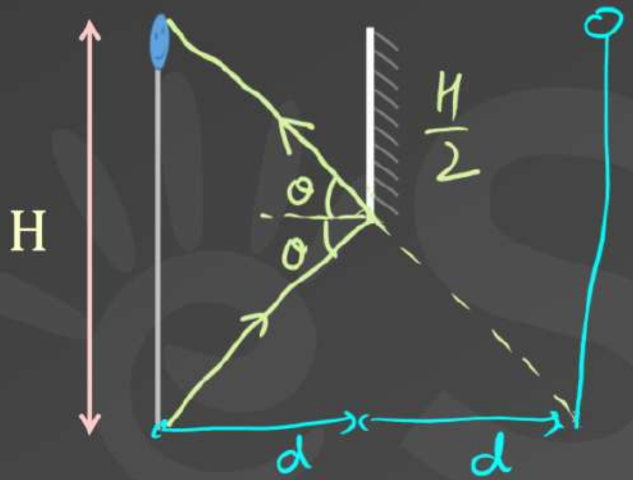
3. The size of the image is same as that of the object.

$$h_i = h_o$$

Properties of Image Formed by a Plane Mirror

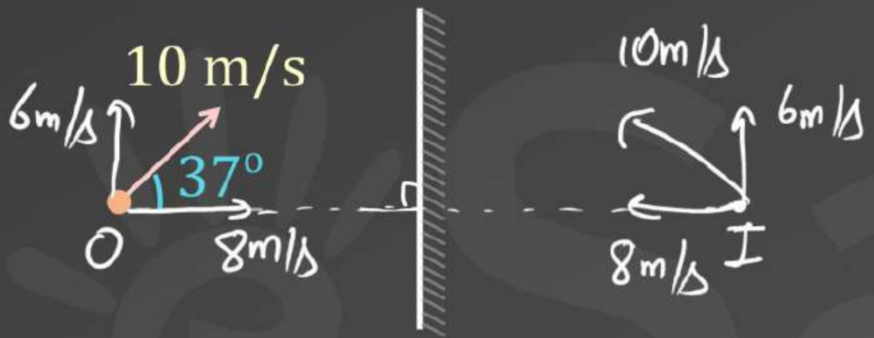
4. Image formed by Plane mirror is side-ways inverted.





Minimum size of a plane mirror required to see the full image of an observer is half the size of that observer.

Velocity of Image



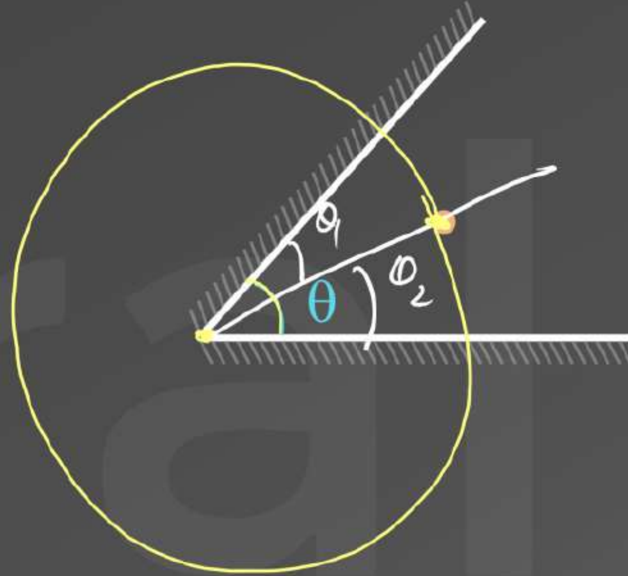
$$(\vec{V}_O)_{\parallel} = (\vec{V}_I)_{\parallel}$$

$$(\vec{V}_{O/M})_{\perp} = -(\vec{V}_{I/M})_{\perp}$$

Mirrors at an Angle

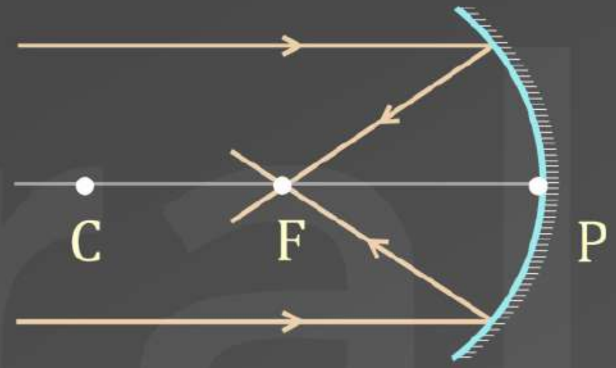
$$\frac{360}{\theta} = N = 8 \qquad \theta = 45^\circ$$

Condition	No. of Images
If N = Even Integer	N − 1
If N = Odd Integer 1. If object is on angle Bisector 2. If Not	 N − 1 N
If N ≠ Integer ××	Count Manually



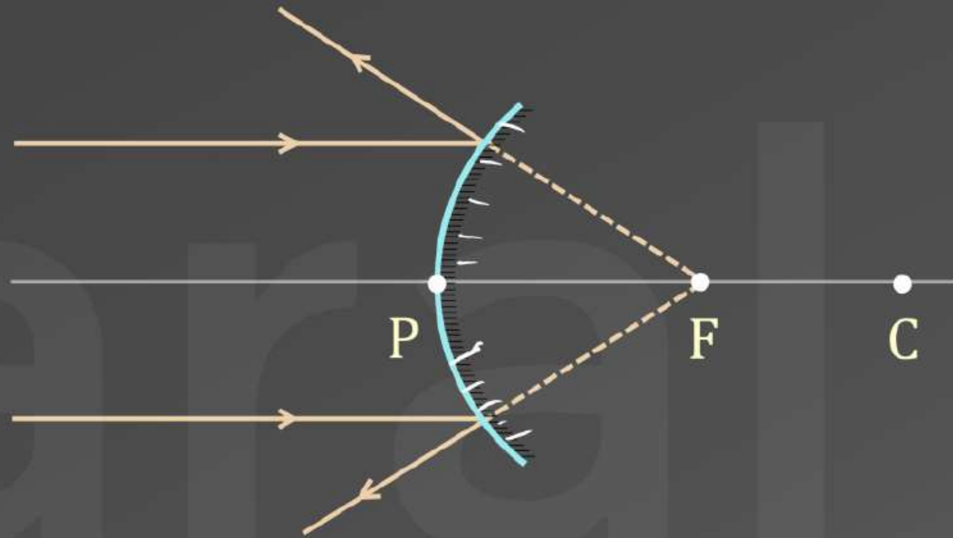
Focus and Focal Length of a Mirror

When a paraxial light beam parallel to the principle axis is incident on a mirror the reflected rays are converged at a point F on the principle axis of a concave mirror.



Focus and Focal Length of a Mirror

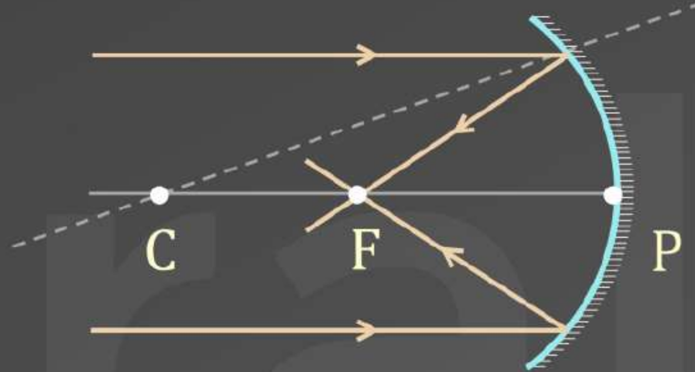
For convex mirror reflected rays appear to diverge from a point F on principle axis. The point F is called principal focus of the mirror.



Focal Length

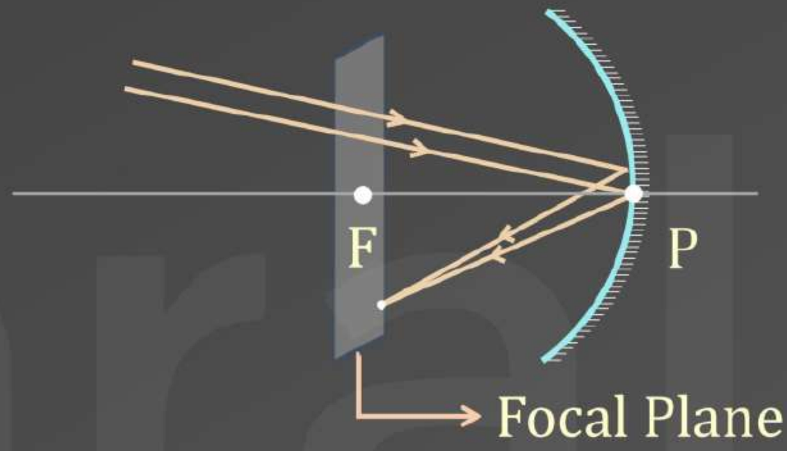
Focal length is the distance of focus from the pole.

$$f = \frac{R}{2}$$



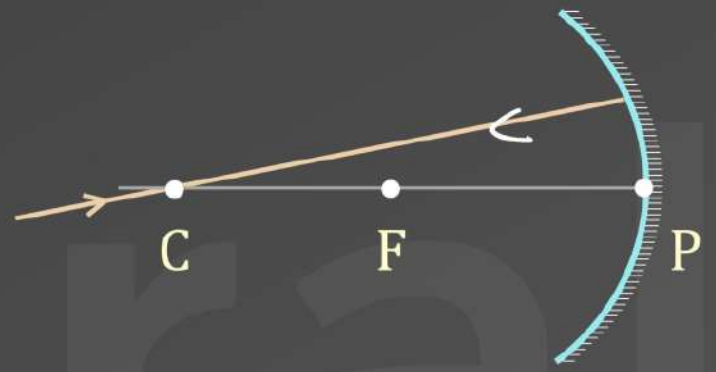
Rare

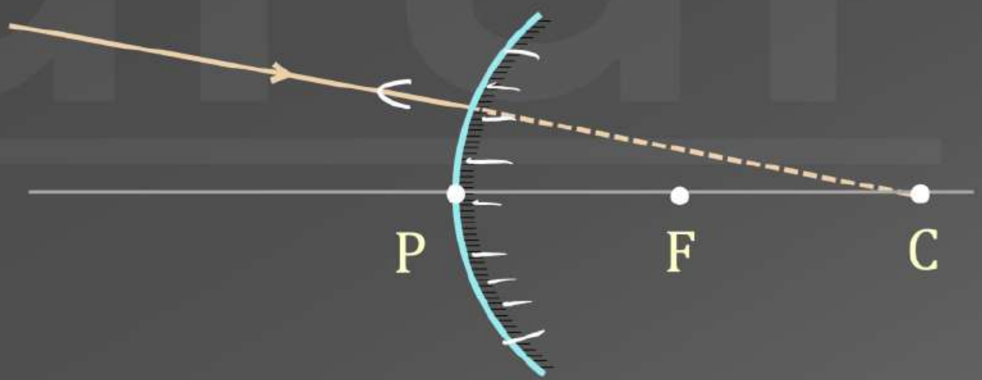
Focal Plane is the plane passing through focus and perpendicular to principal axis.



Ray Tracing Diagram

A ray passing through or directed towards centre of curvature, after reflection from the mirror, retraces its path.

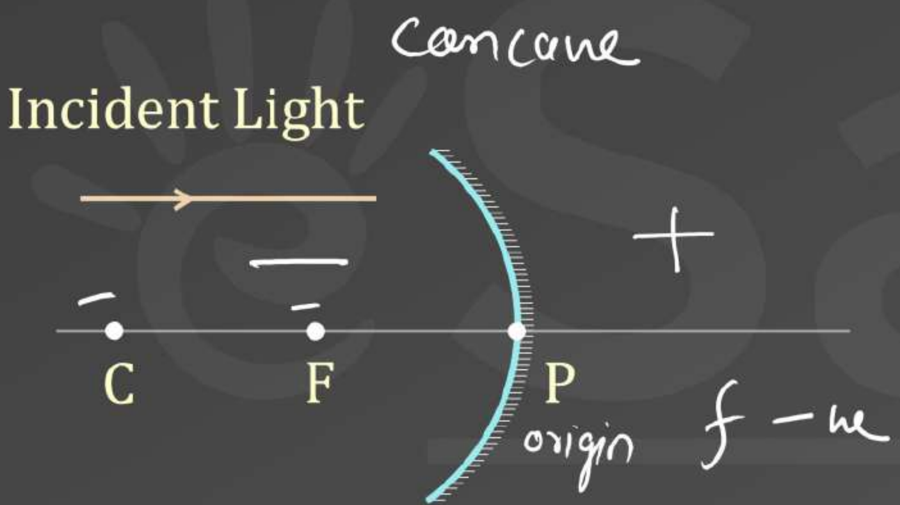




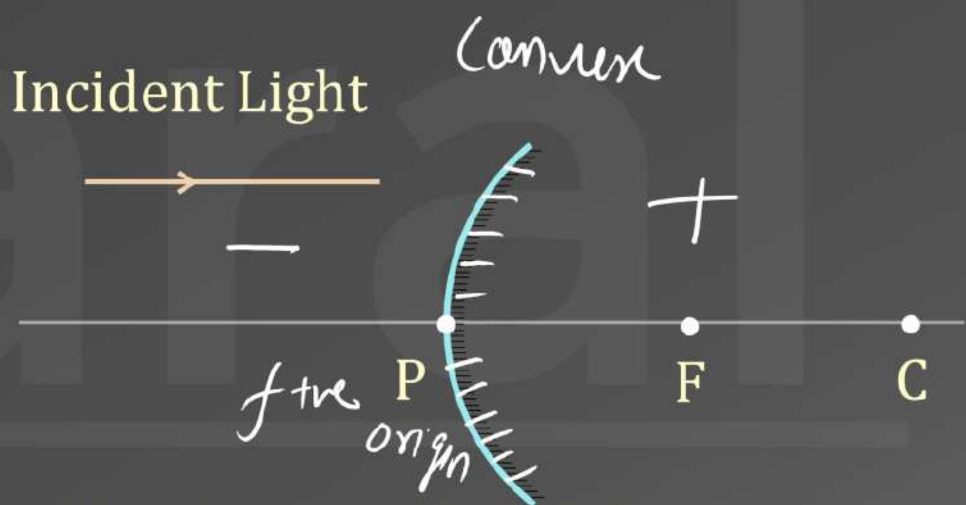
Sign–Convention

Along principal axis, distances are measured from the pole.

Direction of incident light is taken as positive.



Coordinates of C and F are −ve



Coordinates of F and C are +ve

Mirror Equation

TRICK

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

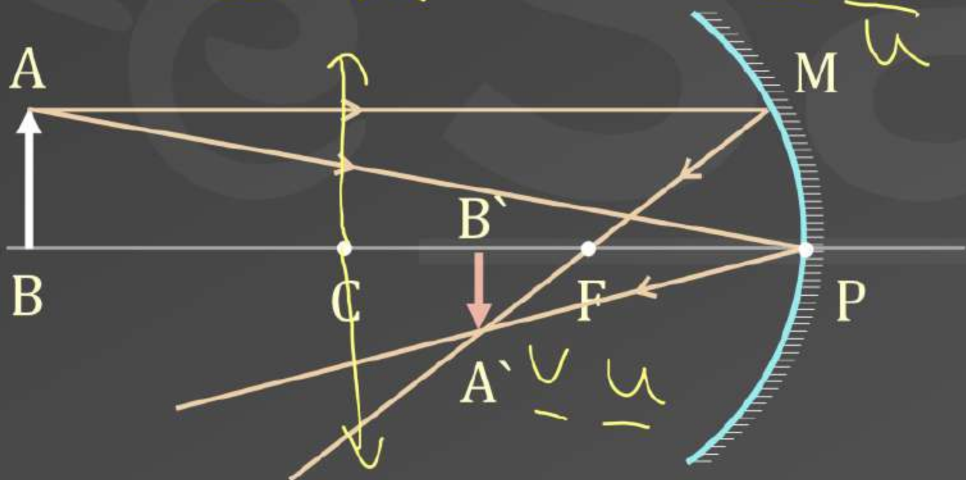
'u' : coordinate of object

'v' : coordinate of image

'f' : coordinate of focus

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

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



Linear magnification
(Transverse magnification)

$$m=\frac{\text{height of image}}{\text{height of object}}=\frac{h_i}{h_o}$$

(hi and ho are put with sign)

Magnification

$$m = \frac{h_i}{h_o}$$

Magnification	Image
$\lvert m \rvert > 1$	Enlarged
$m < 0$ (-ve)	Inverted
$\lvert m \rvert < 1$	Diminished
$m > 0$	Erect

-2

Inv, Enlarged

$+\frac{1}{2}$

Erect, Dim

Net Magnification

$$m_{net} = \frac{h_{I-final}}{h_{object}}$$

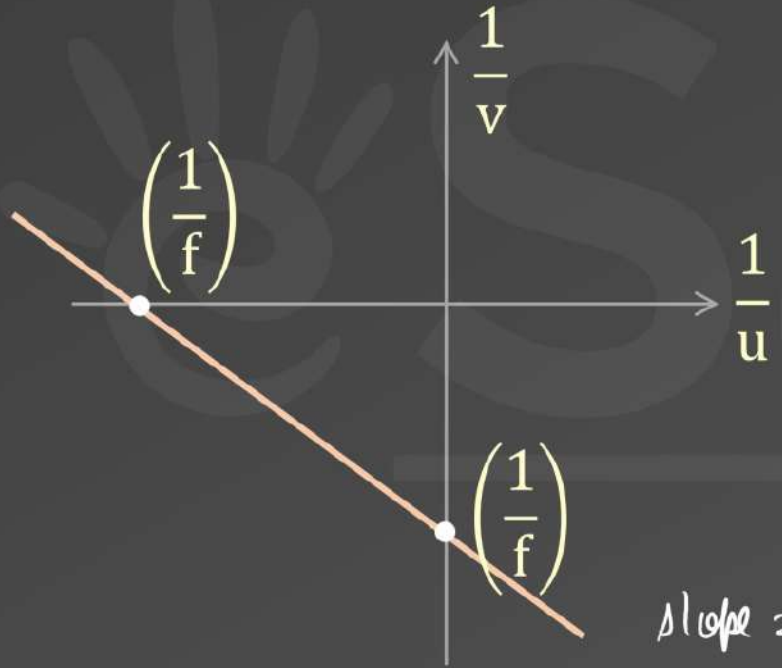
$$m_{net} = m_1 \times m_2 \times m_3 \times \ldots$$

$$m_{net} = \frac{h_{I_1}}{h_0} \times \frac{h_{I_2}}{h_{I_1}} \times \frac{h_{I_3}}{h_{I_2}} \times \ldots = \frac{h_{I-final}}{h_0}$$

TRICK

Graphs

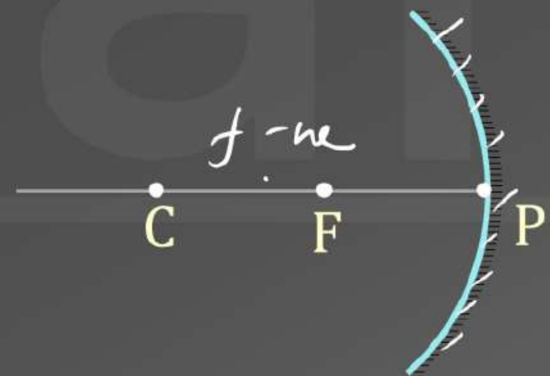
$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{v}=-\frac{1}{u}+\frac{1}{f}$$ f −ve



slope = −1

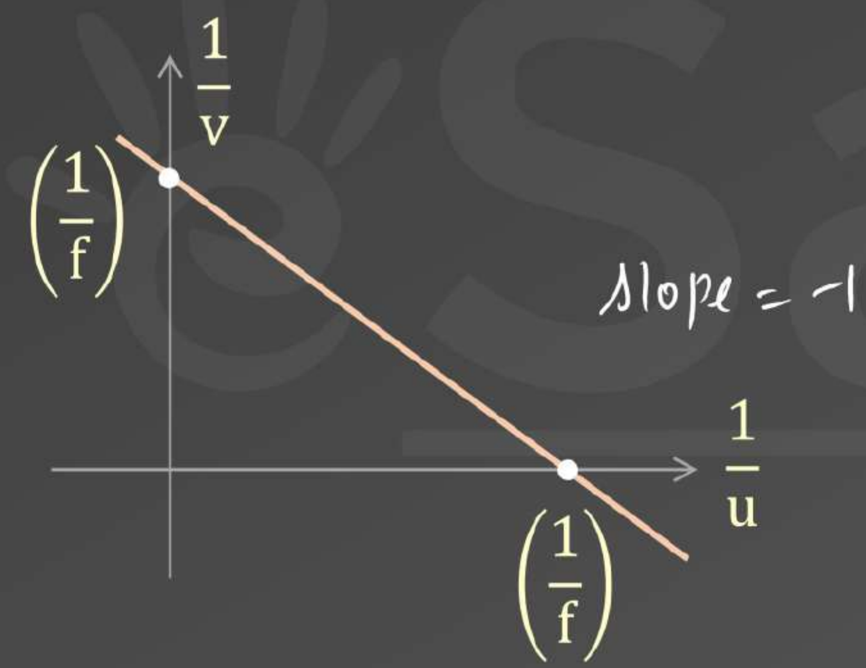
$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

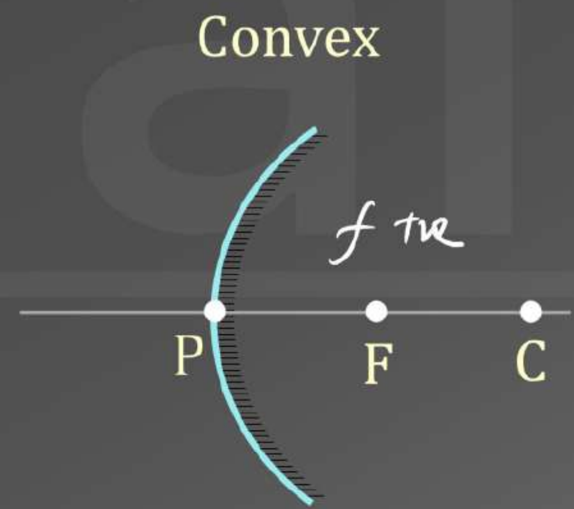
Concave



Graphs

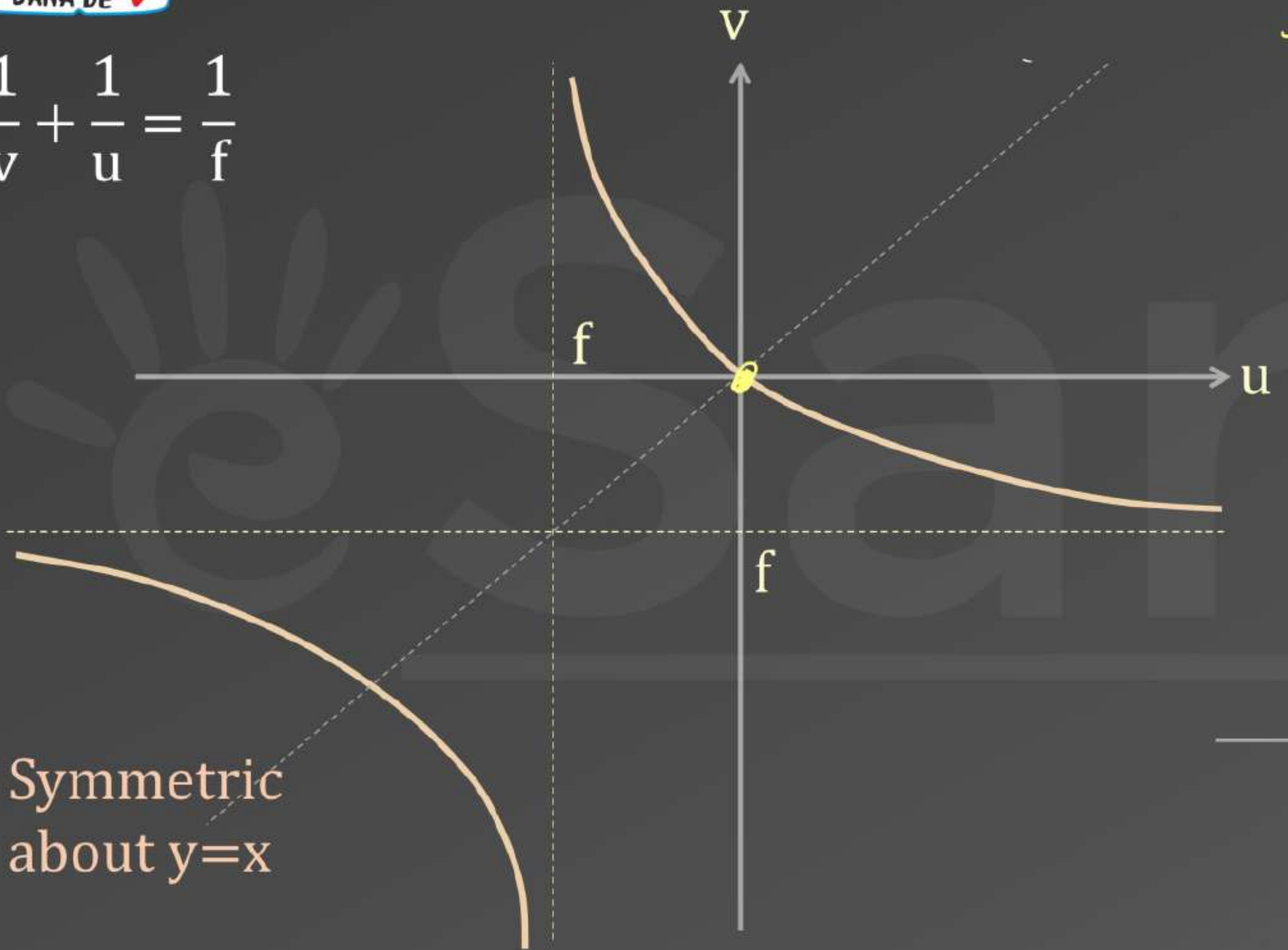
$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f} \quad \Rightarrow \frac{1}{v}=-\frac{1}{u}+\frac{1}{f}$$





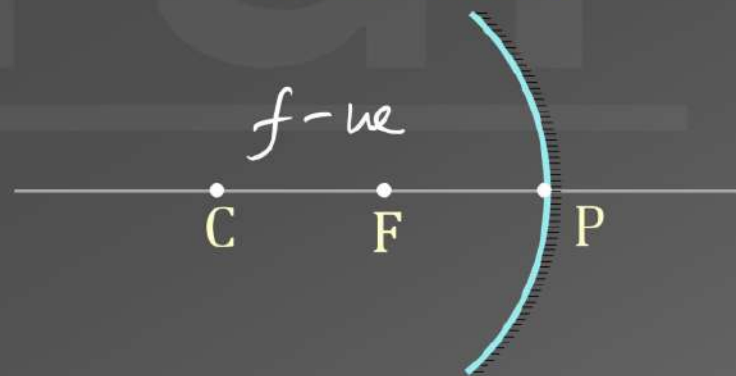
Graphs

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



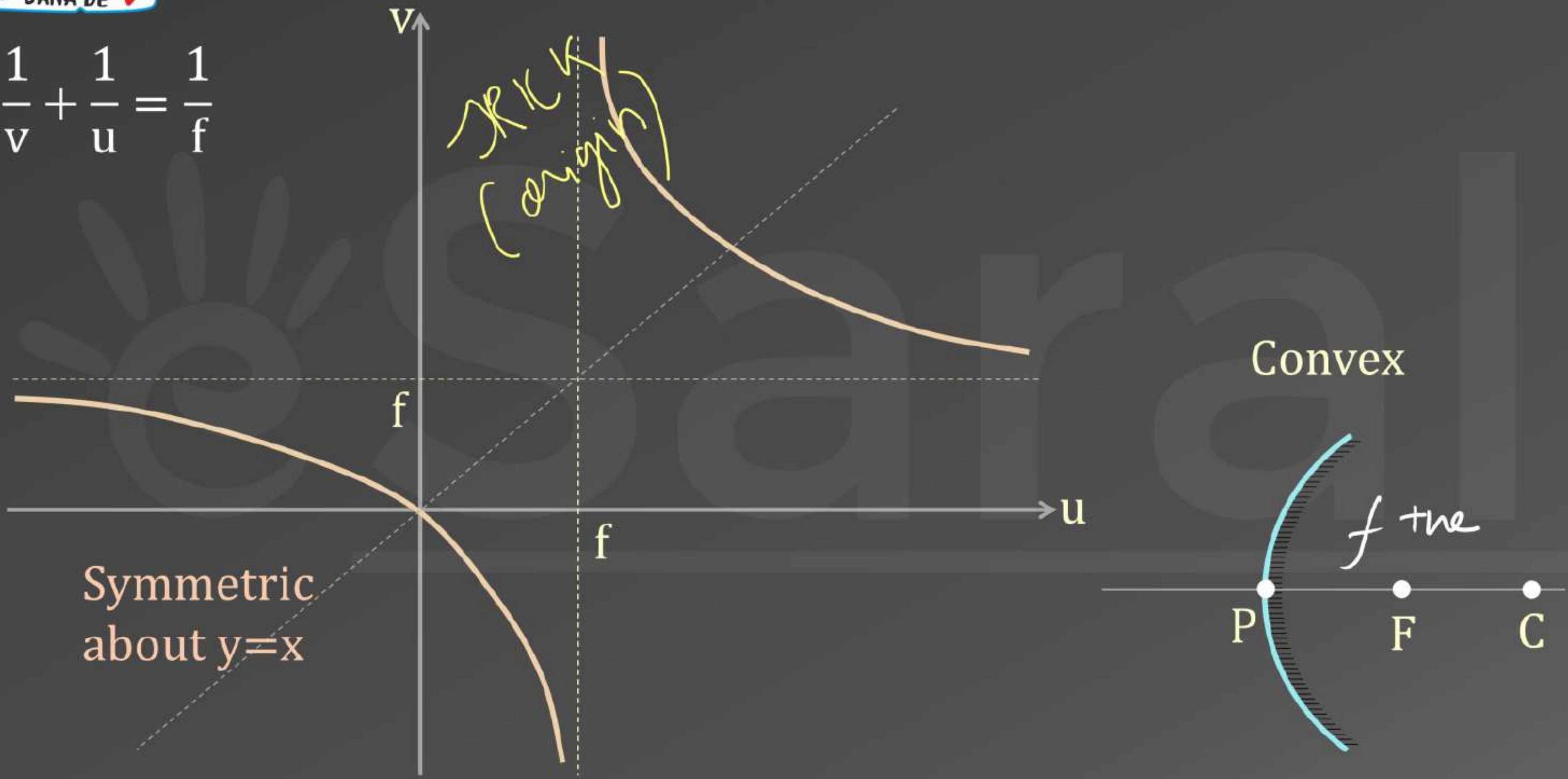
f -ve

Concave



Graphs

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



Newton's Formula

from F

+ve

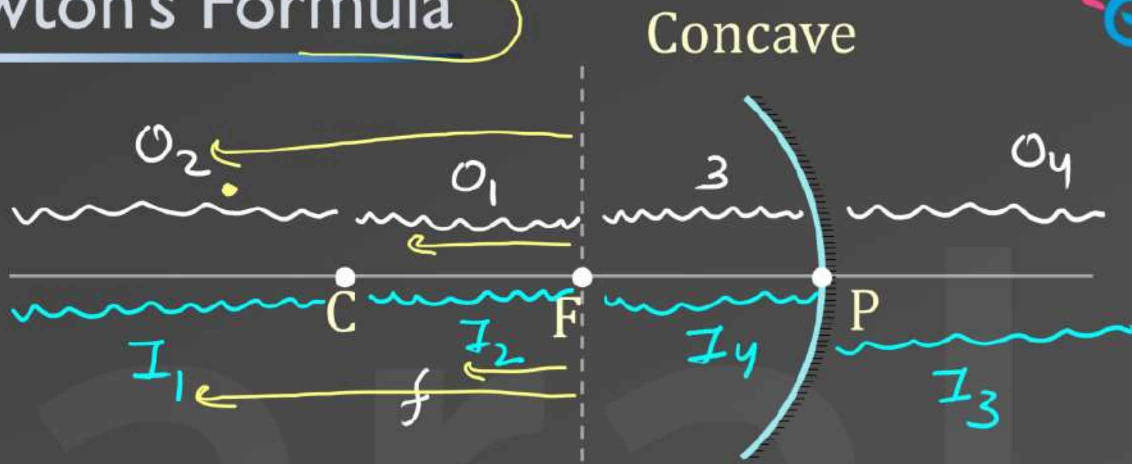
$x_i x_o = f^2$

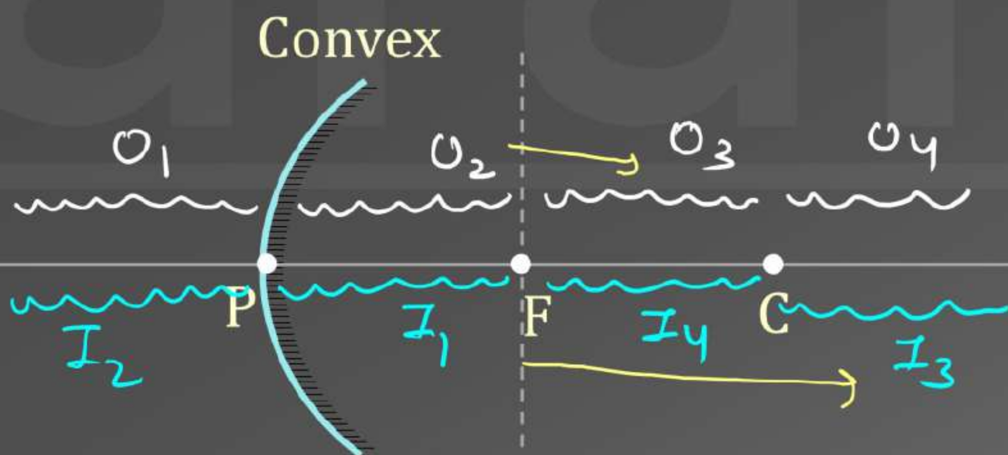
same sign

$x_O x_I = f^2$ +ve

$|x_o| < f$

$|x_I| > f$

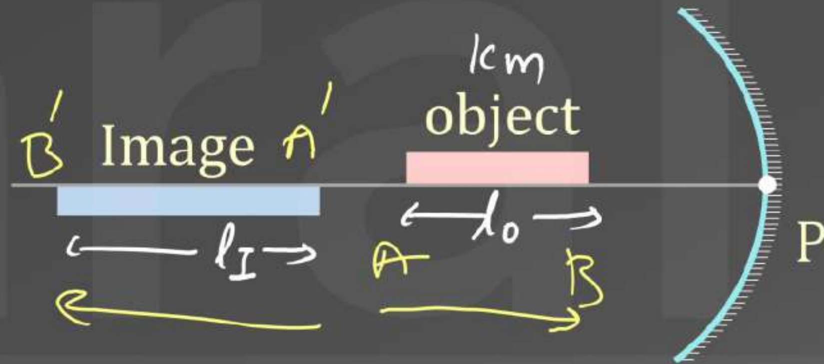




Longitudinal Magnification

$$LM = \frac{\text{Length of image along PA}}{\text{Length of object along PA}}$$

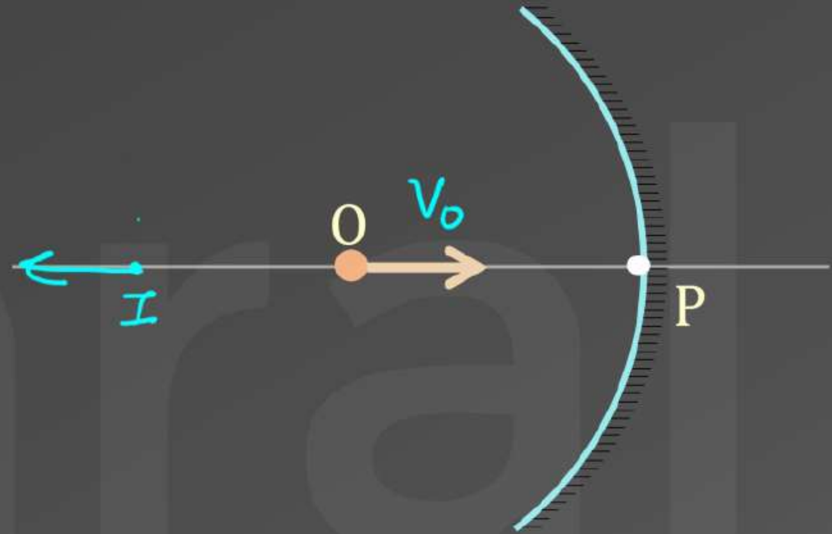
$LM = -m^2$ where m is (TM) $= \frac{l_I}{l_0}$

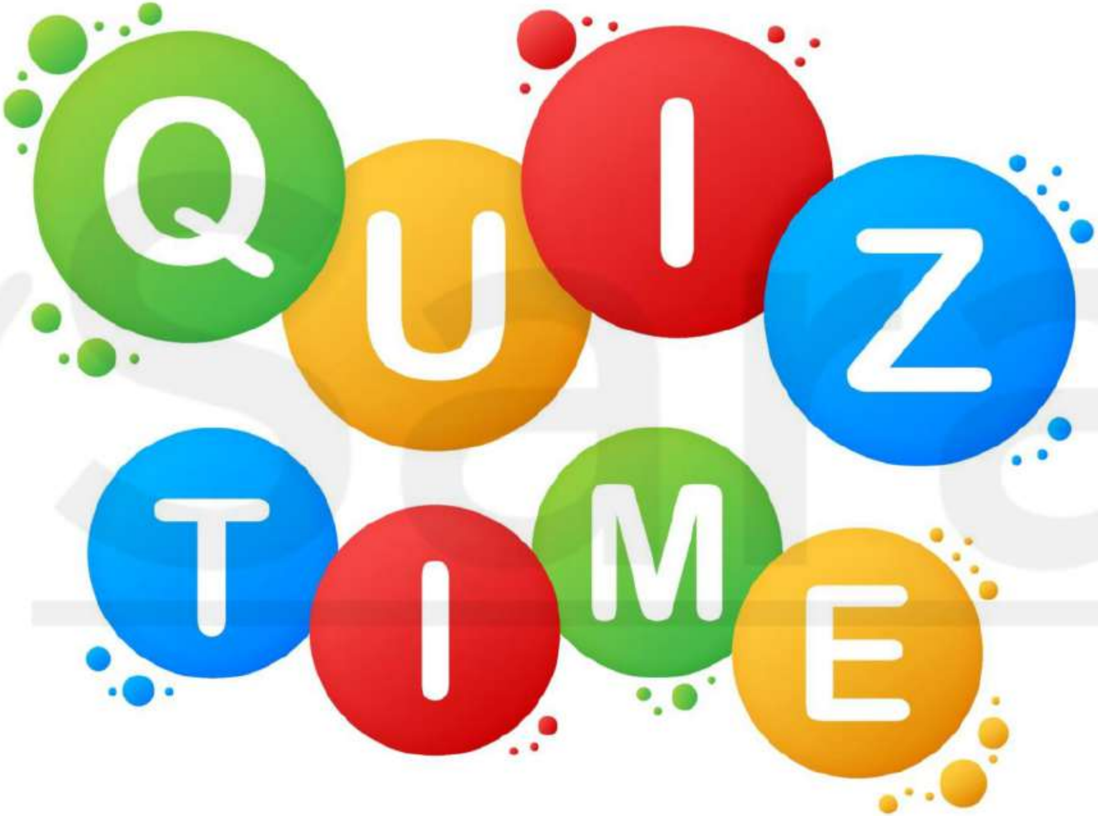


Velocity of Image of Moving Object (Spherical mirror)

Along PA

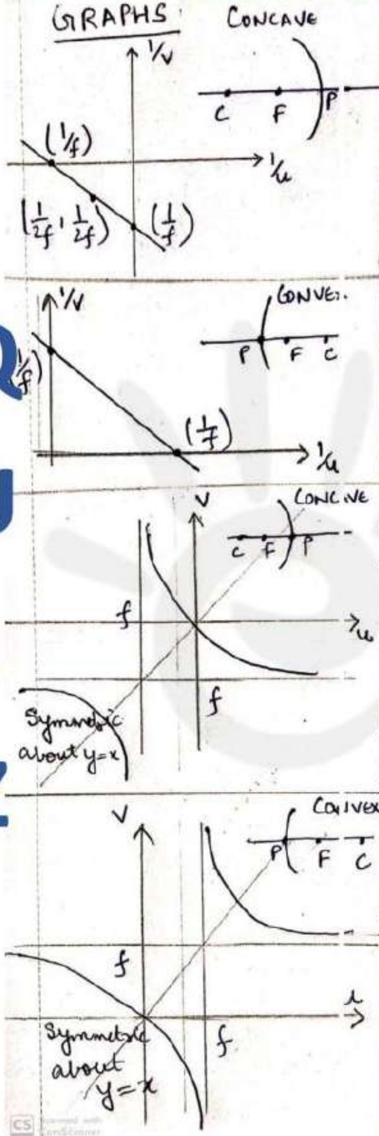
$$\vec{V}_I = -m^2\,\vec{V}_o$$




QUIZ
TIME

REFLECTION

GRAPHS

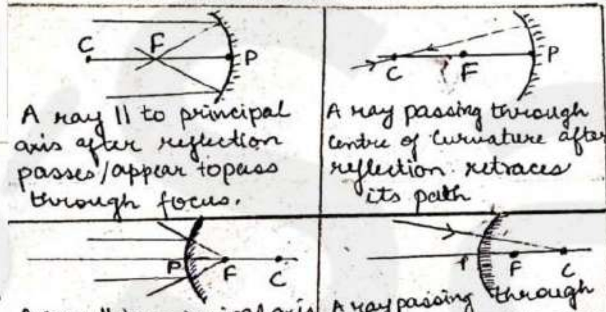


MIRRORS AT AN ANGLE

$N = 360/\theta$

CONDITION	NO. OF IMAGES
If N = EVEN Integer	N − 1
If N = ODD Integer 1. Object on ∠ Bisector 2. If Not	1
If N ≠ Integer	Count Manually

RAY TRACING DAIGRAM



A ray ∥ to principal axis after reflection passes/appear to pass through focus.

A ray passing through centre of curvature after reflection retraces its path.

A ray ∥ to principal axis after reflection passes through focus

A ray passing through Centre of Curvature after reflection retraces its path

MAGNIFICATION

3

LINEAR Magnification

$m = \dfrac{\text{ht. of Image}}{\text{ht. of Object}} = \dfrac{h_i}{h_o}$

(h_i & h_o with Sign.)

$|m| > 1 \rightarrow$ Enlarged

$|m| < 1 \rightarrow$ Diminished

$m < 0 \rightarrow$ Inverted; $m > 0 \rightarrow$ Erect

NET MAGNIFICATION

$m_{net} = \dfrac{h_{I\text{-final}}}{h_{object}}$

$m_{net} = m_1 \times m_2 \times m_3 \times \ldots$

$m_{net} = \dfrac{h_{I_1}}{h_o} \times \dfrac{h_{I_2}}{h_{I_1}} \times \dfrac{h_{I_3}}{h_{I_2}} \times \ldots$

$= \dfrac{h_{I\text{-final}}}{h_o}$

Min size of a plane mirror required to see the full image of an observer is half the size of that observer

FOCAL LENGTH

5

Distance of focus from Pole

MIRROR Equation

2

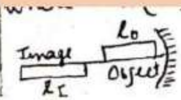
U → Coordinate of Object

V → Coordinate of Image

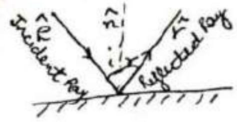
f → focus Coord^n.

LONGITUDINAL Magnification

4



LAWS OF REFLECTION



1. $[\hat{e}\ \hat{r}\ \hat{n}] = 0$

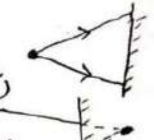
   $[\hat{e} \times \hat{r}] \cdot \hat{n} = 0$

2. $\angle i = \angle r$

OBJECT

→ Real (Intersection of Diverging Rays)

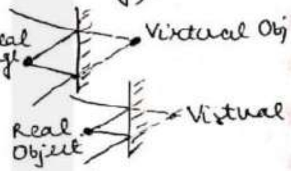
→ Virtual (Intersection of Converging Incident Ray)



IMAGE

→ Real

→ Virtual



PROPERTIES OF IMAGE FORMED BY PLANE MIRROR

1. It Forms (i) Real Image of Virtual Object
   (ii) Virtual Image of Real Object
2. Distance of Object from mirror = Distance of image from the mirror
3. Size of Image = Size of Object ($h_i = h_o$)
4. Image formed is SIDE-WAYS INVERTED.

VELOCITY OF Image

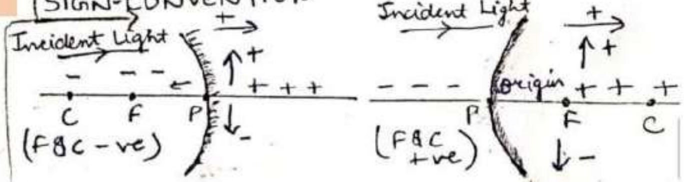
$(\vec{V}_o)_{\parallel} = (\vec{V}_I)_{\parallel}$

$(\vec{V}_{o/m})_{\perp} = -(\vec{V}_{I/m})_{\perp}$

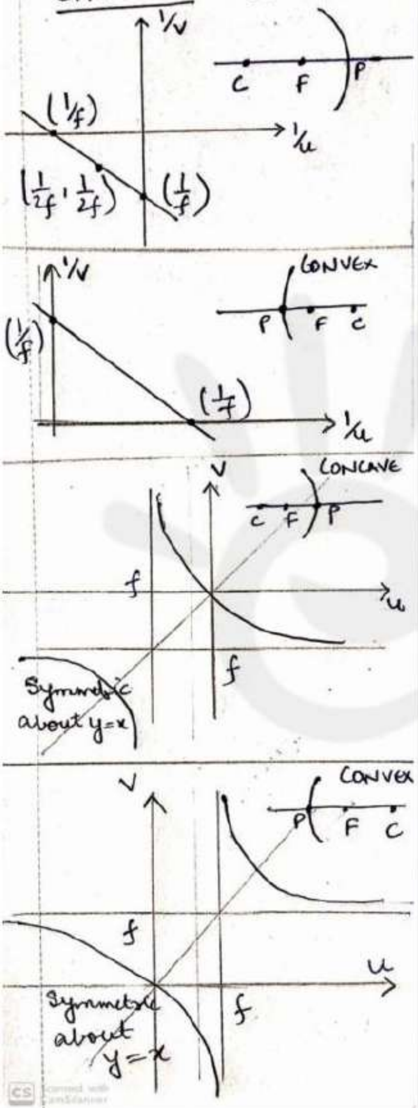
VELOCITY OF Image of Moving Object (Sph. Mirror)

$\vec{V}_I = -m^2 \vec{V}_o$

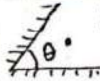
SIGN-CONVENTION



GRAPHS



MIRRORS AT AN ANGLE



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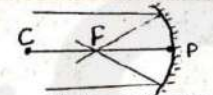
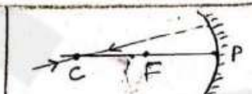
RAY TRACING DAIGRAM

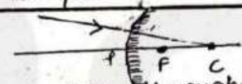


A ray ∥ to principal axis after reflection passes/appear to pass through focus.



A ray passing through centre of curvature after reflection retraces its path

A ray ∥ to principal axis after reflection passes through focus



A ray passing through centre of curvature after reflection retraces its path

MAGNIFICATION

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

LINEAR Magnification

$m = \frac{\text{ht. of Image}}{\text{ht. of Object}} = \frac{h_i}{h_o}$

(h_i & h_o with sign.)

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NET MAGNIFICATION

$m_{net} = \frac{h_{I\text{-}final}}{h_{object}}$

$m_{net} = m_1 \times m_2 \times m_3 \times \ldots$

$m_{net} = \frac{h_{I_1}}{h_o} \times \frac{h_{I_2}}{h_{I_1}} \times \frac{h_{I_3}}{h_{I_2}} \times \ldots$

$= \frac{h_{I\text{-}final}}{h_o}$

Min. size of a plane mirror required to see the full image of an observer is half the size of that observer

FOCAL LENGTH

$f = R/2$

Distance of focus from Pole

REFLECTION

MIRROR Equation

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

$u \rightarrow$ Coordinate of Object

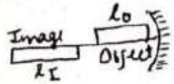
$v \rightarrow$ Coordinate of Image

$f \rightarrow$ focus coord^n.

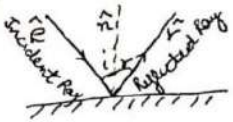
LONGITUDINAL Magnification

$LM = -m^2 = \frac{l_I}{l_o}$

where m is (TM)



LAWS OF REFLECTION



1. $[\hat{e}\ \hat{r}\ \hat{n}] = 0$

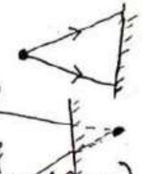
   $[\hat{e} \times \hat{r}] \cdot \hat{n} = 0$

2. $\angle i = \angle r$

OBJECT

→ Real (Intersection of Diverging Rays)

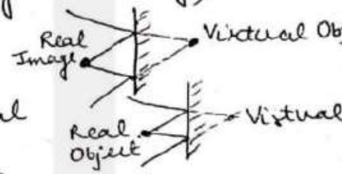
→ Virtual (Intersection of Converging Incident Ray)



IMAGE

→ Real

→ Virtual



PROPERTIES OF IMAGE FORMED BY PLANE MIRROR

1. It forms (i) Real Image of Virtual Object
   (ii) Virtual Image of Real Object
2. Distance of Object from mirror = Distance of image from the mirror
3. Size of Image = Size of Object ($h_i = h_o$)
4. Image formed is SIDE-WAYS INVERTED.

VELOCITY OF Image

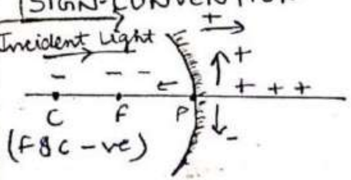
$(\vec{V}_o)_{\parallel} = (\vec{V}_I)_{\parallel}$

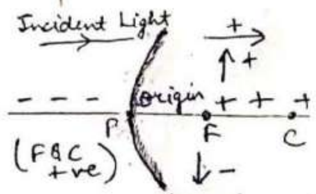
$(\vec{V}_{o/m})_{\perp} = -(\vec{V}_{I/m})_{\perp}$

VELOCITY OF Image of Moving Object (Sph. Mirror)

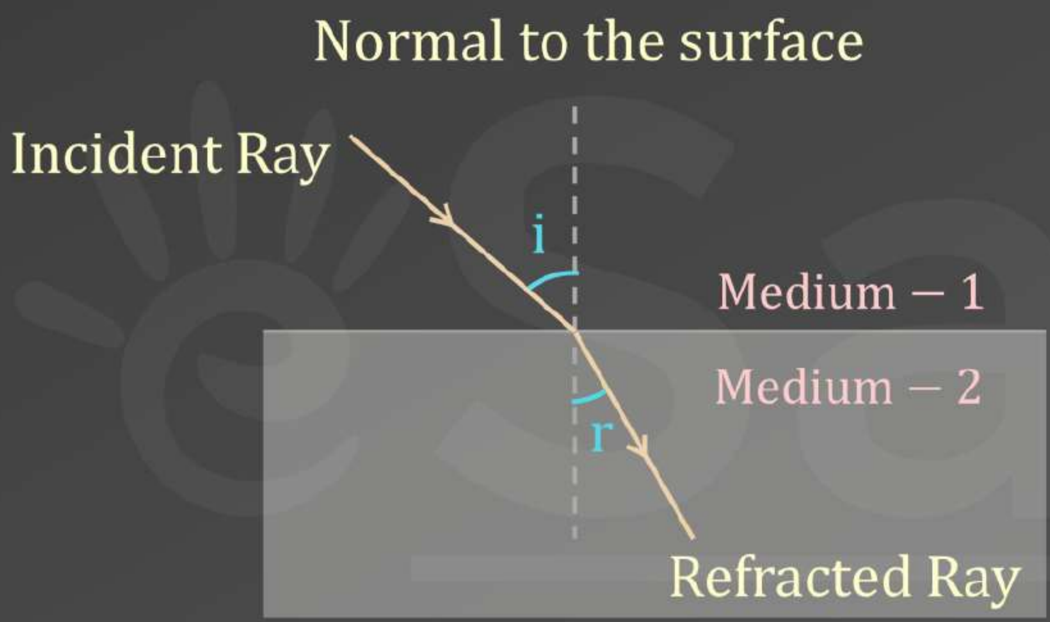
$\vec{V}_I = -m^2 \vec{V}_o$

SIGN-CONVENTION





Refraction



Normal to the surface
Incident Ray
i
Medium – 1
Medium – 2
r
Refracted Ray

Refraction

Refractive index of medium (μ)

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

c → vacuum

v_m → medium

$\mu_{vacuum} = 1$

$\mu_{air} = 1.0003 \approx 1$

$\mu_{water} = 4/3 = 1.33$

$\mu_{glass} = 3/2 = 1.5$

Refraction

$\mu_{air} = 1$ Optically Rarer (Lesser μ)

$\mu_{glass} = 3/2$ Optically Denser (Higher μ)

$\mu_{vacuum} = 1$

$\mu_{air} = 1.0003 \approx 1$

$\mu_{water} = 4/3 = 1.33$

$\mu_{glass} = 3/2 = 1.5$

Refraction

Relative Refractive index of medium(1) w.r.t medium (2) is defined as

$$\mu_{1/2} = \frac{\mu_1}{\mu_2}$$

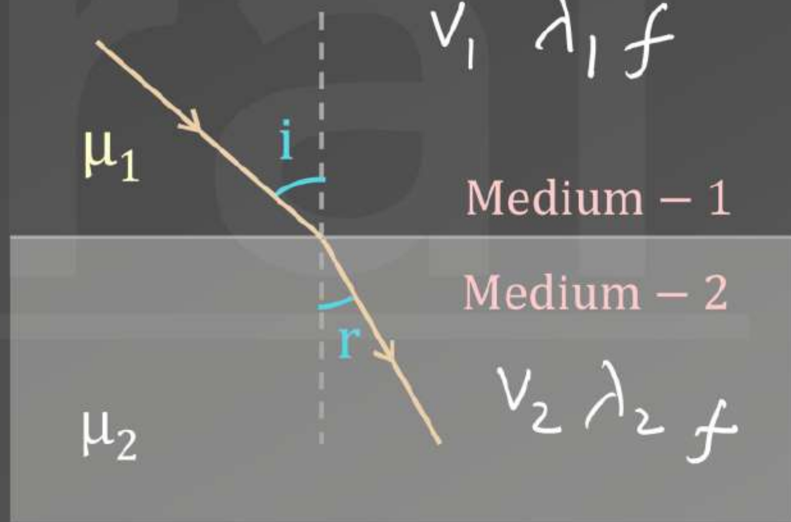
Refraction

$v = f\lambda$

TRICK

$$\frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{\mu_2}{\mu_1}$$

$\mu\uparrow \quad v\downarrow \quad \lambda\downarrow$



When light from same source enters different medium then its speed and wavelength changes but frequency remains same.

Laws of Refraction

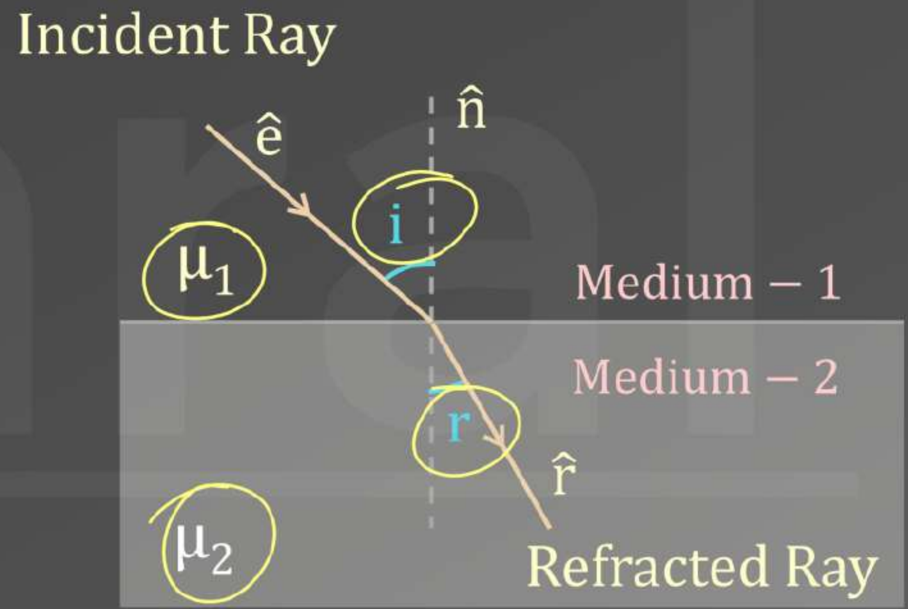
(i) Incident ray, refracted ray and normal to surface always lie in the same plane.

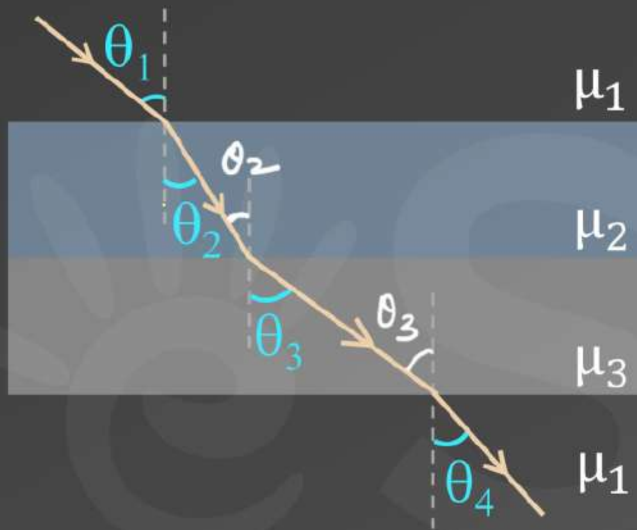
In vector form

$[\hat{e} \;\; \hat{n} \;\; \hat{r}] = 0 \Rightarrow (\hat{e} \times \hat{n}) \cdot \hat{r} = 0$

(ii) Snell's Law

$\mu_1 \sin i = \mu_2 \sin r$





$$\mu_1 \sin\theta_1 = \mu_2 \sin\theta_2 = \mu_3 \sin\theta_3 = \mu_1 \sin\theta_4$$

Atmospheric Refraction

- Early Sunrise and Delayed Sunset
- Apparent flatenning of Sun at sunset and sunrise
- Twinkling of Stars

Apparent Depth

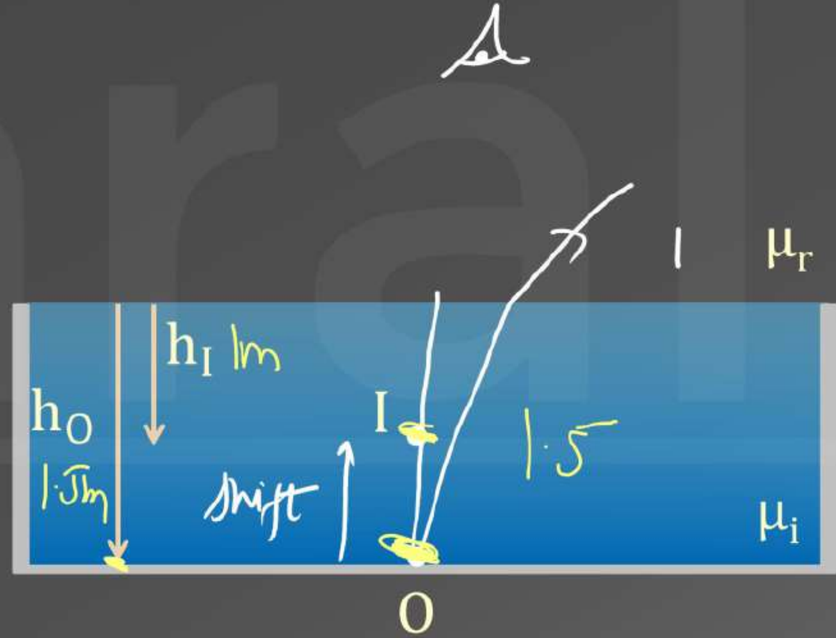
$$h_I = \frac{h_o}{\mu_{i/r}}$$

$$h_I = \frac{h_o}{\mu}$$ ✓

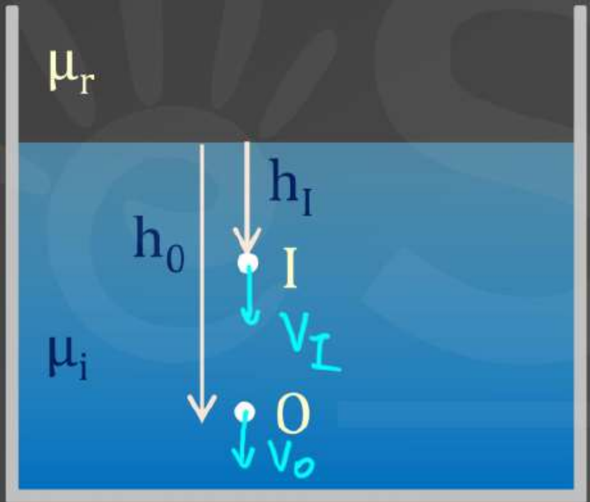
$$\text{Shift} = h_o - h_I$$

$$= h_o\left(1 - \frac{1}{\mu_{i/r}}\right)$$

$$= h_o\left(1 - \frac{1}{\mu}\right)$$ ✗



Velocity of Image Formed due to Refraction from Plane Surface

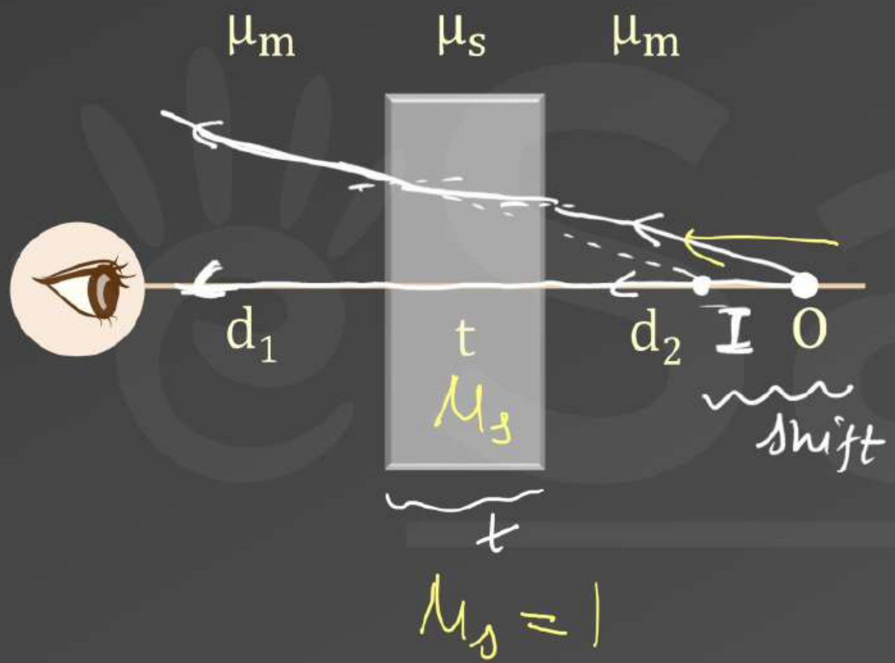


$$h_I = \frac{h_o}{\mu_{i/r}}$$

diff^n wrt t

$$\vec{V}_I = \frac{\vec{V}_o}{\mu_{i/r}}$$

Refraction through Parallel Slab



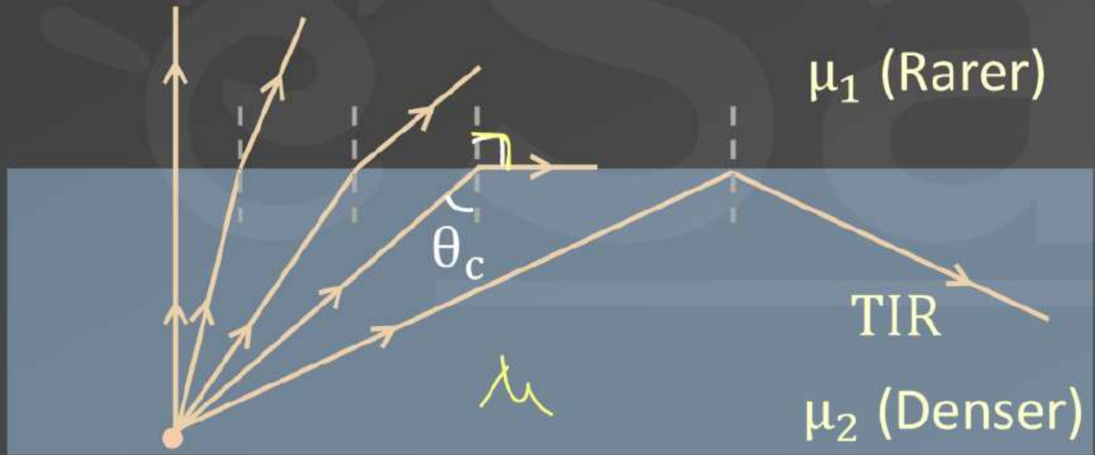
TRICK

$$\text{shift} = t\left(1 - \frac{1}{\mu_{s/m}}\right)$$

in direction of incident Ray

Total Internal Reflection

$$\boxed{\sin\theta_c = \frac{1}{\mu}} = \frac{1}{\mu_{2|1}}$$



Critical Angle (θ_c) : Angle of incident at which angle of refraction becomes 90°.

Applications of TIR

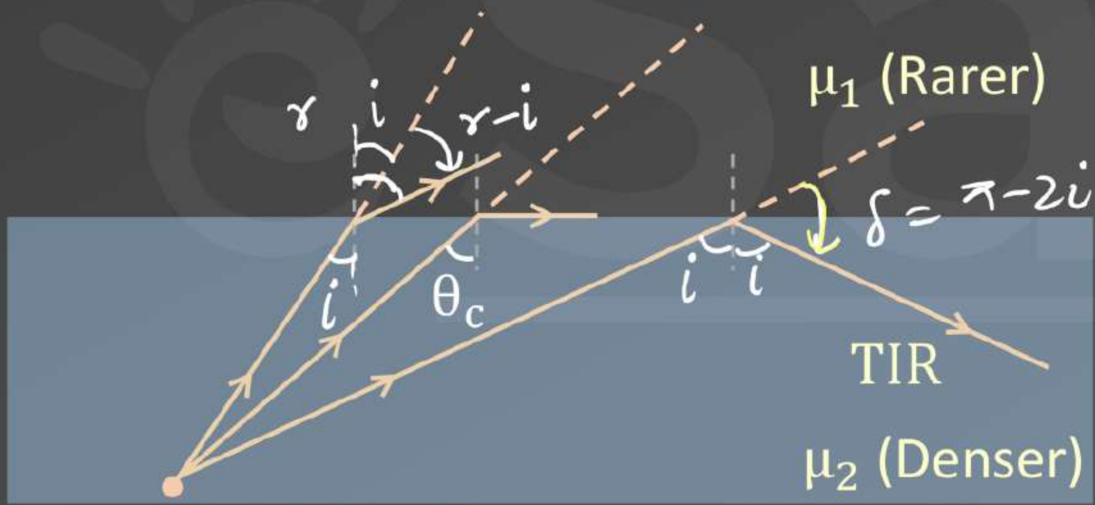
- Optical Fibre
- Mirage / Looming
- Sparkling of Diamond
- Prism to bend light by $90°, 180°$

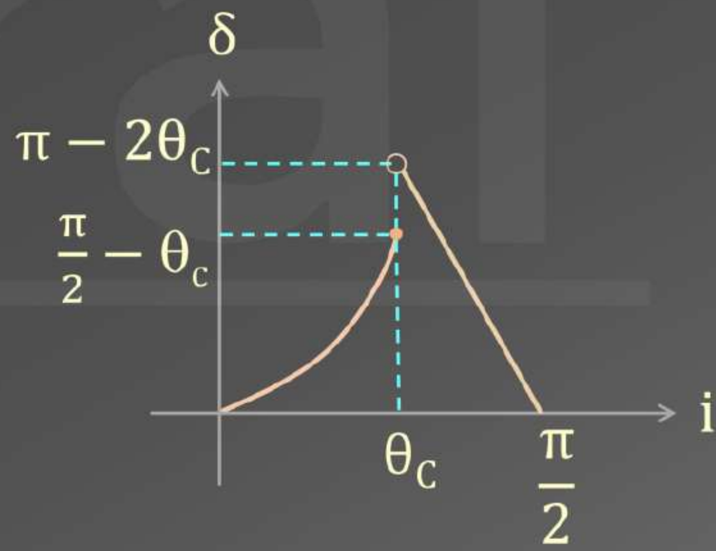
Angle of Deviation

Total Internal Reflection

Refraction : $\delta = r - i$

Reflection : $\delta = \pi - 2i$



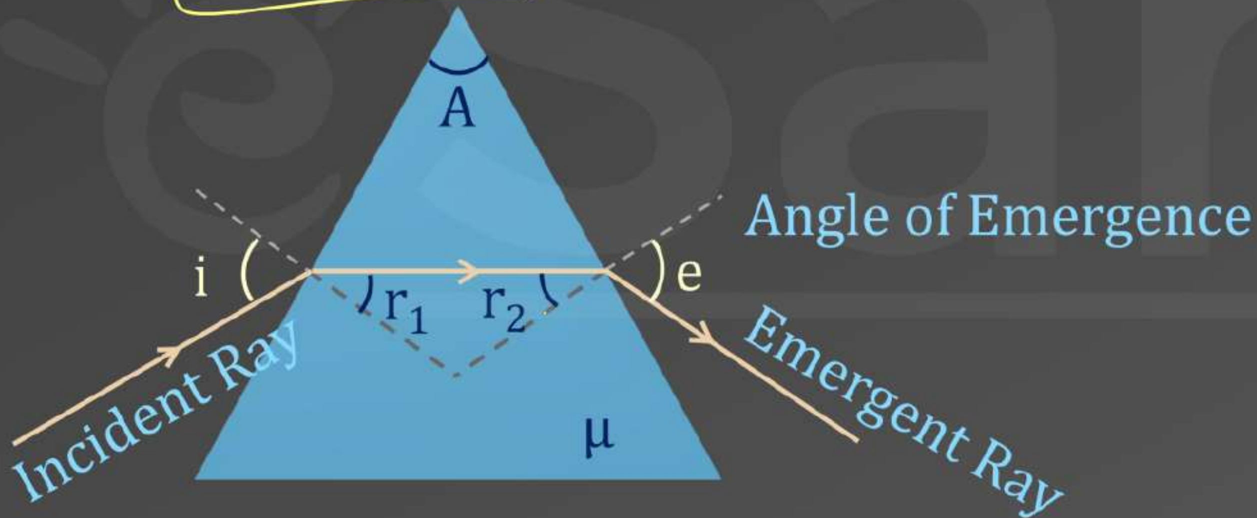


Prism

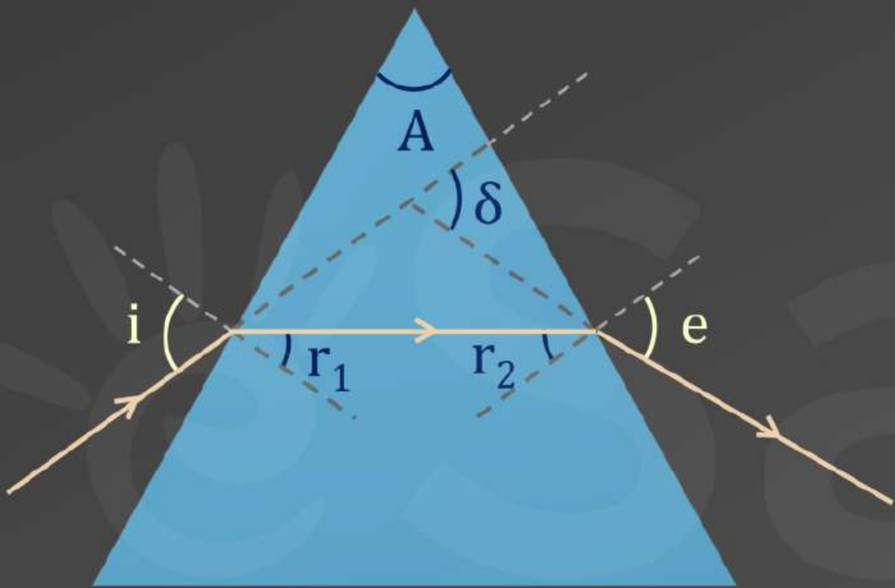
$$1 \sin i = \mu \sin r_1$$

$$\mu \sin r_2 = 1 \sin e$$

$$A = r_1 + r_2$$



Angle of Deviation



$$\delta = i + e - A$$ ☆☆

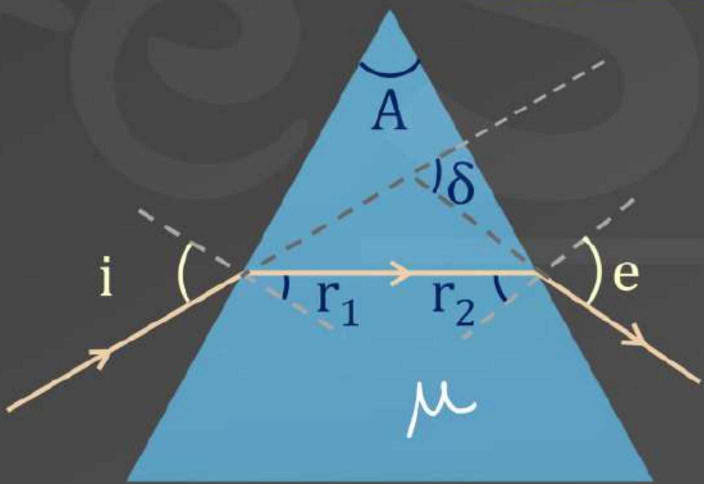
Graph Between Angle of Deviation and Angle of Incidence

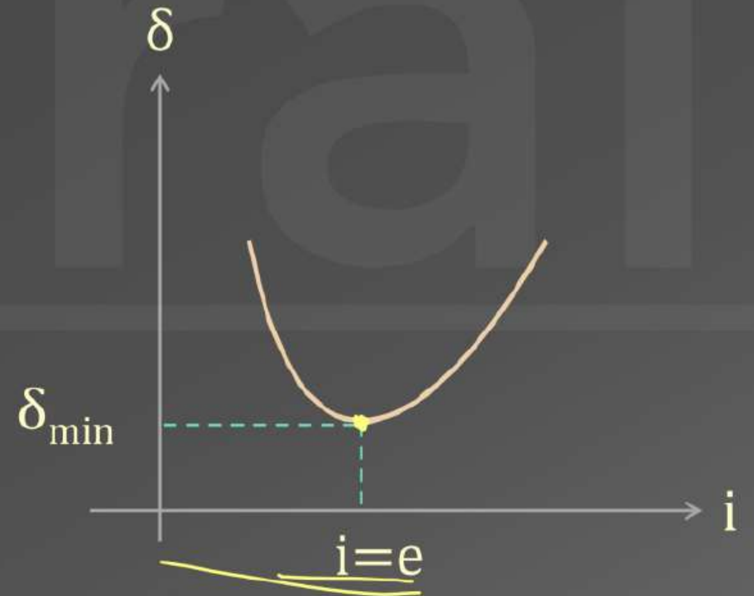
δ_{min}

$i = e$ $\quad r_1 = r_2$

$\delta = i + e - A$

$$\mu = \frac{\sin\left(\frac{\delta_{min} + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$





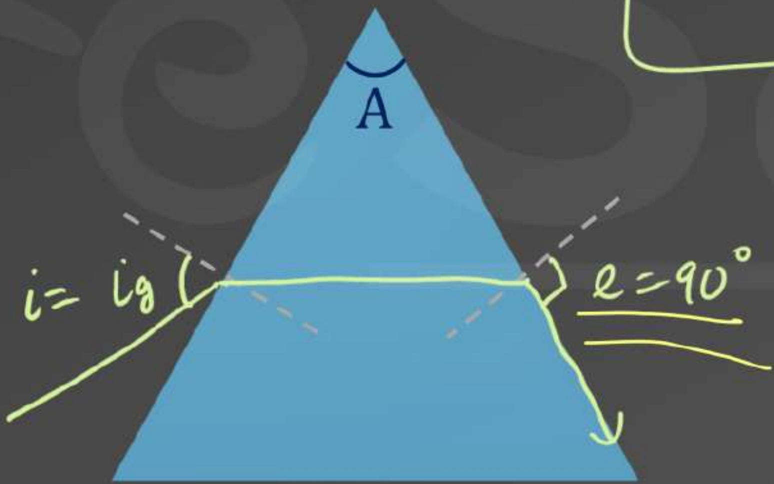
Maximum Angle of Deviation

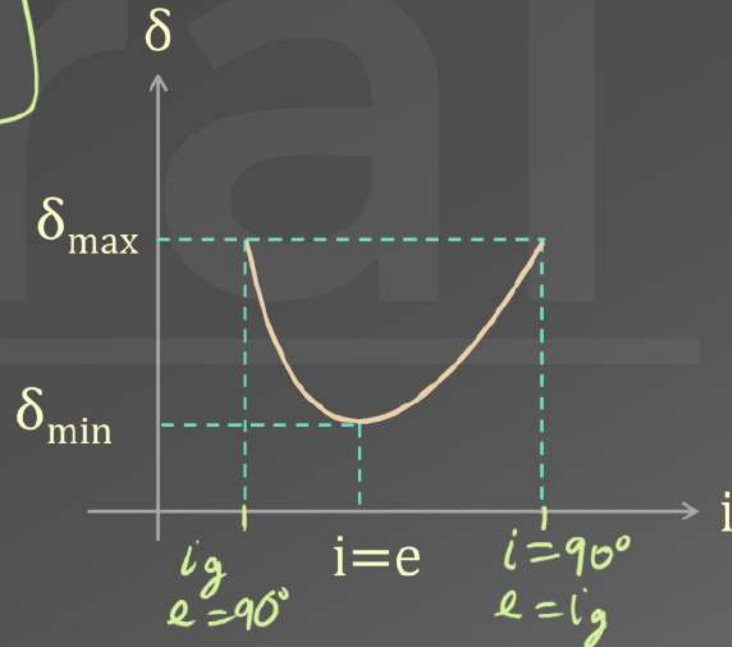
δ_{max}

$i = 90^\circ \qquad e = i_g$

$i = i_g \qquad e = 90^\circ$

$\delta = i + e - A \Rightarrow \delta_{max} = i_g + 90^\circ - A$





Thin Prism

Thin Prism have very small angle of prism.

$$\delta = (\mu - 1)A$$ ☆☆

δmin

$i = e$

$$\mu = \frac{\sin\left(\frac{\delta_{min} + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

δmax

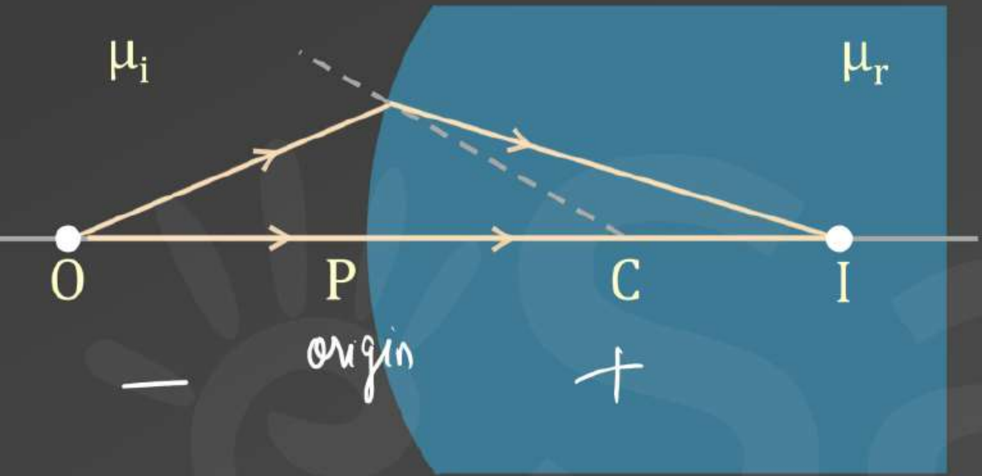
$i = 90°$

$e = i_g$

$i = i_g$

$e = 90°$

Refraction from Curved Surface



P is taken as origin.

Direction along incident ray is taken as positive.

$$\frac{\mu_r}{v} - \frac{\mu_i}{u} = \frac{\mu_r - \mu_i}{R}$$

u = Coordinate of object.

v = Coordinate of image.

R = Coordinate of centre of curvature.

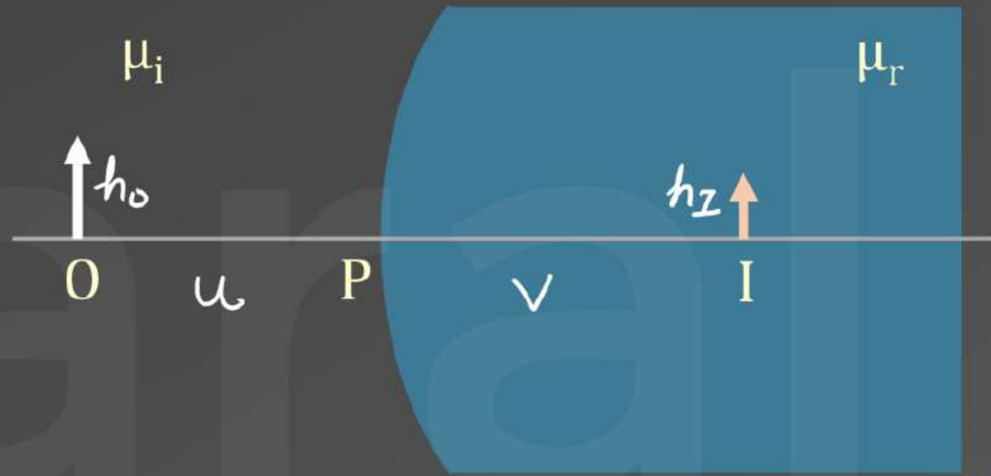
μ_i = Refractive index of medium having incident rays.

μ_r = Refractive index of medium having refracted rays.

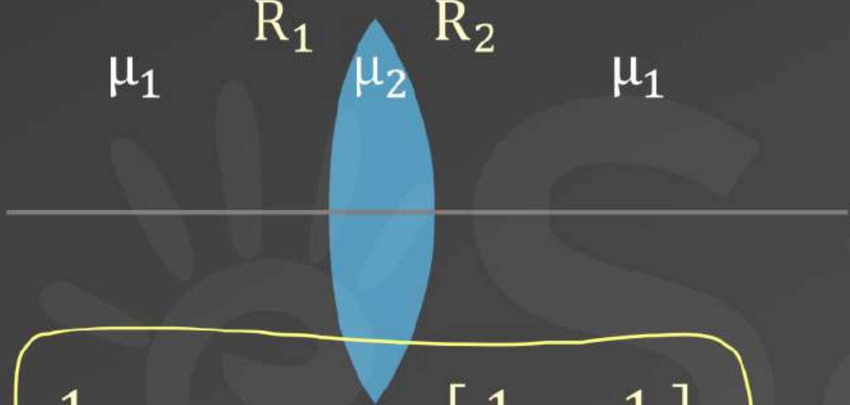
Transverse Magnification

$$m = \frac{\text{Height of image}}{\text{Height of object}} \quad \text{(with sign)}$$

$$m = \frac{h_I}{h_O} = \frac{v/\mu_r}{u/\mu_i}$$

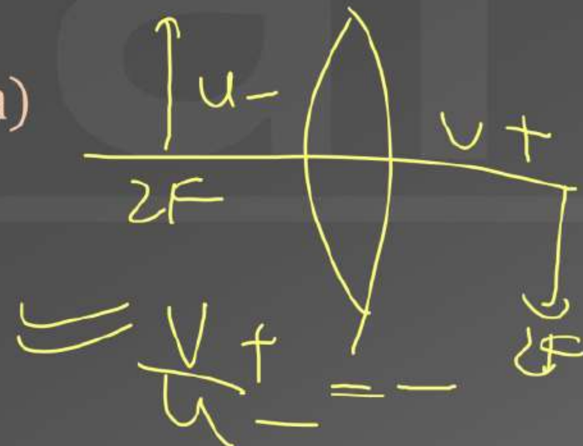


Lens



$$m = \frac{h_I}{h_o} = \frac{v}{u}$$

$$\frac{1}{f} = (\mu_{2/1} - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$ (Lens Maker's formula)



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

TRICK → (Less)

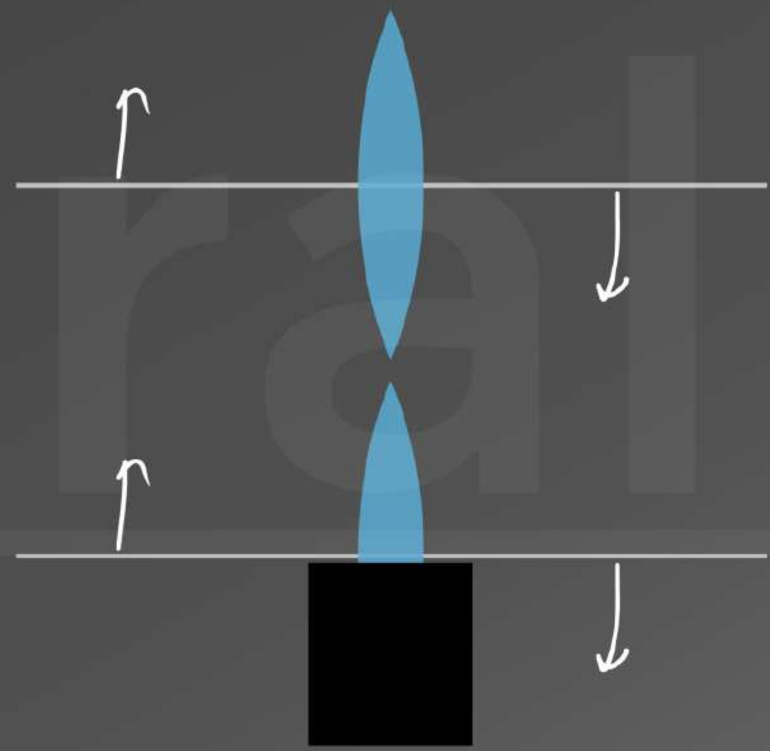
Lens formula

u, v, f, R_1, R_2 are coordinates

Cutting of Lens

Location of image remains unchanged, only intensity decreases

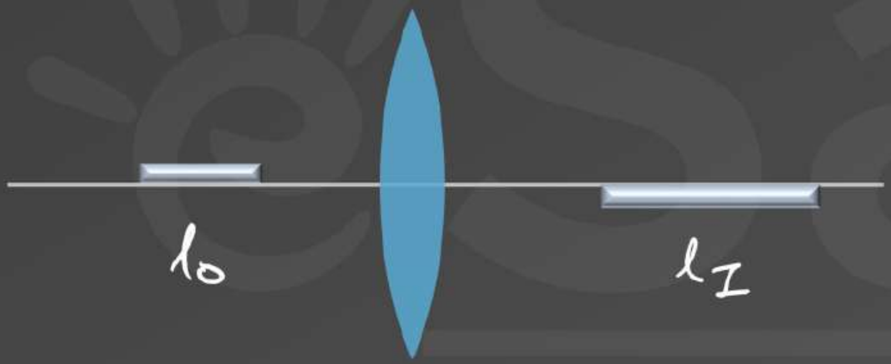
Remember Donkey☺ !!



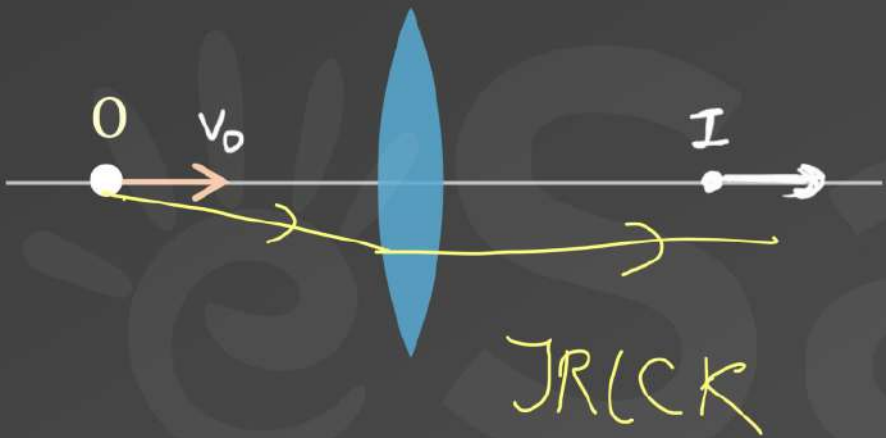
Longitudinal Magnification in Lens

$$LM = m^2 = \frac{l_I}{l_o}$$

$$m = \frac{h_I}{h_o} = \frac{v}{u}$$



Velocity of Image

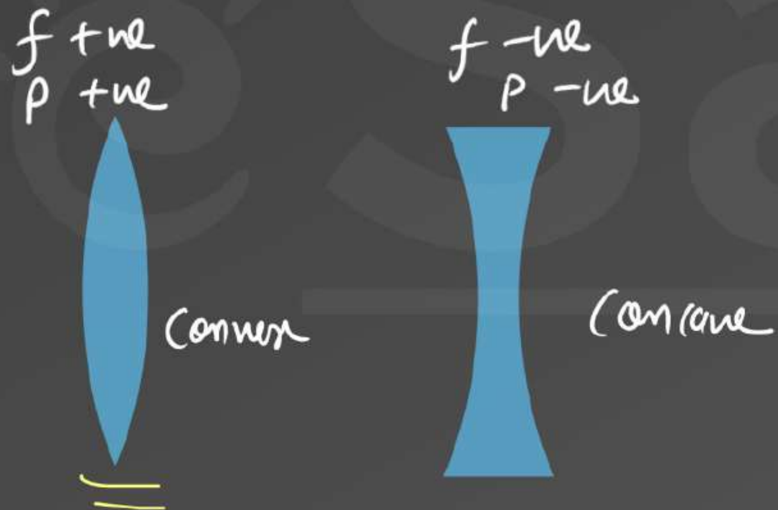


$$\vec{V}_I = m^2 \vec{V}_0$$

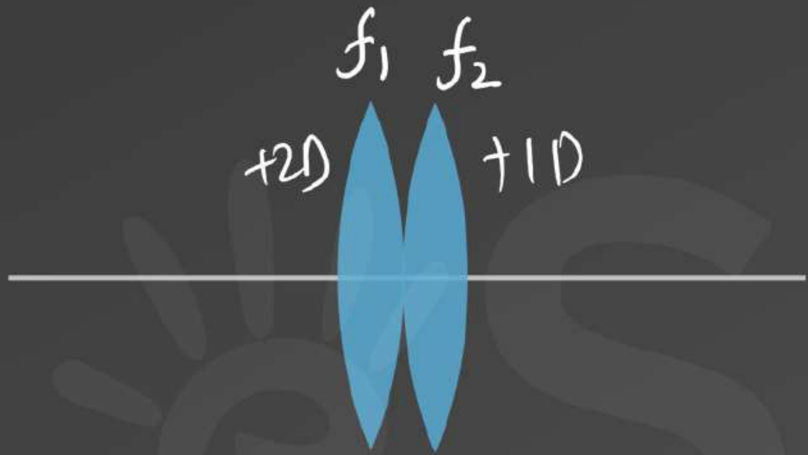
Power of Lens

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

SI unit : dioptre (D) (m^{-1})



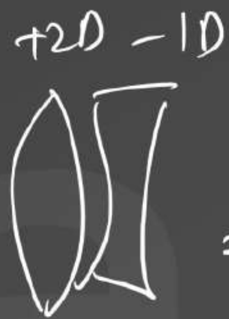
Lenses Kept Very Close to Each Other



$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \ldots$$

$$P_{eq} = P_1 + P_2 + P_3 + \ldots$$

with sign

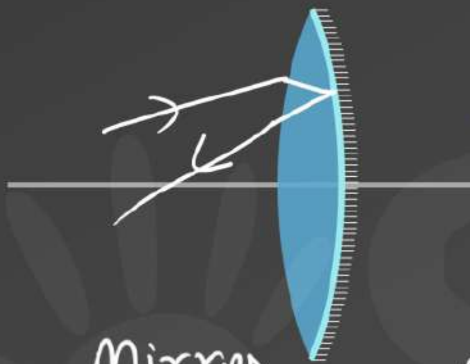


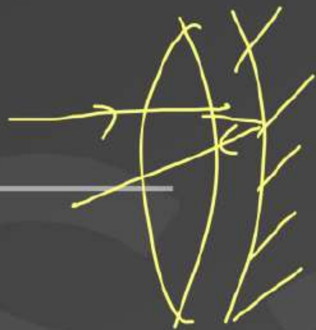
$= +1D$

$$2 + (-1) = +1$$

~~$f_{eq} = f_1 + f_2 + f_2$~~

Silvering of Lens





$$P_m = -\frac{1}{f_m}$$

$$P_{eq} = P_1 + P_2 + P_3 + \dots$$

L M L

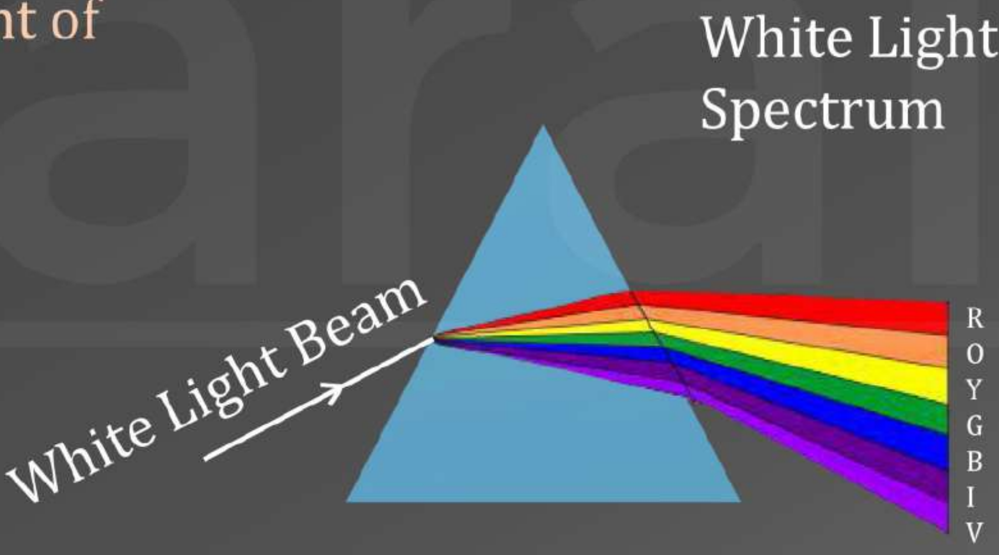
$$P_{eq} = P_L + P_m + P_L$$

$$P_{eq} = \frac{1}{f_L} - \frac{1}{f_m} + \frac{1}{f_L} = -\frac{1}{f_{eqm}}$$

Dispersion

The phenomenon of splitting of light into its component colours is known as Dispersion.

The pattern of colour component of light is called spectrum of light.



Dispersion

Cauchy's eq.

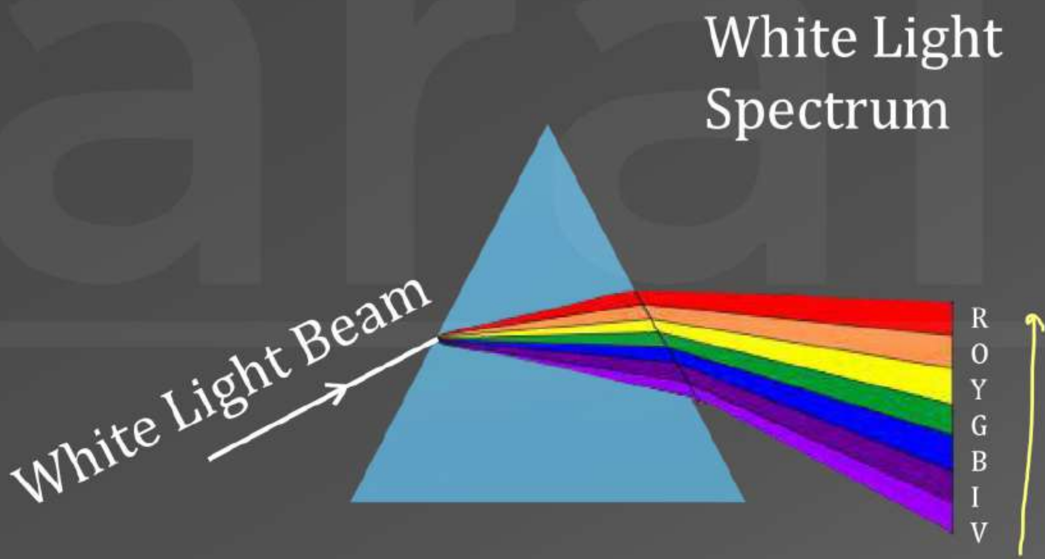
$$\mu = A + \frac{B}{\lambda^2}$$

$\lambda \uparrow \quad \mu \downarrow$

λ_{min} μ_{max} ... λ_{max} μ_{min}

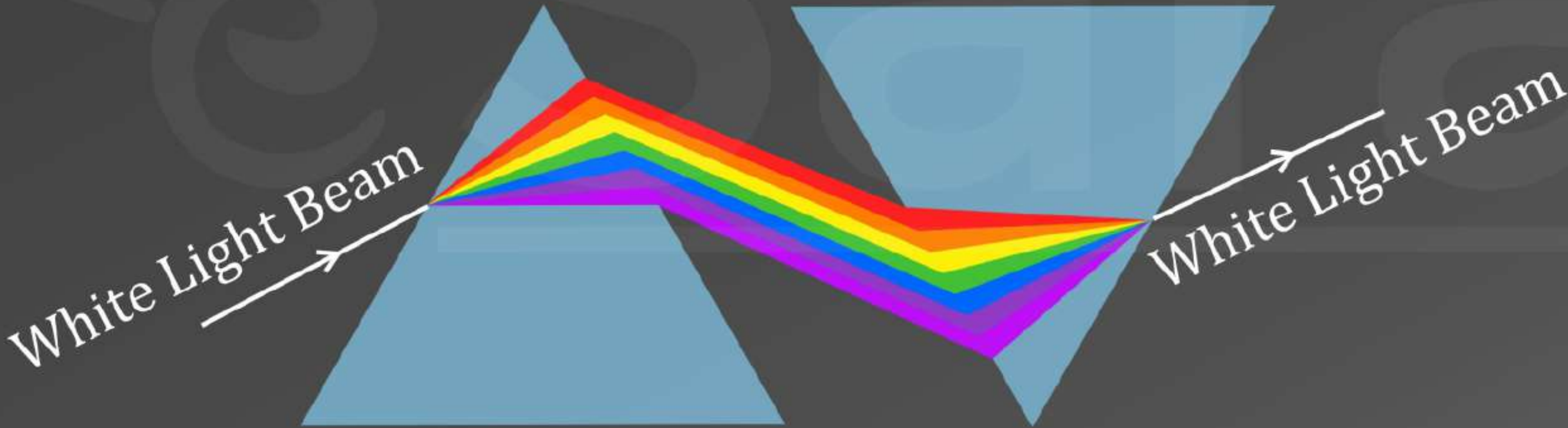
V I B G Y O R

Most deviation ... Least deviation

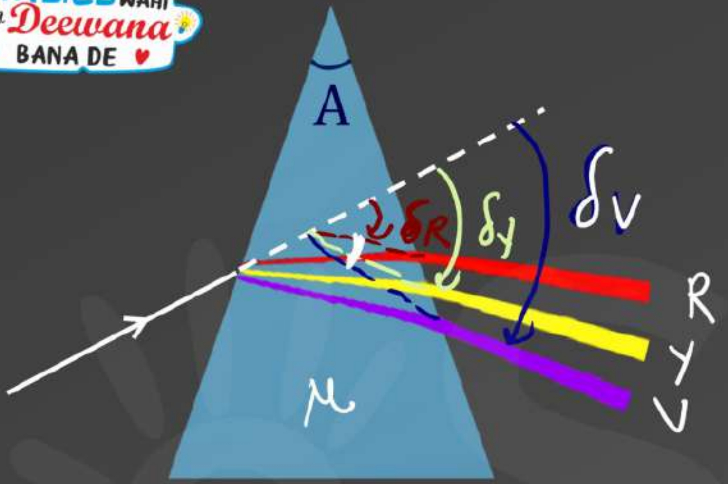


Dispersion

Achromatic Combination



Thin Prism



$$\delta_v = (\mu_v - 1)A$$

$$\delta_y = (\mu_y - 1)A$$

$$\delta_R = (\mu_R - 1)A$$

$$\delta = (\mu - 1)A$$

$$\mu_y \approx \frac{\mu_V + \mu_R}{2}$$

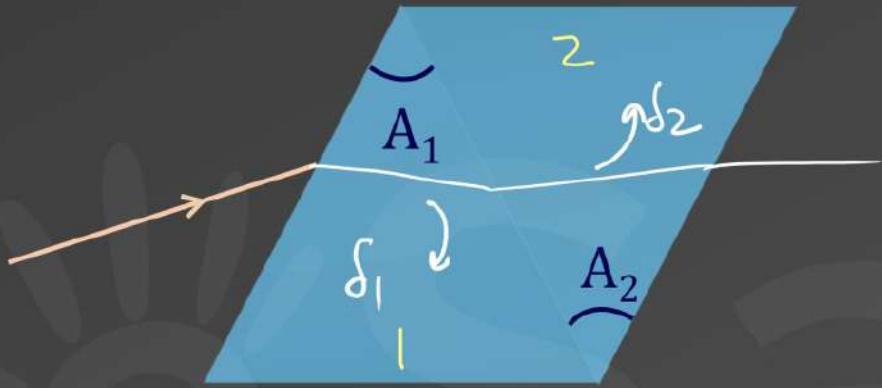
Angular dispersion $(\theta) = \delta_V - \delta_R$

$$= (\mu_V - \mu_R)\,A$$

Average deviation $= \delta_y = (\mu_y - 1)A$

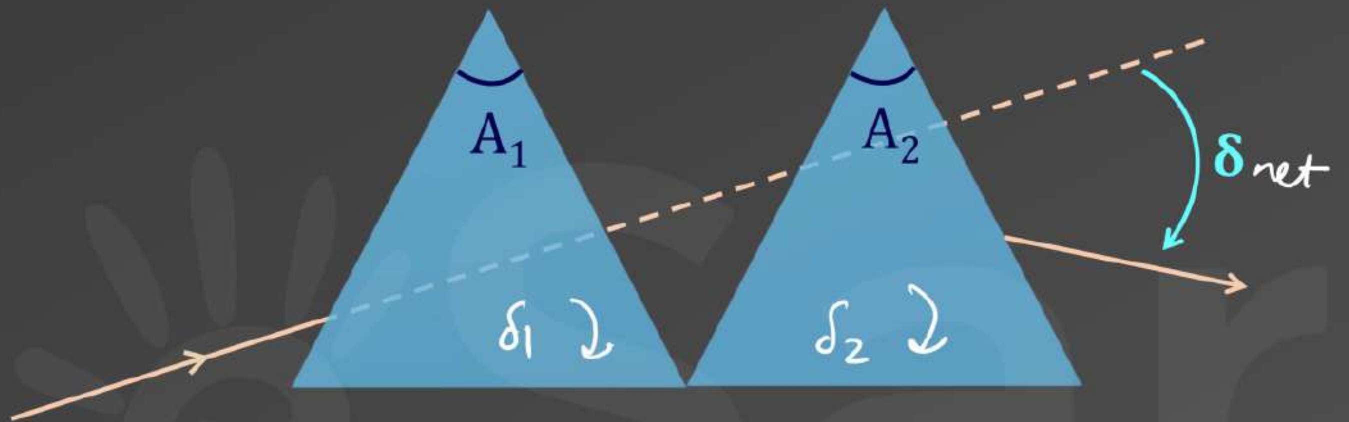
Dispersive power $\omega = \dfrac{\theta}{\delta_y} = \dfrac{(\mu_V - \mu_R)A}{(\mu_y - 1)A}$

θ is property of prism but
ω is property of material.



$$\delta_{net} = \delta_1 - \delta_2$$

$$\theta_{net} = \theta_1 - \theta_2$$



$$\delta_{net} = \delta_1 + \delta_2$$

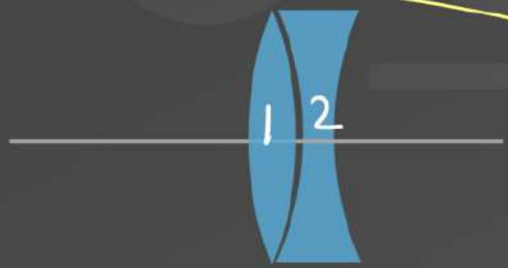
$$\theta_{net} = \theta_1 + \theta_2$$

Dispersion But Not Average Deviation $\delta_{net} = 0$

Average Deviation But No Dispersion $\theta_{net} = 0$

Achromatic Combination

$$\frac{\omega_1}{f_{x_1}} + \frac{\omega_2}{f_{x_2}} = 0$$



QUIZ TIME

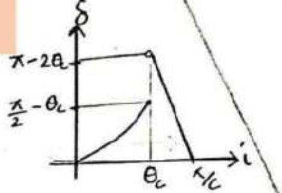
REFRACTION

QUIZ

Total Internal Reflection

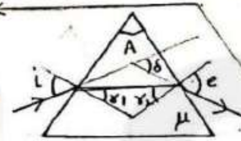
1

Angle of Deviation



PRISM

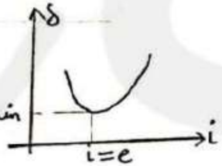
$A = r_1 + r_2$



Angle of Deviation

2

GRAPH b/w ∠ of Deviation & ∠ of Incidence



$\mu = \dfrac{\sin\left(\frac{\delta_{min}+A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

Maximum ∠ of Deviation

$\delta_{max} = i_g + 90 - A$

Thin Prism

$\delta = (\mu - 1)A$

Refraction from Curved Surface

$\dfrac{\mu_r}{v} - \dfrac{\mu_i}{u} = \dfrac{\mu_r - \mu_i}{R}$

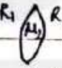
Transverse Magnification

$m = \dfrac{h_I}{h_o} = \dfrac{v/\mu_r}{u/\mu_i}$

Achromatic Combination

$\dfrac{\omega_1}{f_{Y_1}} + \dfrac{\omega_2}{f_{Y_2}} = 0$

LENS



→ Lens Maker's formula

3

→ Lens Formula $= \dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$

→ Longitudinal Magnification in Lens ⇒

5

→ Velocity of Image $= \vec{V}_I$ ... $\vec{V}_o$

→ Power of Lens $= P = 1/f$

REFRACTIVE INDEX OF MEDIUM

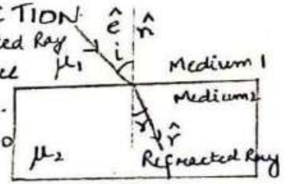
$\mu = \dfrac{C}{V_m}$ C → Speed of Light in Vaccum; V_m → Speed of Light in Medium

$V_m = f\lambda_m \Rightarrow \dfrac{V_1}{V_2} = \dfrac{\lambda_1}{\lambda_2} = \dfrac{\mu_2}{\mu_1}$ [frequency same]

LAWS OF REFRACTION

1) Incident Ray, Refracted Ray and normal to Surface always lie in same plane.

$[\hat{e}\ \hat{n}\ \hat{r}] = 0 \Rightarrow \{\hat{e} \times \hat{n}\} \cdot \hat{r} = 0$



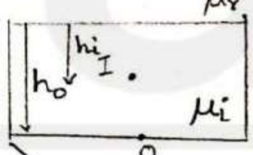
2. SNELL'S LAW

$\mu_1 \sin i = \mu_2 \sin r$

Atmospheric Refraction

1. Early Sunrise & Delayed Sunset
2. Apparent flattening of Sun at Sunrise and Sunset
3. Twinkling of Stars

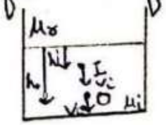
APPARENT DEPTH



4

Shift $= h_o\left(1 - \dfrac{1}{\mu_{i/r}}\right)$

Velocity of Image formed due to Refraction from Plane Surface

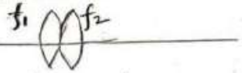


$\vec{V}_I = \dfrac{\vec{V}_o}{\mu_{i/r}}$

Refraction through Parallel Slab

SHIFT $= t\left(1 - \dfrac{1}{\mu_{s/m}}\right)$

Lens kept Very Close to Each Other



$\dfrac{1}{f_{eq}} = \dfrac{1}{f_1} + \dfrac{1}{f_2} + \dfrac{1}{f_3} + \cdots$

$P_{eq} = P_1 + P_2 + P_3 + \cdots$ (with sign)

Silvering of Lens

$P_{eq} = P_L + P_m + P_L$

$P_{eq} = \dfrac{1}{f_L} - \dfrac{1}{f_m} + \dfrac{1}{f_L} = -\dfrac{1}{f_{eq}}$

Dispersion

Cauchy's eqn

$\mu = A + \dfrac{B}{\lambda^2}$ λ↑ μ↓

VIBGYOR — Most Deviation (V) … Least Deviation (R)

THIN PRISM

$\mu_y \approx \dfrac{\mu_V + \mu_R}{2}$

Angular Dispersion (θ) $= \delta_V - \delta_R = (\mu_V - \mu_R)A$

Avg. Deviation $= \delta_Y = (\mu_Y - 1)A$

Dispersive Power $\omega = \dfrac{\theta}{\delta_Y} = \dfrac{(\mu_V - \mu_R)A}{(\mu_Y - 1)A}$

θ is property of Prism

ω is property of Material

Dispersion but not Avg Deviation

$\delta_{net} = 0$

Avg Deviation but Not Dispersion

$\theta_{net} = 0$

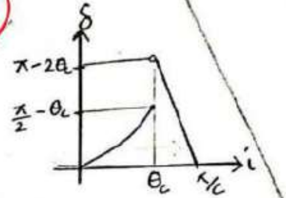
eSaral

REFRACTION

Total Internal Reflection

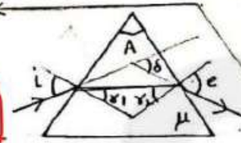
$\sin\theta_c = \frac{1}{\mu}$

Angle of Deviation



PRISM

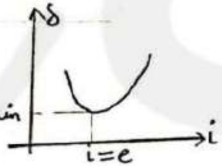
$A = r_1 + r_2$



Angle of Deviation

$\delta = i + e - A$

GRAPH b/w ∠ of Deviation & ∠ of Incidence



$\mu = \frac{\sin\left(\frac{\delta_{min}+A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

Maximum ∠ of Deviation

$\delta_{max} = i_g + 90 - A$

Thin Prism

$\delta = (\mu - 1)A$

Refraction from Curved Surface

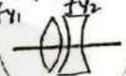
$\frac{\mu_r}{v} - \frac{\mu_i}{u} = \frac{\mu_r - \mu_i}{R}$

Transverse Magnification

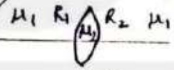
$m = \frac{h_I}{h_o} = \frac{v/\mu_r}{u/\mu_i}$

Achromatic Combination

$\frac{\omega_1}{f_{Y_1}} + \frac{\omega_2}{f_{Y_2}} = 0$



LENS



→ Lens Maker's formula

$\frac{1}{f} = (\mu_{2/1} - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

→ Lens Formula $= \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

→ Longitudinal Magnification in Lens ⇒ $LM = m^2$

→ Velocity of Image ← $\vec{V}_I = m^2 \vec{V}_o$

→ Power of Lens $= P = 1/f$

REFRACTIVE INDEX OF MEDIUM

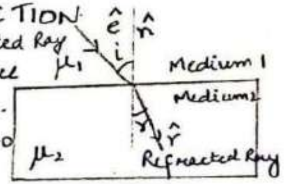
$\mu = \frac{C}{V_m}$ → C: Speed of Light in Vaccum; V_m: Speed of Light in Medium

$V_m = f\lambda_m \Rightarrow \frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2} = \frac{\mu_2}{\mu_1}$ [frequency same]

→ LAWS OF REFRACTION

1) Incident Ray, Refracted Ray and normal to Surface always lie in same plane.

$[\hat{e}\ \hat{n}\ \hat{r}] = 0 \Rightarrow (\hat{e} \times \hat{n}) \cdot \hat{r} = 0$



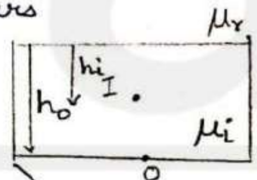
2. SNELL'S LAW

$\mu_1 \sin i = \mu_2 \sin r$

→ Atmospheric Refraction

1. Early Sunrise & Delayed Sunset
2. Apparent flattening of Sun at Sunrise and Sunset
3. Twinkling of Stars

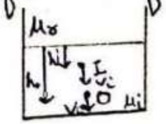
→ APPARENT DEPTH



$h_I = \frac{h_o}{\mu_{i/r}}$

Shift $= h_o\left(1 - \frac{1}{\mu_{i/r}}\right)$

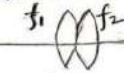
→ Velocity of Image formed due to Refraction from Plane Surface



$\vec{V}_I = \frac{\vec{V}_o}{\mu_{i/r}}$

→ Refraction through Parallel Slab SHIFT $= t\left(1 - \frac{1}{\mu_{s/m}}\right)$

LENS kept Very Close to Each Other



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Dispersion

Cauchy's eq^n

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V I B G Y O R

Most Deviation — Least Deviation

THIN PRISM

$\mu_y \approx \frac{\mu_V + \mu_R}{2}$

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Dispersive Power $\omega = \frac{\theta}{\delta_y} = \frac{(\mu_V - \mu_R)A}{(\mu_y - 1)A}$

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ω is property of Material

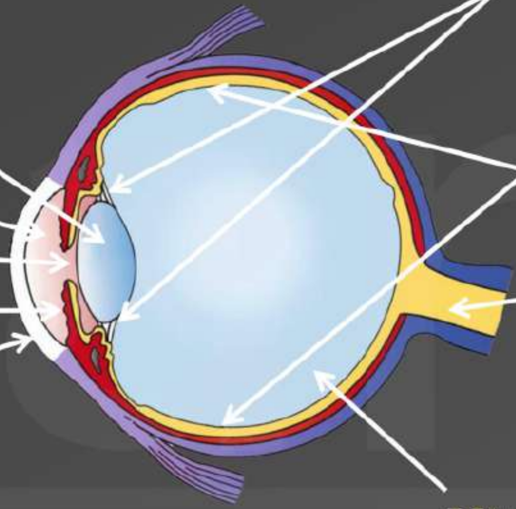
Dispersion but not Avg Deviation

$\delta_{net} = 0$

Avg Deviation but Not Dispersion

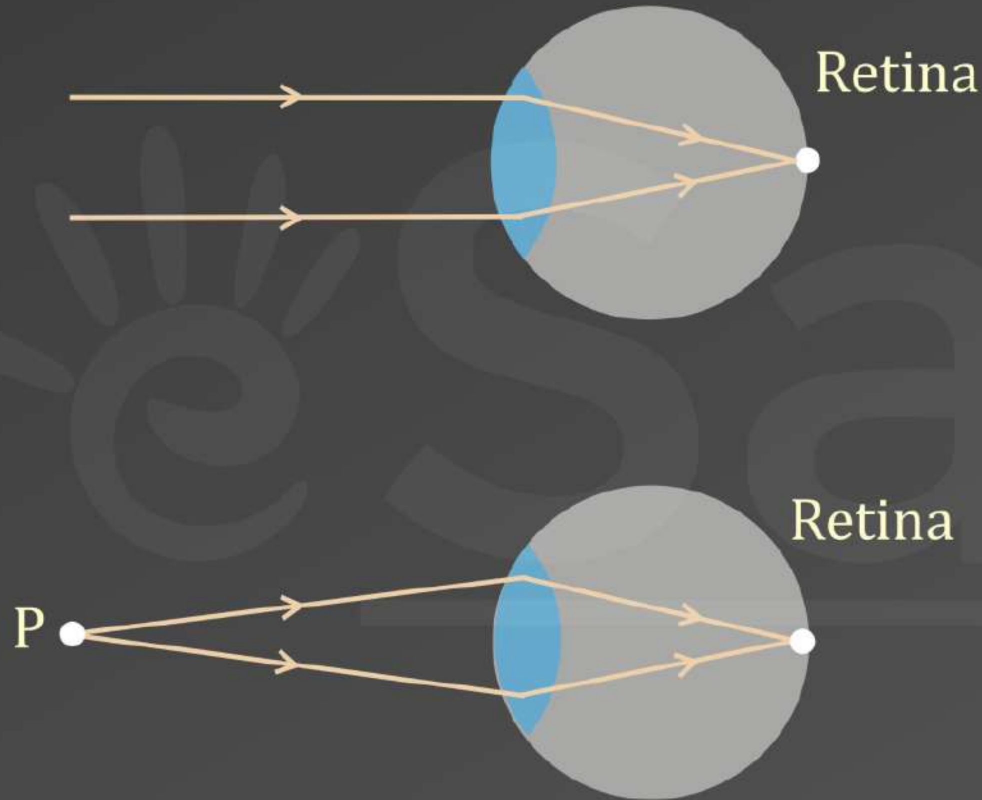
$\theta_{net} = 0$

Human Eye



Crystalline Lens
Aqueous humour
Pupil
Iris
Cornea
Ciliary Muscles
Retina
Optic nerve
Vitreous humour

Human Eye



Accommodation

Far Point at ∞

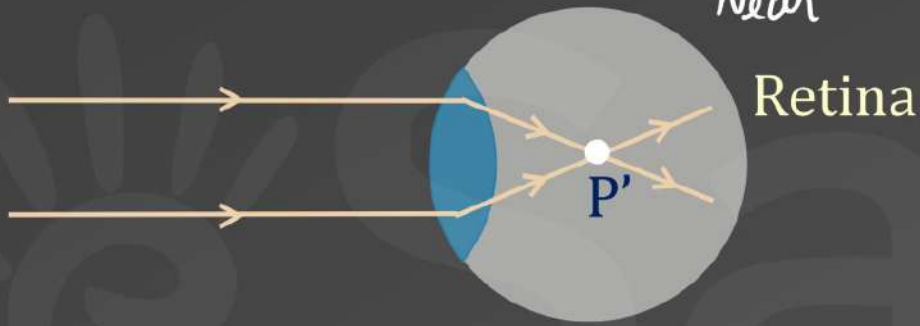
Near Point at 25cm

Least Distance for Distinct Vision

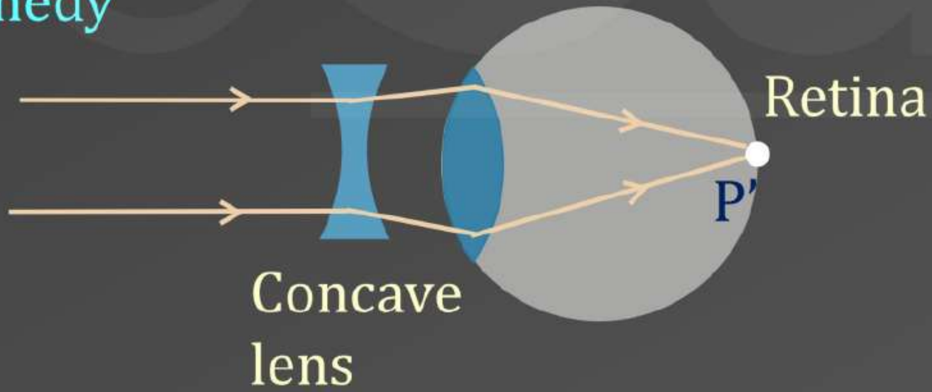
Defects of Eyes

1. Nearsightedness : (Myopia)

पास Near   दूर Far   TRICK



Remedy

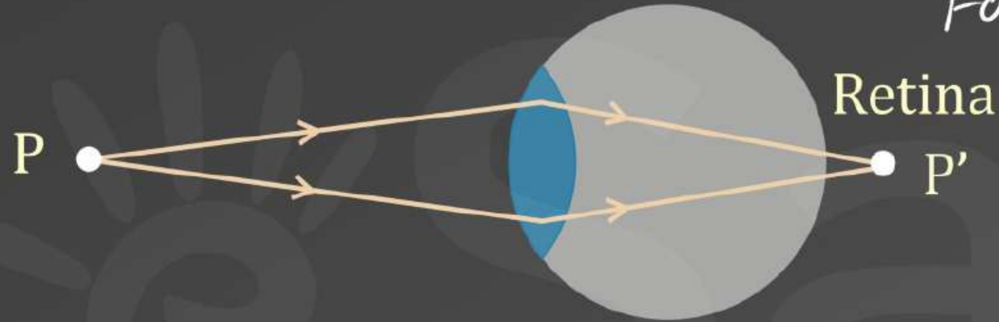


Defects of Eyes

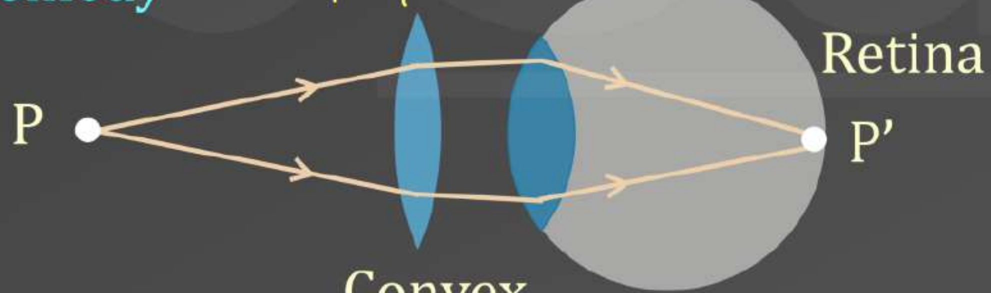
2. Farsightedness : (Hypermetropia)

दूर ✓ पास ✗ TRICK

Far Near

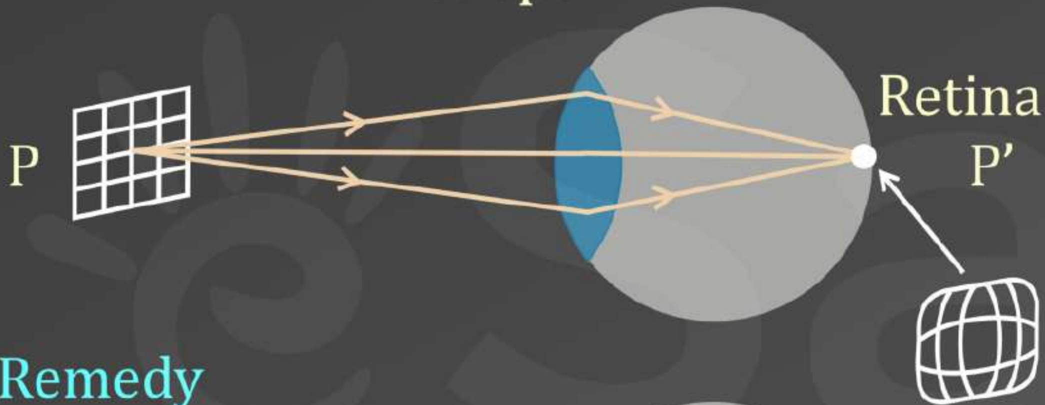


Remedy P +

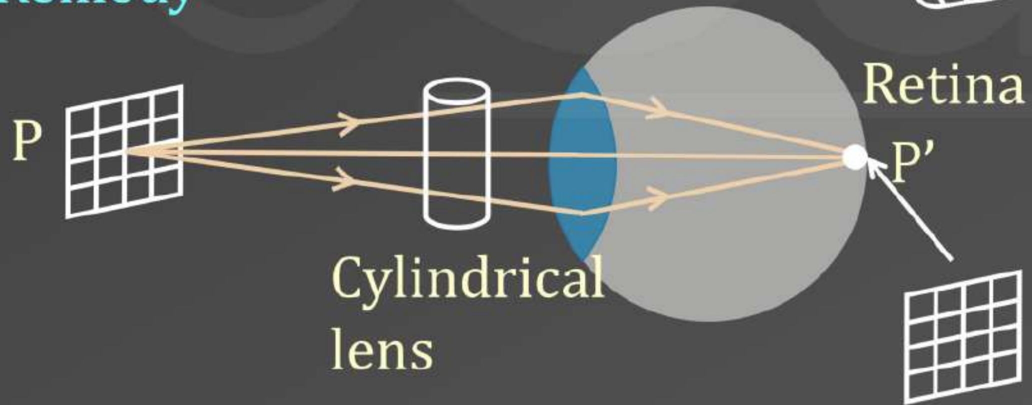


Defects of Eyes

3. Astigmatism: When Cornea not spherical in shape



Remedy



Human Eye

In old age Near Point of eyes may increase to as much as 200cm. This defect of eye is called Presbyopia.

Simple Microscope

Image at ∞ (Normal Adjustment)

Angular Magnification $= \dfrac{D}{f}$

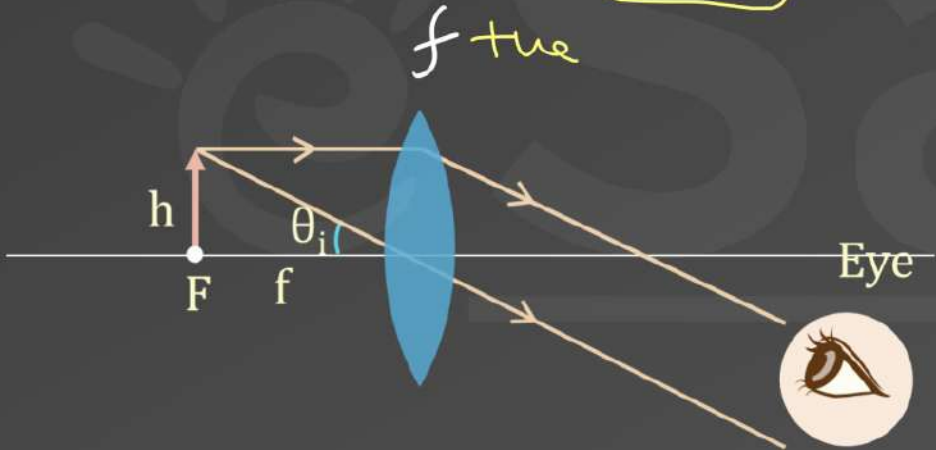
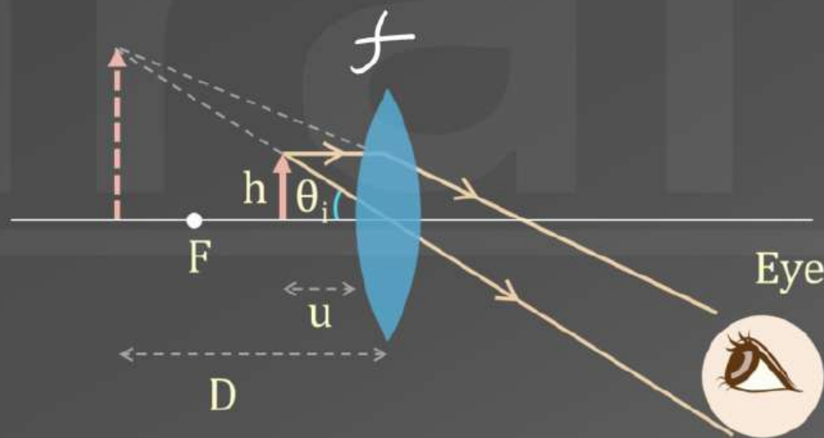
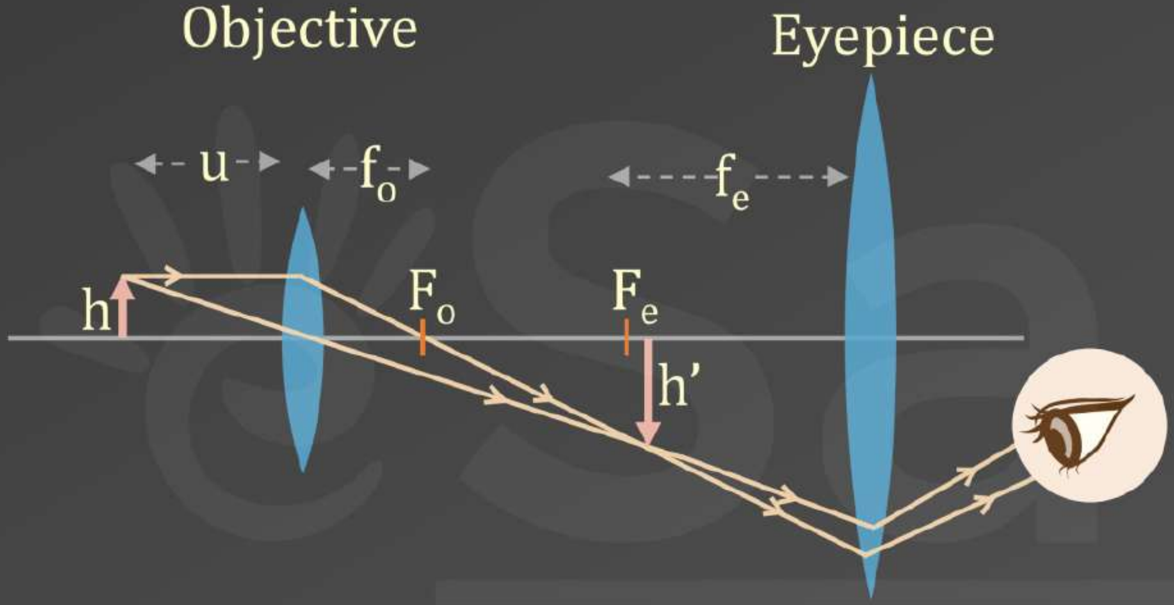


Image at Least Distance of Distinct Vision

Angular Magnification $= \dfrac{D}{f} + 1$



Compound Microscope



Total Magnification

↑

$$M = m_o \times m_e$$

Mag. by Objective lens (Transverse)

Mag. by Eyepiece (Angular)

Compound Microscope

Image at ∞ (Normal Adjustment)

Tube length of comp Micro.

$$\text{Total Magnification} = \frac{L}{f_o}\frac{D}{f_e}$$

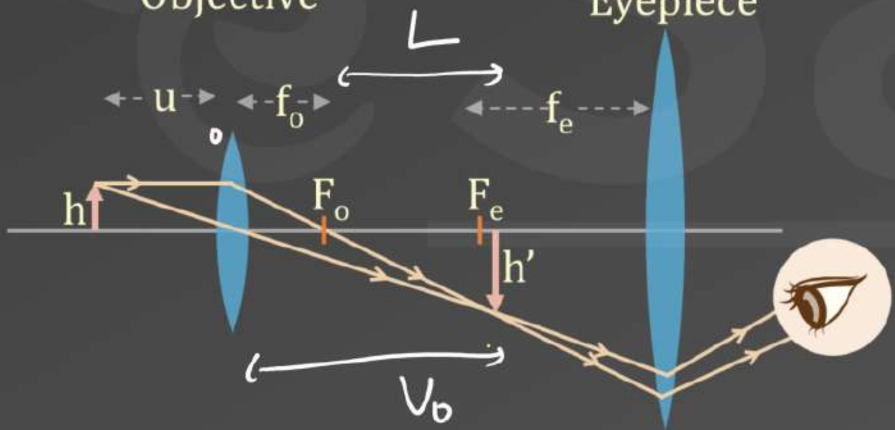
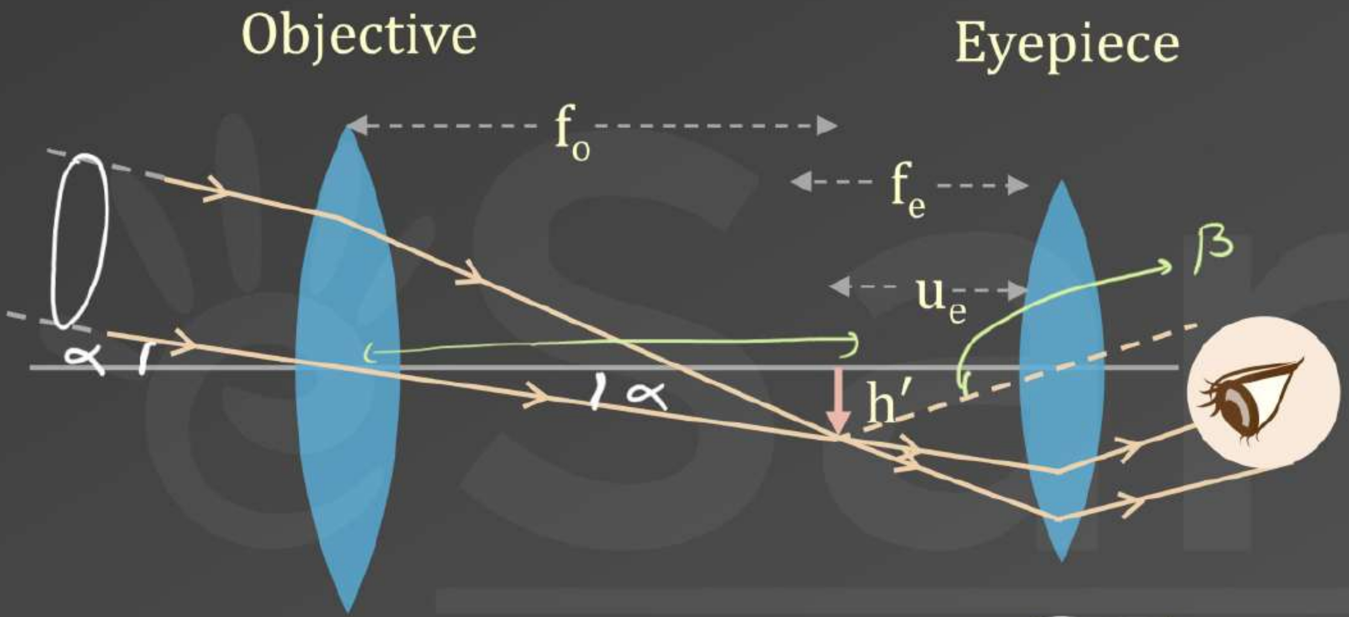


Image at Least Distance of Distinct Vision

$$\text{Total Magnification} = \left|\frac{v_o}{u_o}\right|\left(\frac{D}{f_e}+1\right)$$

Telescope



Magnifying Power $= \dfrac{\beta}{\alpha} = \boxed{\dfrac{f_o}{|u_e|}}$

Telescope

Image at ∞ (Normal Adjustment)

Magnifying Power $= \frac{f_o}{f_e}$

In this case length of telescope tube is $f_o + f_e$

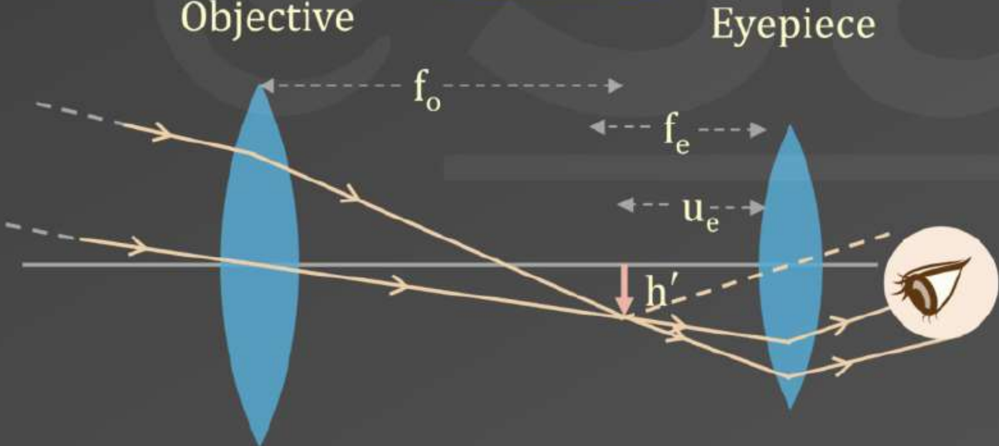
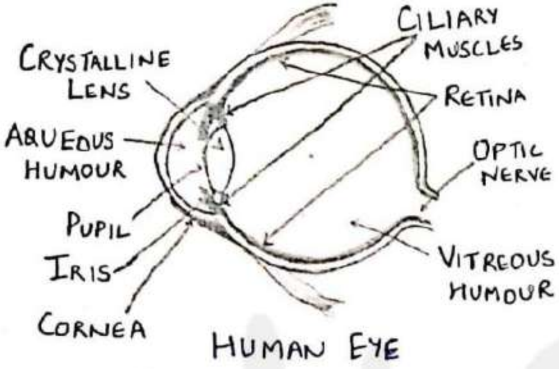


Image at Least Distance of Distinct Vision

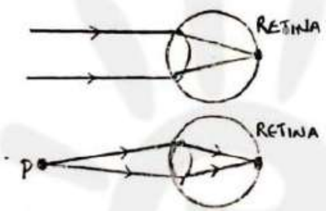
Magnifying Power $= f_o\left(\frac{1}{f_e} + \frac{1}{D}\right)$

$\frac{f_o}{f_e} + \frac{f_o}{D}$

QUIZ TIME



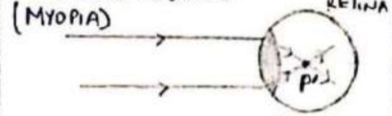
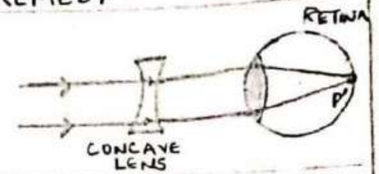
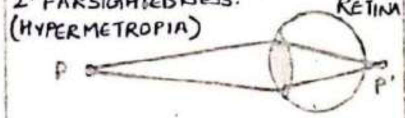
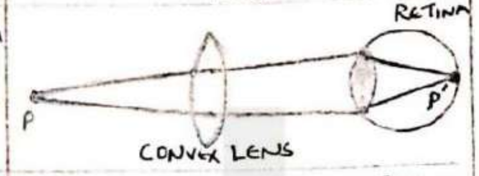
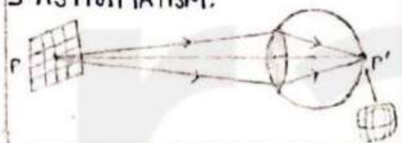
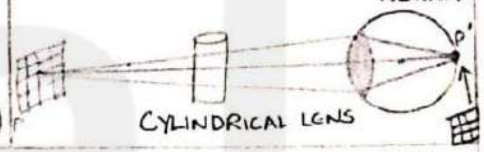
HUMAN EYE



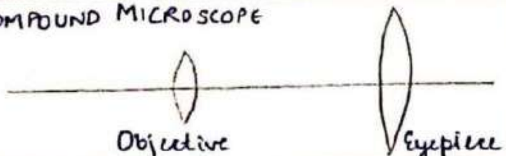
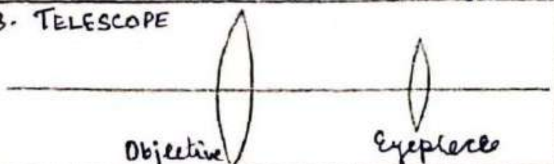
Accommodation
- Far point at ∞
- Near point at 25cm

Least Distance for Distinct Vision

OPTICAL INSTRUMENTS

DEFECTS OF EYES	REMEDY
1. NEARSIGHTEDNESS: (MYOPIA) 	
2. FARSIGHTEDNESS: (HYPERMETROPIA) 	
3. ASTIGMATISM: 	

4. PRESBYOPIA: In old age, Near point increases to as much 200cm.

INSTRUMENT	IMAGE AT ∞ (Normal Adjustment)	Image at Least Distance of Distinct Vision
1. SIMPLE MICROSCOPE 	Angular Magnification 1	Angular Magnification 2
2. COMPOUND MICROSCOPE  Objective, Eyepiece	Total Magnification, $M = m_o \times m_e$ 3	Total Magnification $= \left\|\frac{v_o}{u_o}\right\| \left(\frac{D}{f_e}+1\right)$
3. TELESCOPE  Objective, Eyepiece	Magnifying Power $= \beta/\alpha = \left\|\frac{f_o}{f_e}\right\|$ 4 In this case, Length of Telescope is f_o+f_e	Magnifying Power $= f_o\left(\frac{1}{f_e}+\frac{1}{D}\right)$

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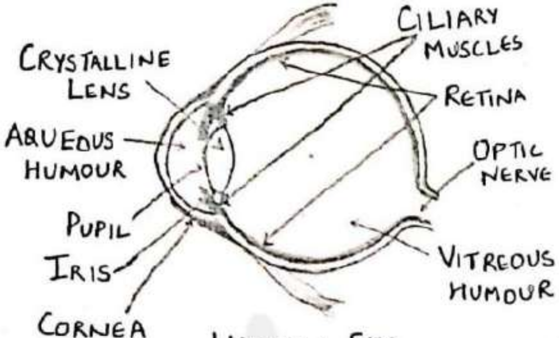
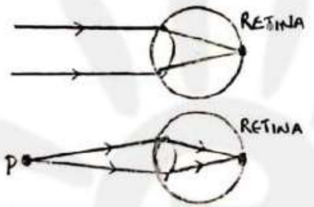


HUMAN EYE



Accommodation
- Far point at ∞
- Near point at 25 cm

Least Distance for Distinct Vision

OPTICAL INSTRUMENTS

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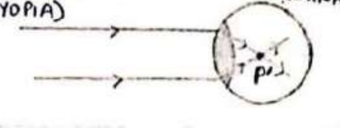
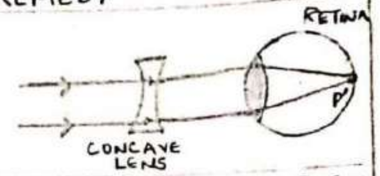
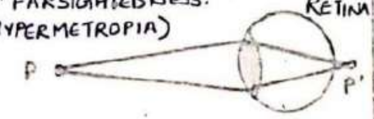
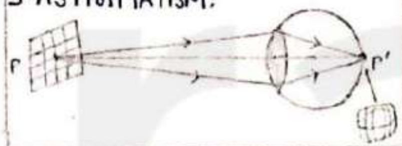
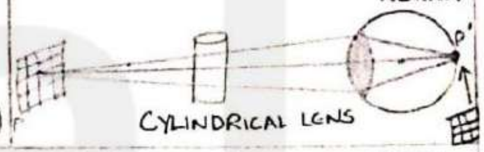
1. NEARSIGHTEDNESS: (MYOPIA) 	
2. FARSIGHTEDNESS: (HYPERMETROPIA) 	
3. ASTIGMATISM: 	

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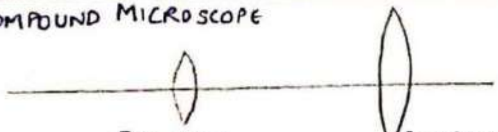
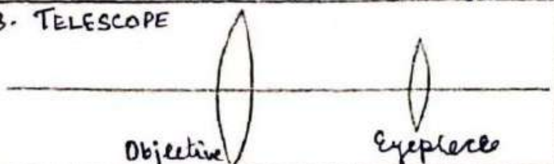
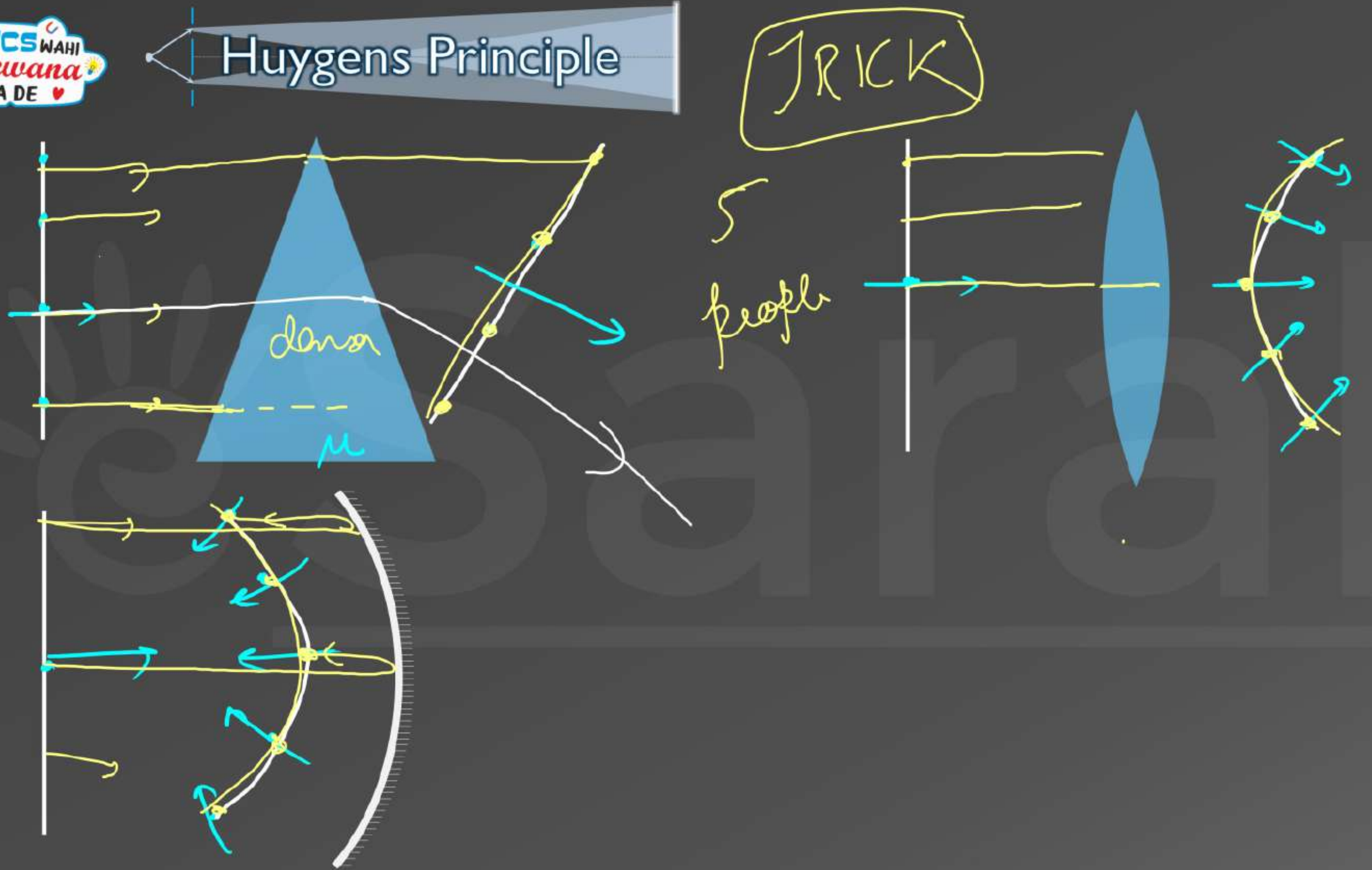
INSTRUMENT	IMAGE AT ∞ (Normal Adjustment)	Image at Least Distance of Distinct Vision
1. SIMPLE MICROSCOPE 	Angular Magnification $= \frac{D}{f}$	Angular Magnification $= \frac{D}{f} + 1$
2. COMPOUND MICROSCOPE  Objective, Eyepiece	Total Magnification, $M = m_o \times m_e$ $= \frac{L}{f_o}\frac{D}{f_e}$	Total Magnification $= \left\lvert \frac{v_o}{u_o} \right\rvert \left(\frac{D}{f_e} + 1 \right)$
3. TELESCOPE  Objective, Eyepiece	Magnifying Power $= \beta/\alpha = \left\lvert \frac{f_o}{u_e} \right\rvert$ $= \frac{f_o}{f_e}$ In this case, Length of Telescope is $f_o + f_e$	Magnifying Power $= f_o \left(\frac{1}{f_e} + \frac{1}{D} \right)$

Wave Optics
Superfast Revision

Huygens Principle



Two sources are said to be Coherent if they produce waves having constant (with respect to time) phase difference.

For Incoherent sources, phase difference varies with time.

Two independent ordinary sources (like lamps) are incoherent sources.

Interference of Waves

$$y_1 = A_1 \sin(kx - \omega t)$$

$$y_2 = A_2 \sin(kx - \omega t + \phi)$$

$$(A_{res})^2 = A_1^2 + A_2^2 + 2A_1A_2 \cos\phi$$

$$I \propto A^2$$

$$I_{res} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$$

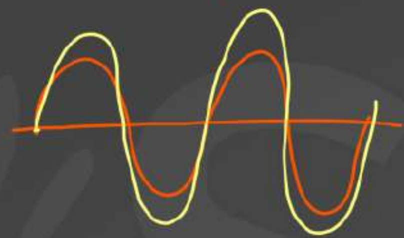
If $I_1 = I_2 = I_0$, then

$$I_{res} = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$$

Constructive Interference

$\cos\phi = 1$

$\phi = 2n\pi$



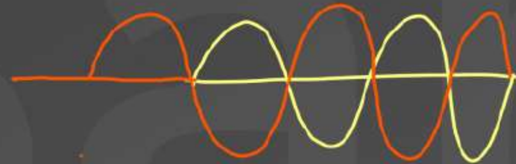
$A_{max} = (A_1 + A_2)$

$$I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$$

$I_{max} = 4I_0$ (If same source of I_0)

$\Delta x = 0, \lambda, 2\lambda, 3\lambda \ldots = n\lambda$

Destructive Interference



$\cos\phi = -1$

$\phi = (2n + 1)\pi$

$A_{min} = (A_1 - A_2)$

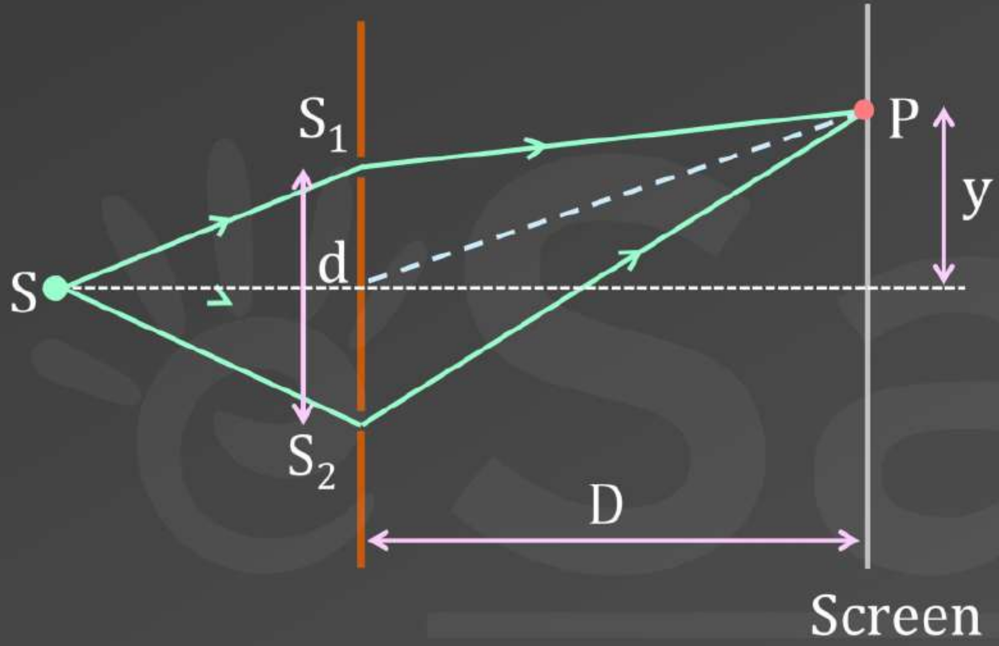
$$I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$$

$I_{min} = 0$ (If same source of I_0)

$\Delta x = 0.5\lambda, 1.5\lambda, 2.5\lambda \ldots = \left(n + \frac{1}{2}\right)\lambda$

PHYSICS WAHI jo Deewana BANA DE

Young's Double Slit Experiment (YDSE)

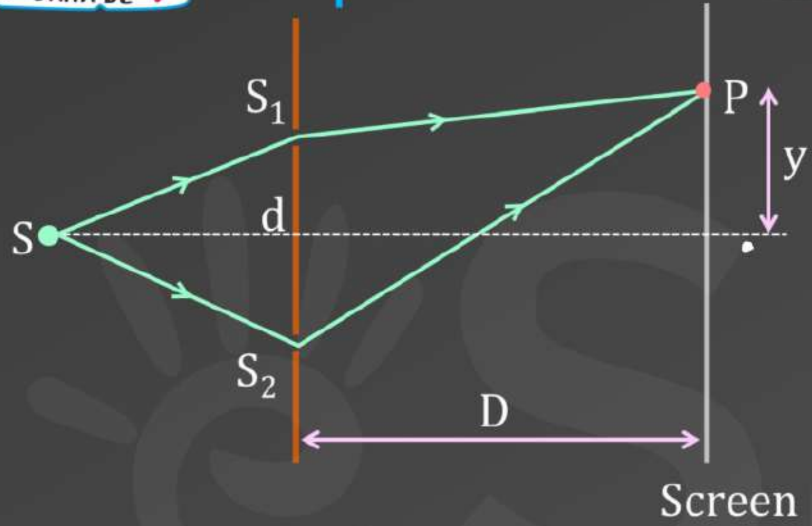


$$\Delta x = \frac{yd}{D}$$

d is distance between slits S_1 and S_2

D is distance between slit and screen

Young's Double Slit Experiment (YDSE)

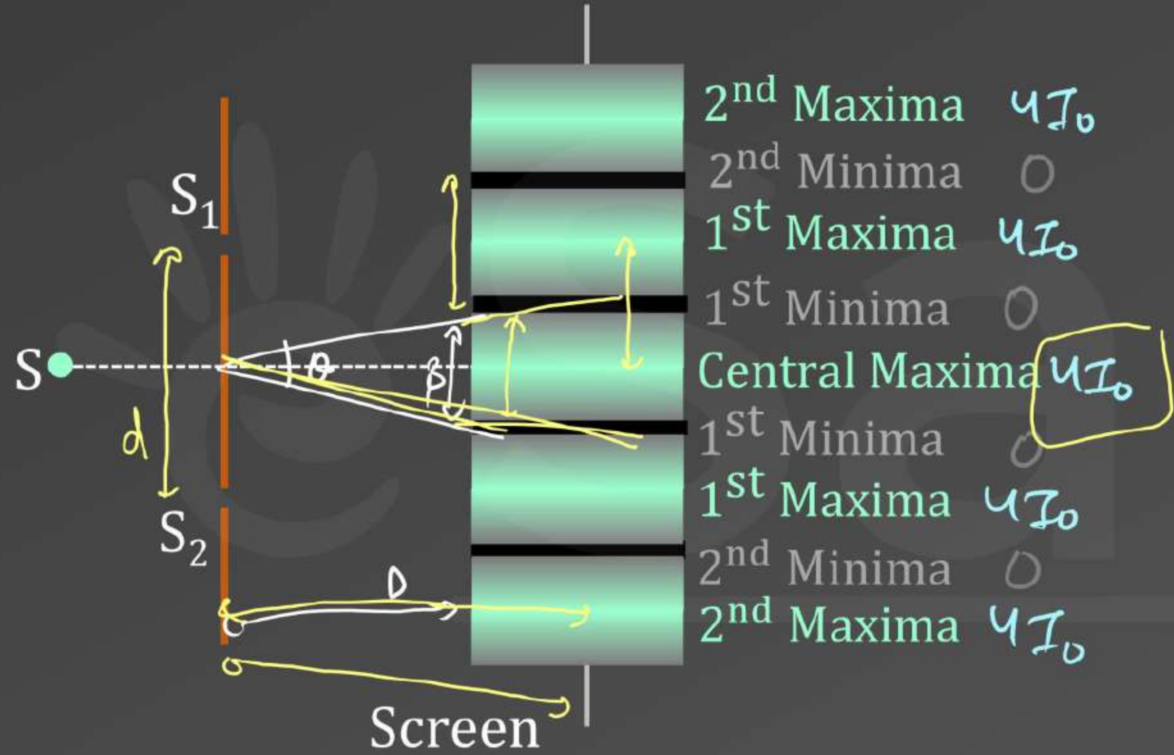


$\Delta x = \frac{yd}{D}$

$y = \frac{\Delta x D}{d}$

$y =$	0	$\frac{\lambda D}{2d}$	$\frac{\lambda D}{d}$	$\frac{3\lambda D}{2d}$	$\frac{2\lambda D}{d}$
	Central Maxima	1st Minima	1st Maxima	2nd Minima	2nd Maxima

Fringe Width

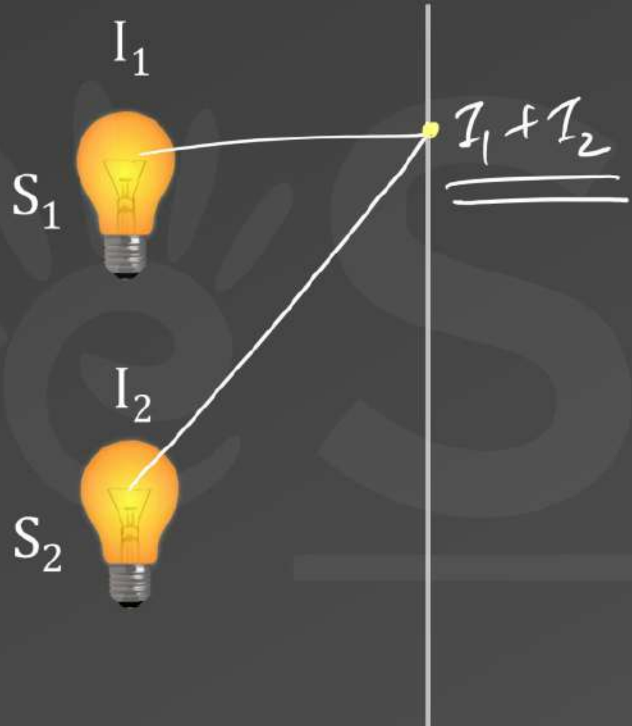


The distance between two successive dark fringes (or bright fringes) is known as Fringe Width (β).

$$\text{Fringe Width } '\beta' = \frac{\lambda D}{d}$$

$$\theta = \frac{\beta}{D} = \frac{\lambda}{d}$$

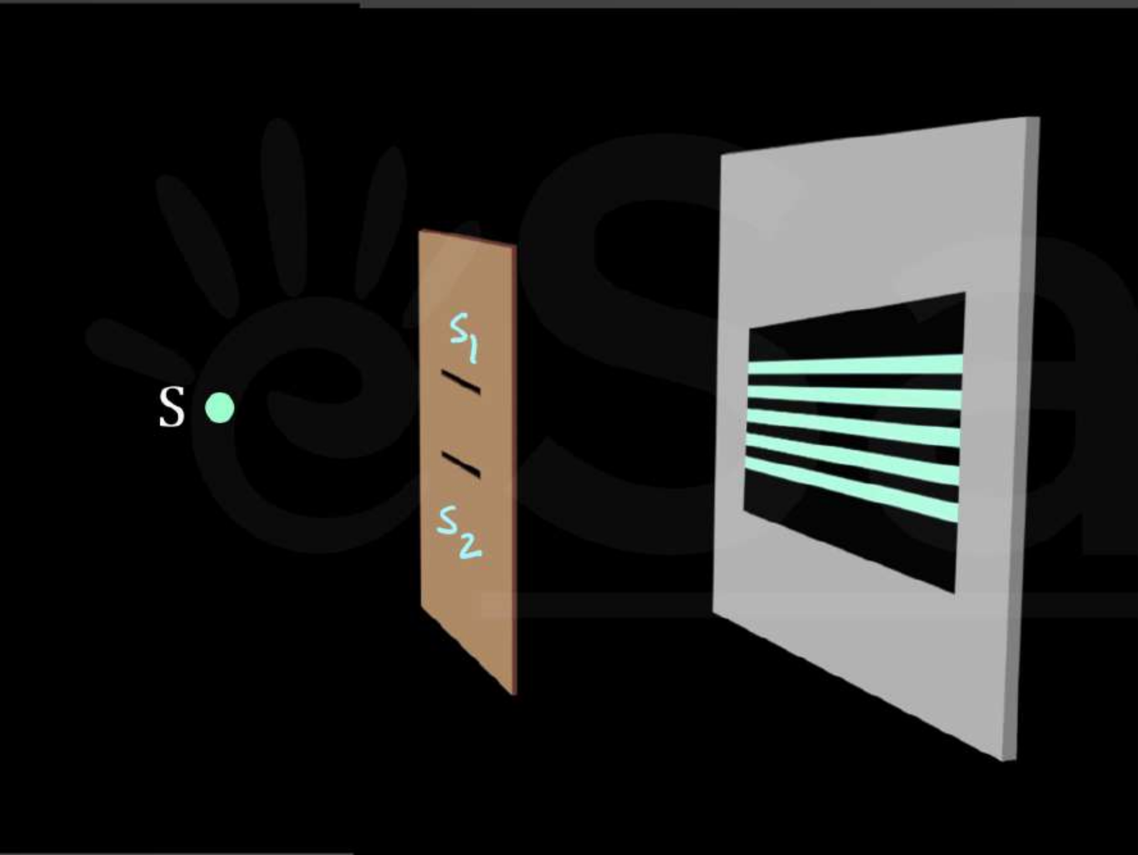
Angular Fringe Width



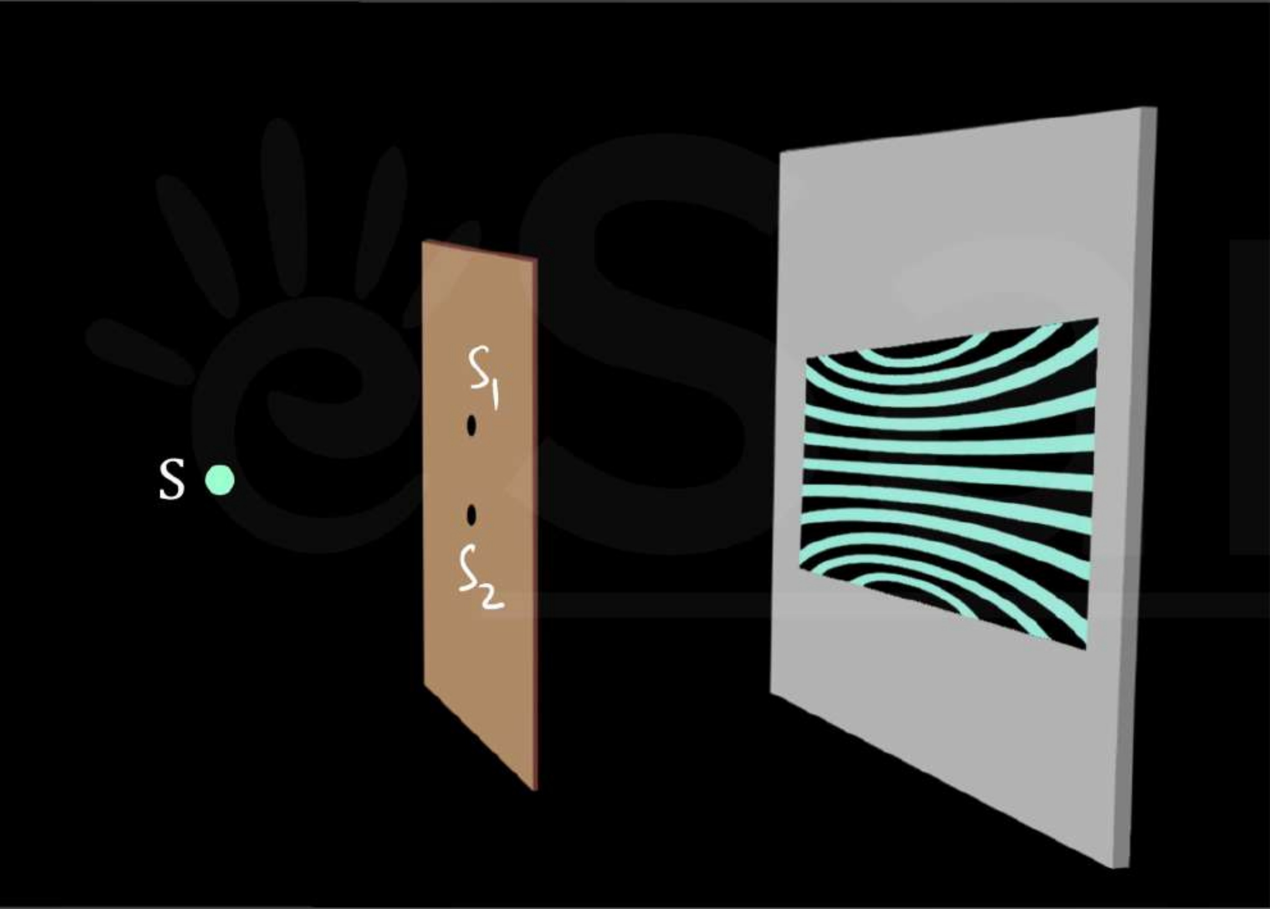
Incoherent Sources

$$I_{res} = I_1 + I_2$$

Shape of Fringes



Shape of Fringes



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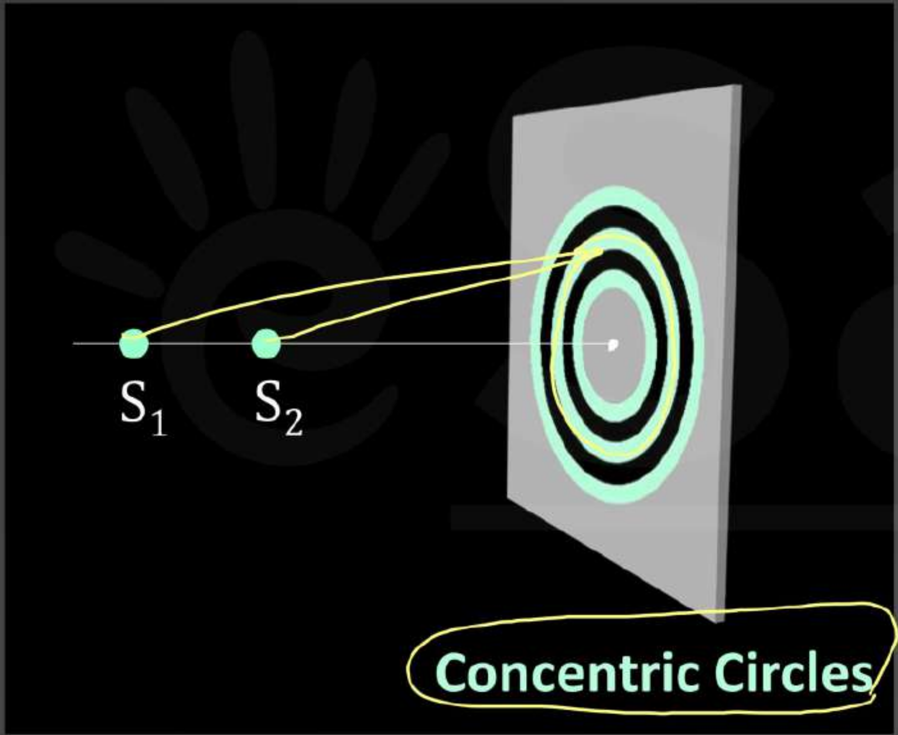
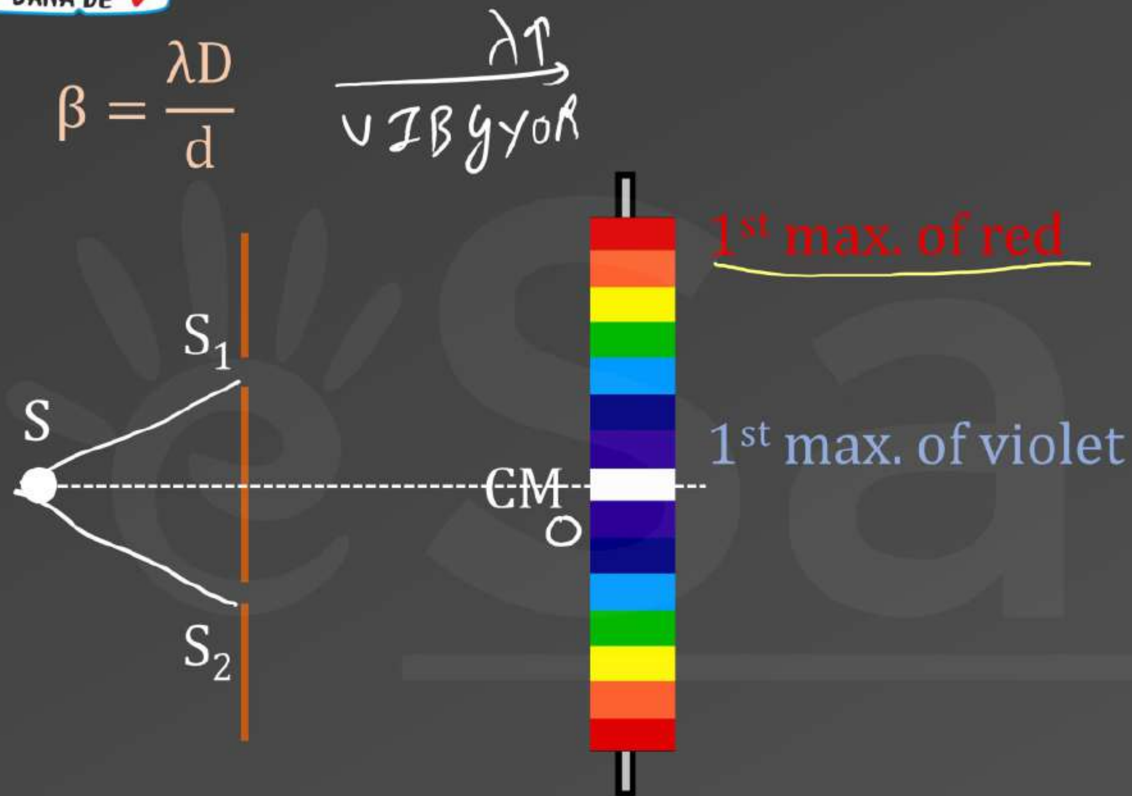


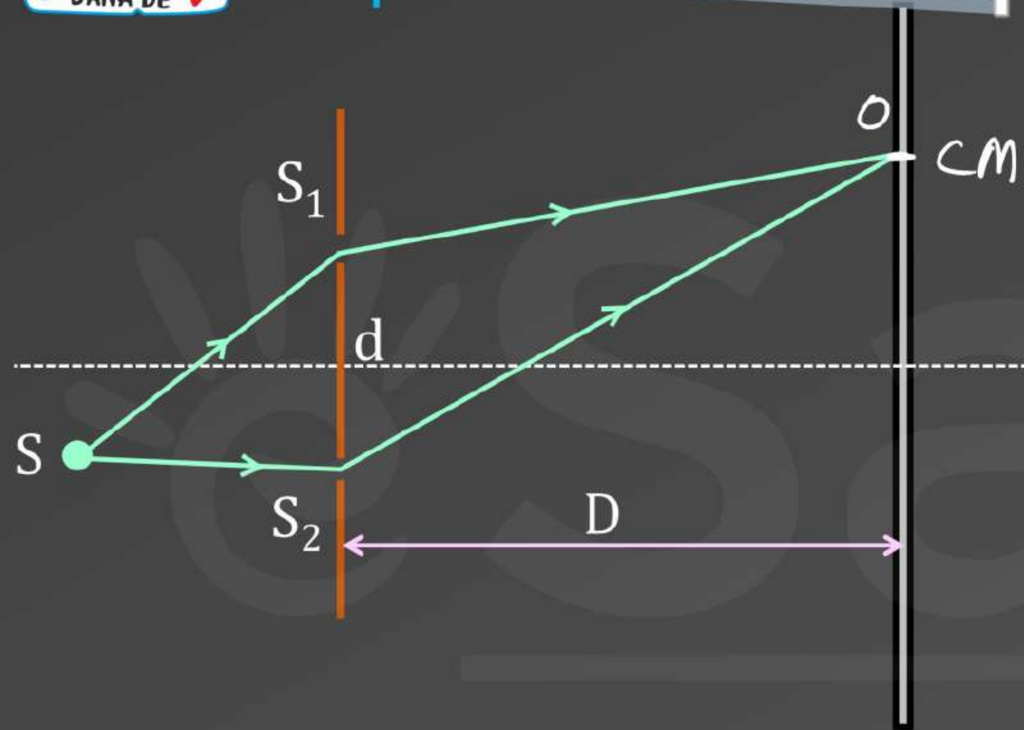
$$\beta = \frac{\lambda D}{d}$$

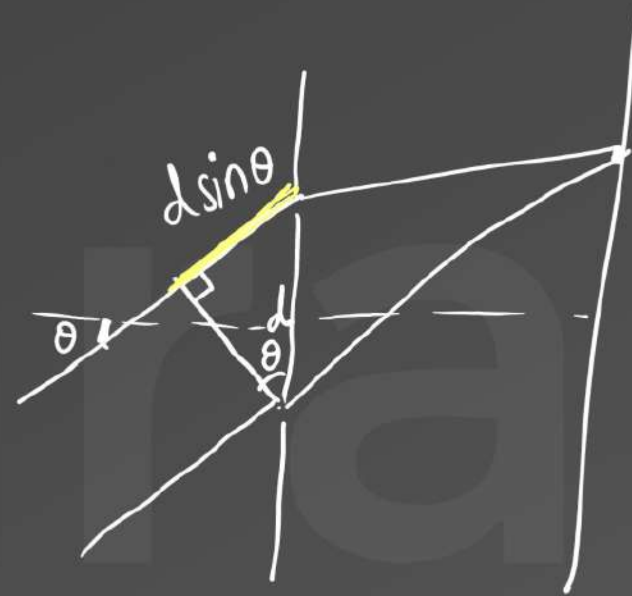


In YDSE with white light, we get a white fringe at central maxima i.e at a point of zero phase difference.

CM is followed by coloured fringes on its both sides.

Variations in YDSE



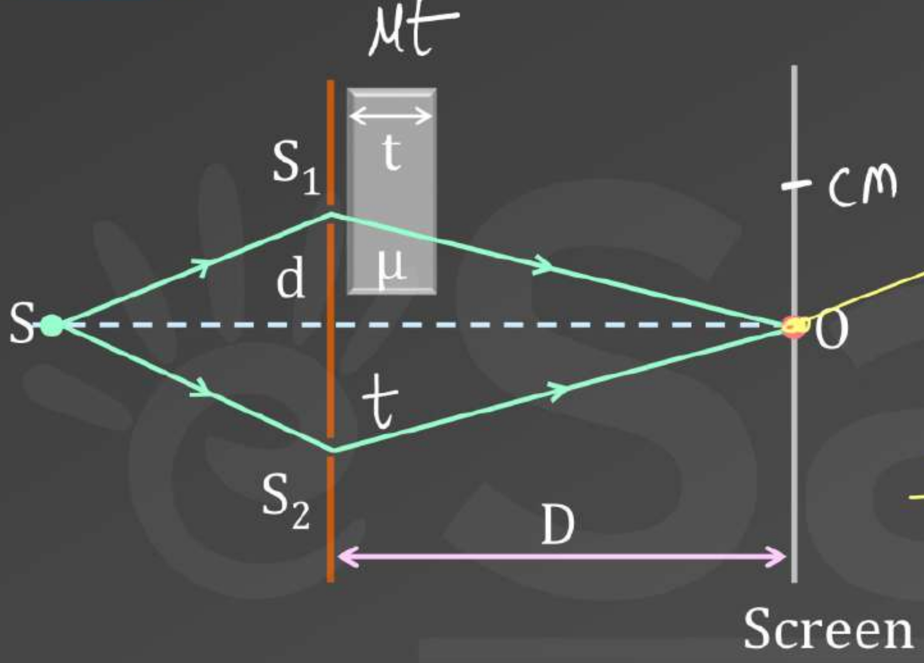


In this case CM shifts but fringe width remains same.

$$\beta = \frac{\lambda D}{d}$$

Optical path = μt

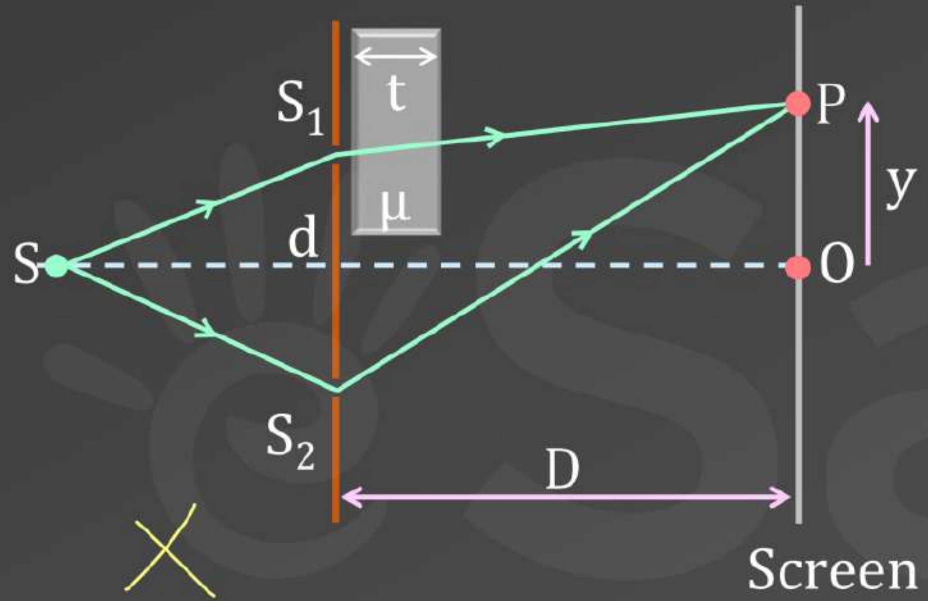
Pattern shifts ↑



Optical Path difference at O

$$\Delta x = (\mu - 1)t$$

$$\beta = \frac{\lambda_{air} D}{d}$$ → no change



$$(\Delta x) = (\mu - 1)t - \left(\frac{yd}{D}\right)$$

$$\beta = \frac{\lambda_{air} D}{d}$$ → no change

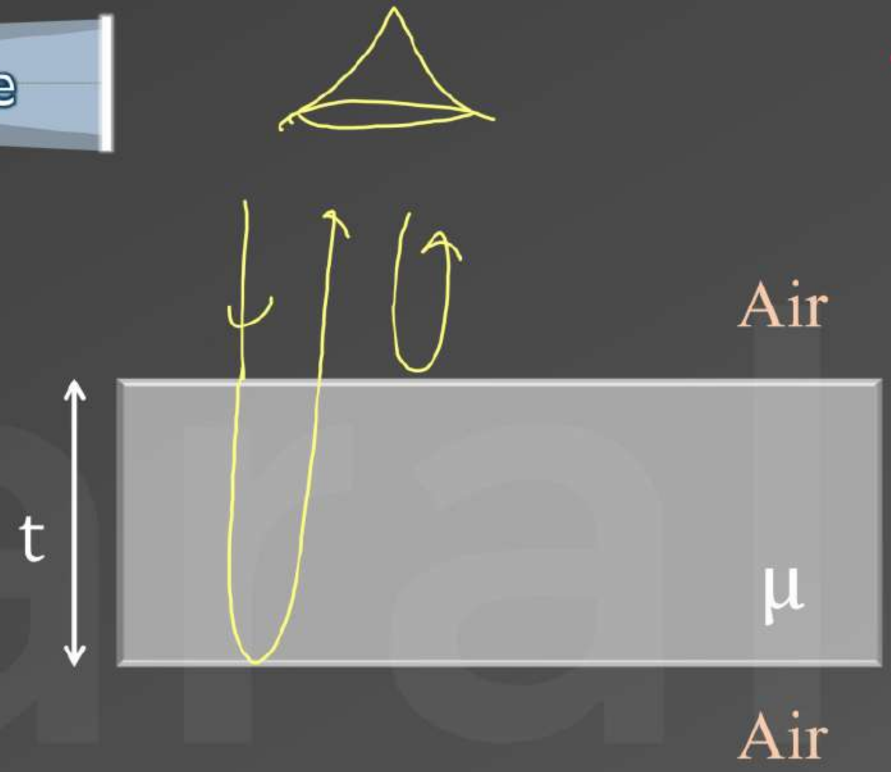
Thin Film Interference

a) Interference in Reflection

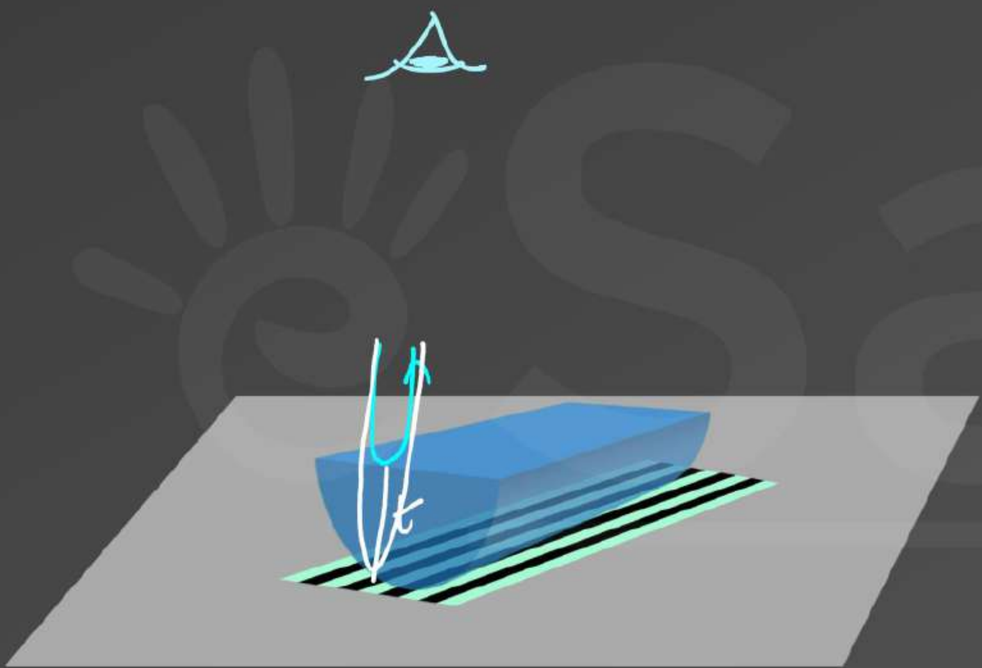
$(\Delta x)_{opt.} = 2\mu t$

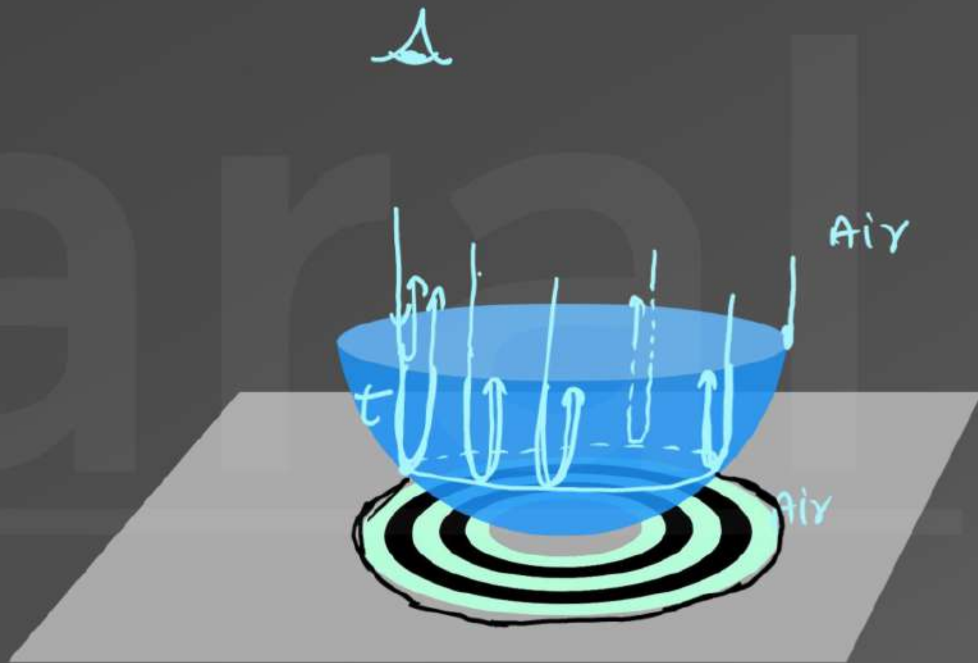
If $2\mu t = n\lambda$ Minima

$2\mu t = \left(n + \frac{1}{2}\right)\lambda$ Maxima



Newton's Rings

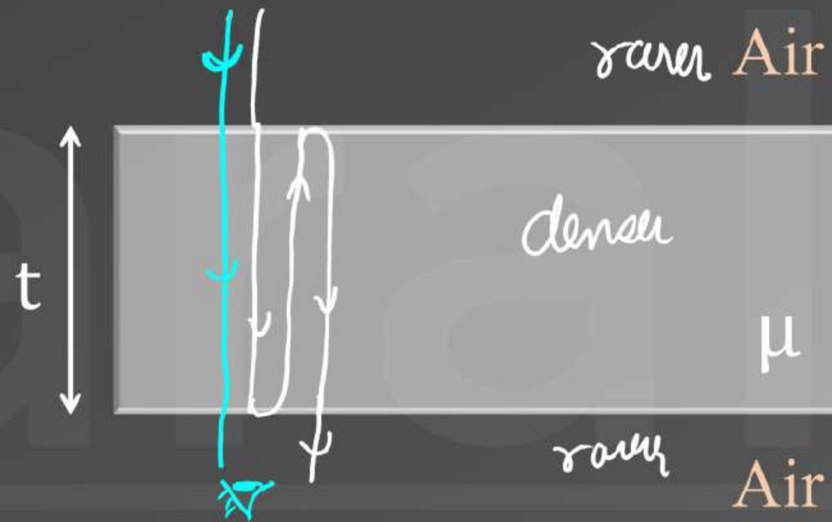




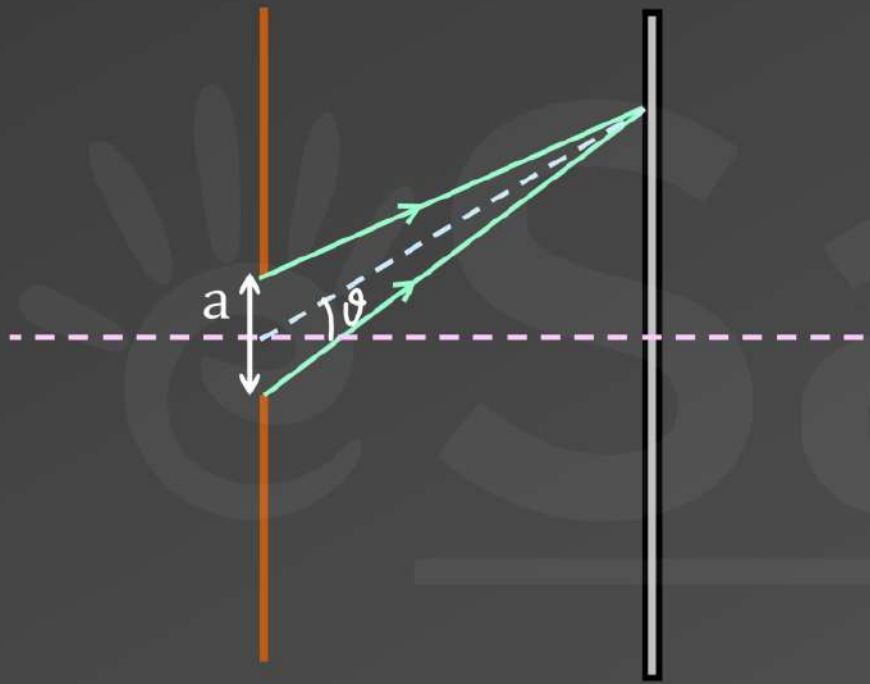
b) Interference in Transmission

$2\mu t = \Delta\lambda_{opt}$

- $n\lambda_{air}$ — const
- $(n+\frac{1}{2})\lambda_{air}$ — dest



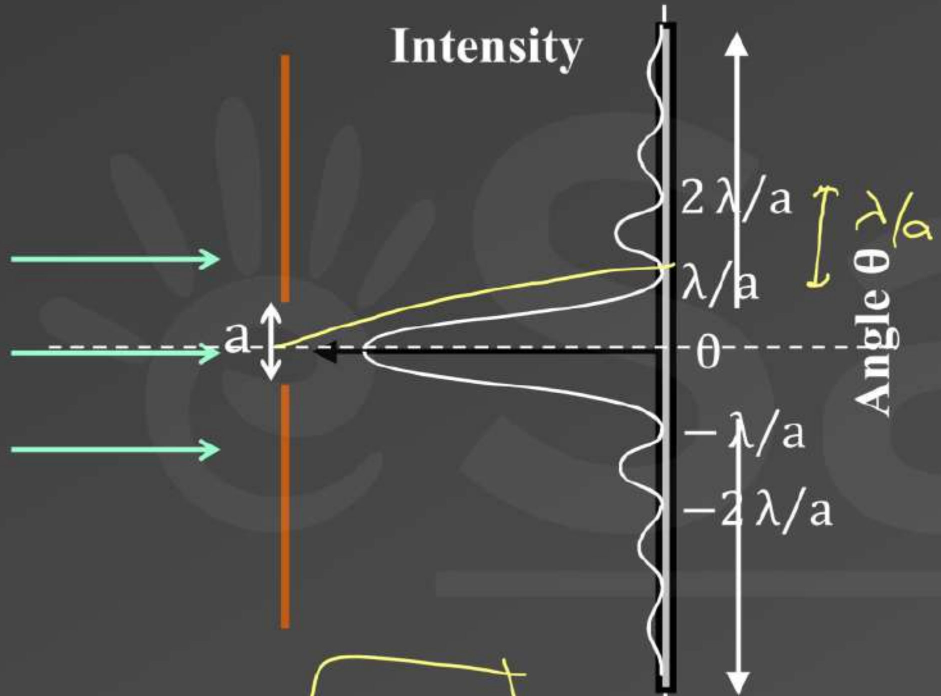
Diffraction Through Single Slit



$$a\theta = \left(n + \frac{1}{2}\right)\lambda \quad \text{Maxima}$$

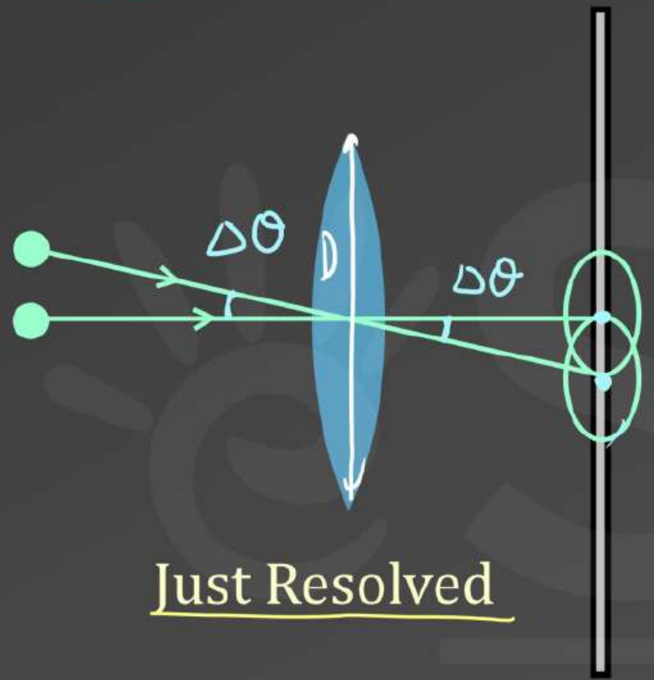
$$a\theta = n\lambda \quad \text{Minima}$$

Diffraction Through Single Slit



$$\theta = \frac{n\lambda}{a}$$

Resolution of Optical Instruments



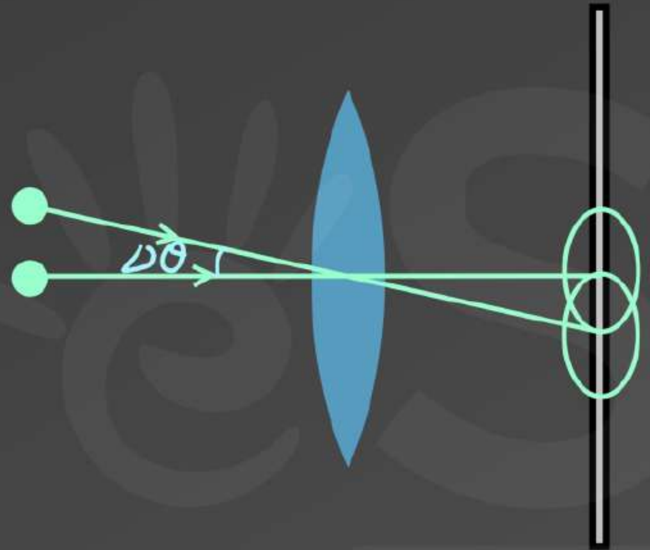
$$\Delta\theta_{min} = \frac{1.22\lambda}{D}$$

D is Diameter of Lens

Just Resolved

(Resolved : seen as separated)

Resolving Power of Telescope



$$\text{R.P of Telescope} = \frac{1}{\Delta\theta_{min}} = \frac{D}{1.22\lambda}$$

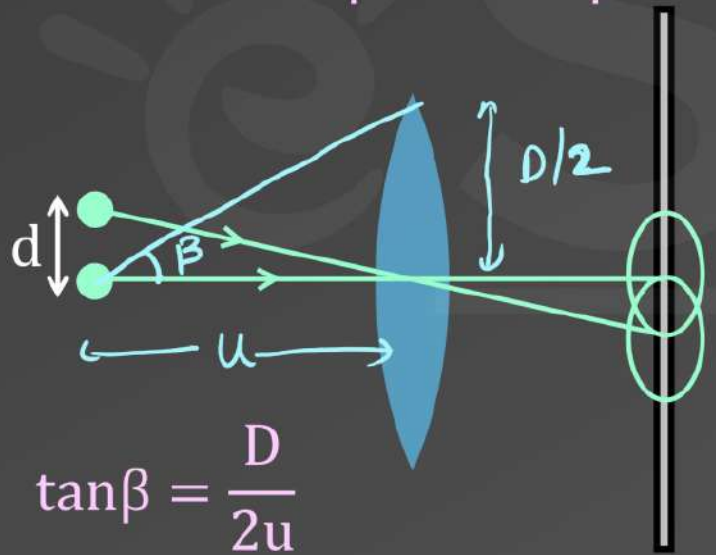
D = Diameter of Objective Lens.

Resolving Power of Microscope

RP of Microscope = $\frac{1}{d_{min}}$

Defined as reciprocal of the distance between 2 objects which can be just resolved when seen through microscope.

$$d_{min} = \frac{1.22\lambda}{2\tan\beta} = \frac{1.22\lambda}{2\sin\beta}$$



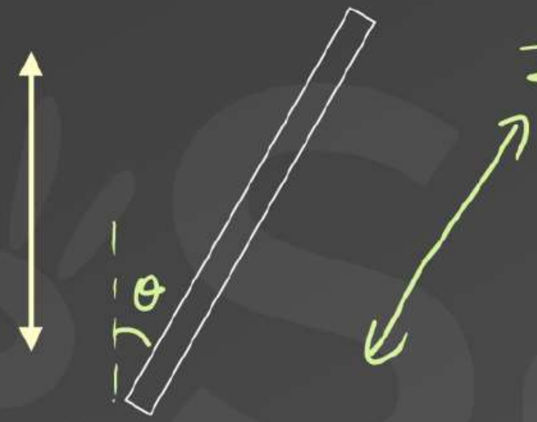
$$\tan\beta = \frac{D}{2u}$$

Simplest

Polarised Wave

Polaroid

I_0



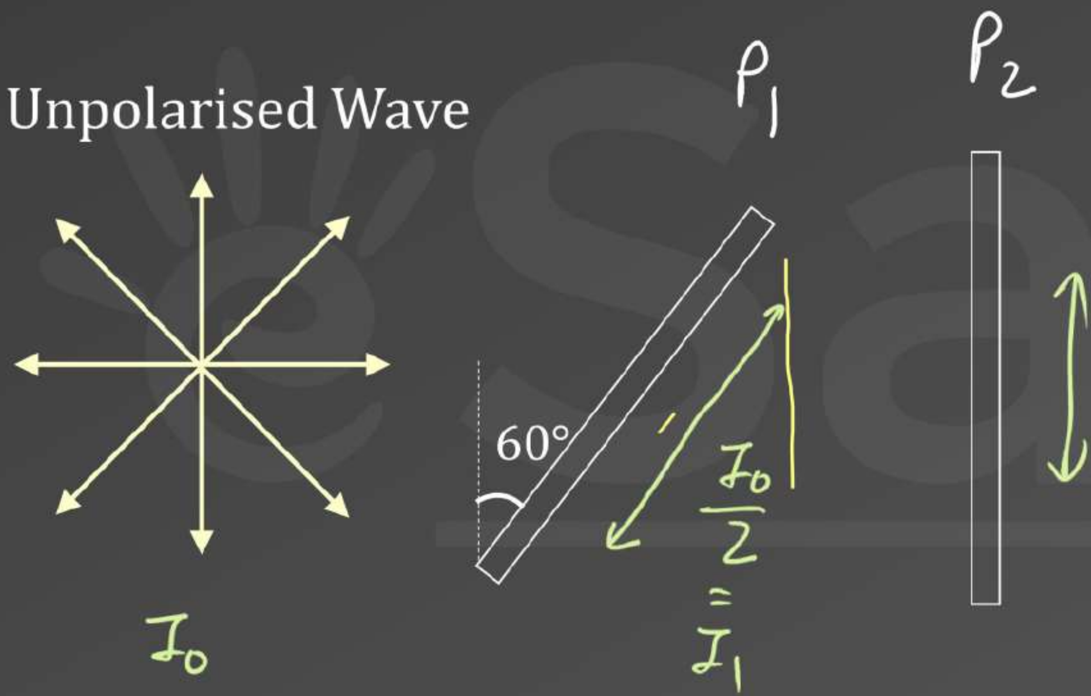
$I = I_0 \cos^2\theta$

$$I = I_0 \cos^2\theta$$

Malus' Law

Unpolarised Wave

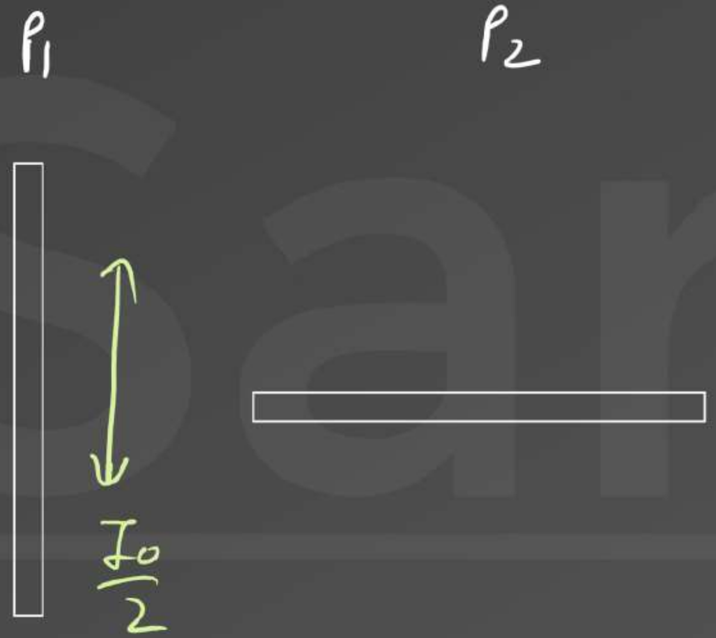
Polaroid



$$I_2 = I_1 \cos^2 60^\circ$$

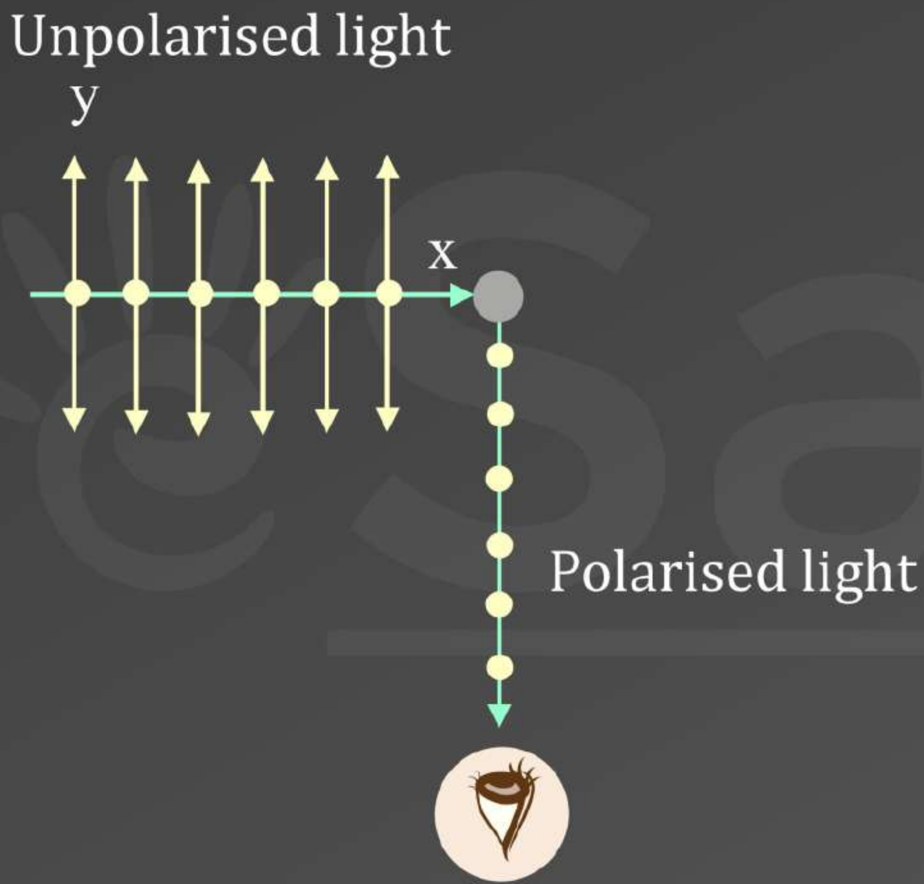
$$= \frac{I_0}{2} \times \frac{1}{4} = \boxed{\frac{I_0}{8}}$$

Unpolarised Wave



$$\frac{I_0}{2}\cos^2 90^\circ = 0$$

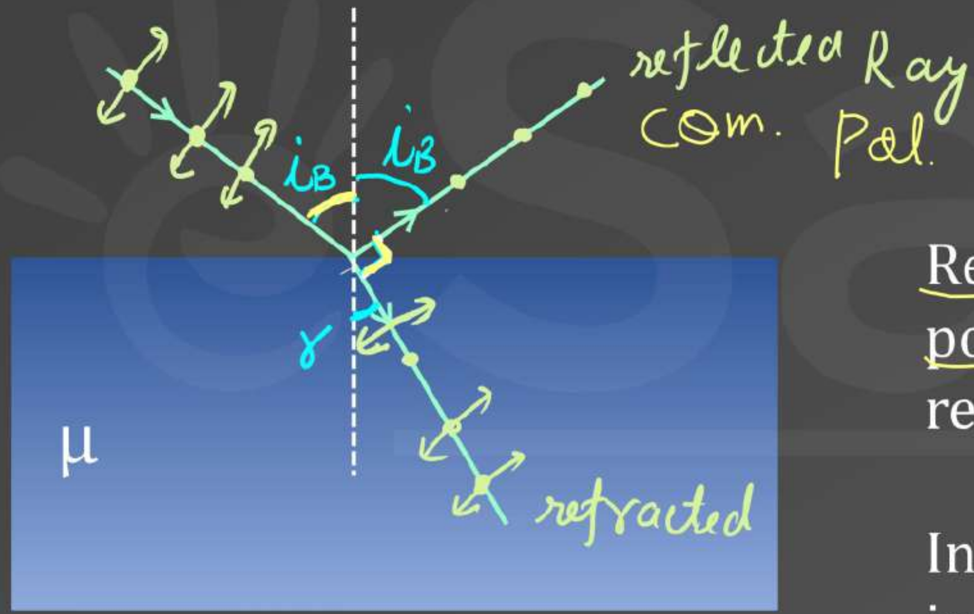
Polarisation by Scattering



Polarisation by Reflection

$\tan i_B = \mu$ → Brewster's Law

$\Rightarrow i_B = \tan^{-1}(\mu)$



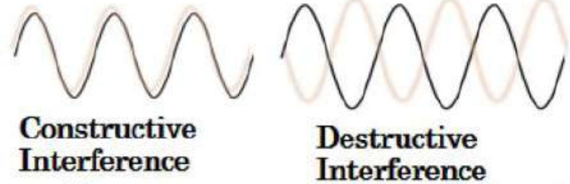
$i_B + r = 90°$

Reflected light is completely polarised when refracted and reflected rays are perpendicular.

In this situation the angle of incidence is called Brewster's Angle.

QUIZ TIME

WAVE OPTICS



- Two sources are said to be Coherent if they produce waves having constant (with respect to time) phase difference.
- For Incoherent sources, phase difference varies with time.
- Two independent ordinary sources (like lamps) are incoherent sources.

Constructive Interference

$\cos\phi = 1$

$\phi = 2n\pi$

$A_{max} = (A_1 + A_2)$

$I_{max} =$ 1

$I_{max} = 4I_0$ (If same source of I0)

$\Delta x = 0, \lambda, 2\lambda, 3\lambda\ldots = n\lambda$

Destructive Interference

$\cos\phi = -1$

$\phi = (2n+1)\pi$

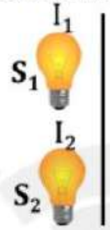
$A_{min} = (A_1 - A_2)$

$I_{min} =$ 2

$I_{min} = 0$ (If same source of I0)

$\Delta x = 0.5\lambda, 1.5\lambda, 2.5\lambda\ldots = \left(n + \frac{1}{2}\right)\lambda$

Incoherent Sources



$I_{res} = I_1 + I_2$

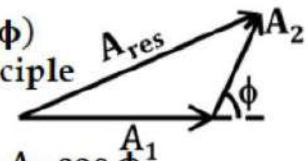
Interference of Waves

$y_1 = A_1 \sin(kx - \omega t)$

$y_2 = A_2 \sin(kx - \omega t + \phi)$

By Superposition Principle

$y_{res} = y_1 + y_2$



$(A_{res})^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$

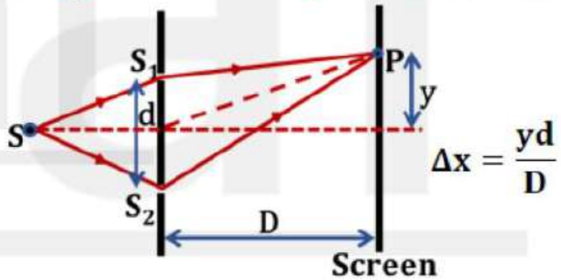
$I \propto A^2$

$I_{res} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$

If $I_1 = I_2 = I0$, then

$I_{res} = 4I_0\cos^2\left(\frac{\phi}{2}\right)$

Young's Double Slit Experiment (YDSE)



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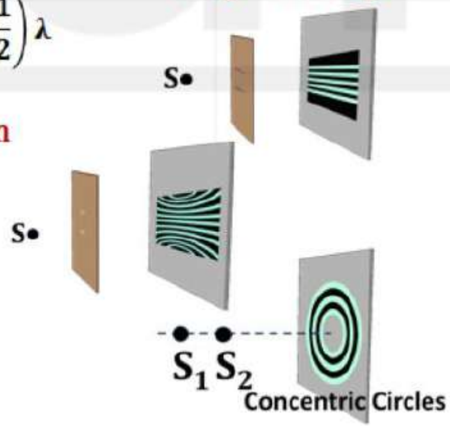
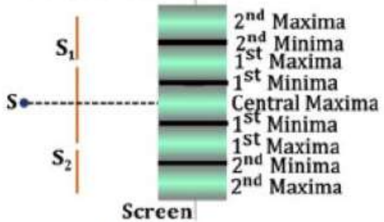
y	0	$\frac{\lambda D}{2d}$	$\frac{\lambda D}{d}$	$\frac{3\lambda D}{2d}$	$\frac{2\lambda D}{d}$
Max /Min	Central Maxima	1st Minima	1st Maxima	2nd Minima	2nd Maxima

Shape of Fringes



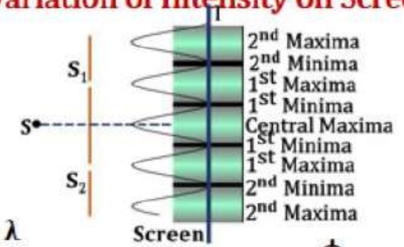
Fringe Width β'



$'\beta' = \frac{\lambda D}{d}$

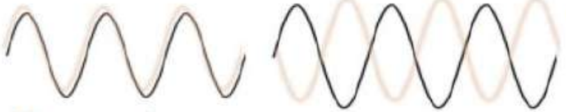
Angular Fringe Width $\theta = \frac{\beta}{D} = \frac{\lambda}{d}$

Variation of Intensity on Screen



$I_{res} = 4I_0\cos^2\frac{\phi}{2}$

WAVE OPTICS



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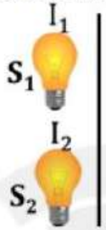

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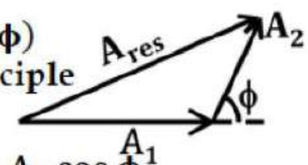

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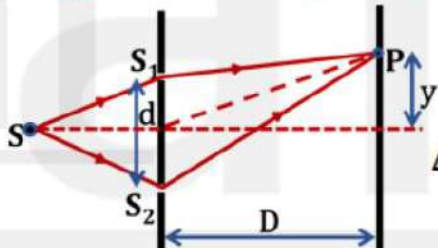

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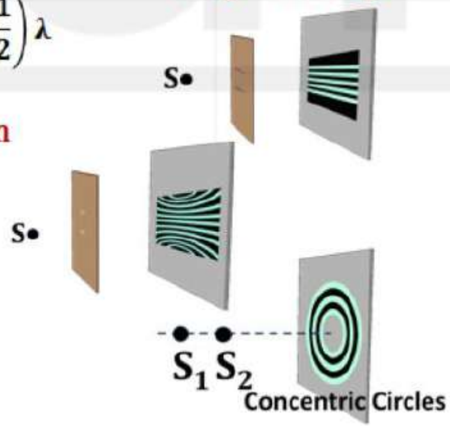
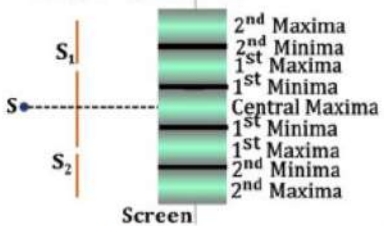
Shape of Fringes



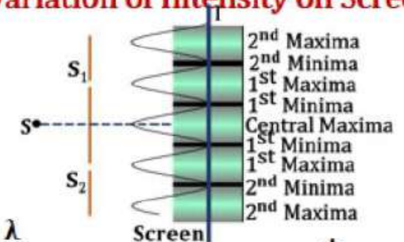
Fringe Width β′



$'\beta' = \frac{\lambda D}{d}$

Angular Fringe Width $\theta = \frac{\beta}{D} = \frac{\lambda}{d}$

Variation of Intensity on Screen



$I_{res} = 4I_0\cos^2\frac{\phi}{2}$

eSaral

WAVE OPTICS

Thin Film Interference

a) Interference in Reflection

$$\Delta x_{opt} = \left(n + \frac{1}{2}\right)\lambda_{air} \rightarrow \text{Cons}$$

$$2\mu t = \left(n + \frac{1}{2}\right)\lambda_{air} \rightarrow \text{Cons}$$

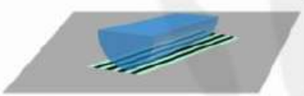
$$2\mu t = n\lambda_{air} \rightarrow \text{Dest}$$

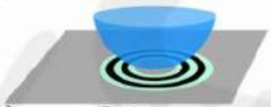
b) Interference in Transmission

$(\Delta x)_{opt} = 2\mu t$

$$2\mu t = \left(n + \frac{1}{2}\right)\lambda_{air} \rightarrow \text{Dest}$$

$$2\mu t = n\lambda_{air} \rightarrow \text{Cons}$$





$(\Delta x)_{opt} = 2\mu t$

$$2\mu t = \left(n + \frac{1}{2}\right)\lambda \rightarrow \text{Cons}$$

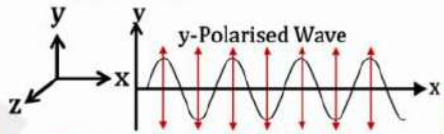
$$2\mu t = n\lambda \rightarrow \text{Des}$$

$(\Delta x)_{opt.} = 2\mu t$

$$2\mu t = \left(n + \frac{1}{2}\right)\lambda_{air} \rightarrow \text{Cons}$$

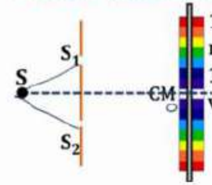
$$2\mu t = n\lambda_{air} \rightarrow \text{Dest}$$

Polarisation



Unpolarised Wave

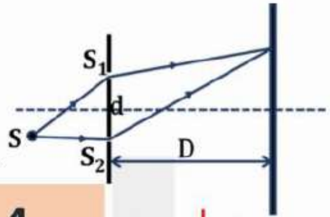
YDSE with white light



$\beta =$ 3

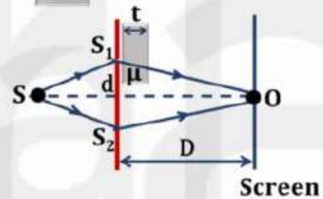
Variations in YDSE

In this case CM shifts but fringe width remains same.



Optical path = 4

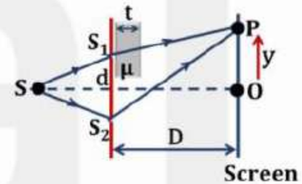
μt



Phase difference at O

$\Delta x = (\mu - 1)t$

$$\beta = \frac{\lambda_{air} D}{d} \quad \text{No change}$$



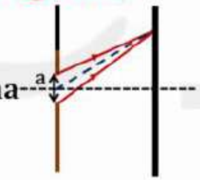
$$(\Delta x) = (\mu - 1)t - \left(\frac{yd}{D}\right)$$

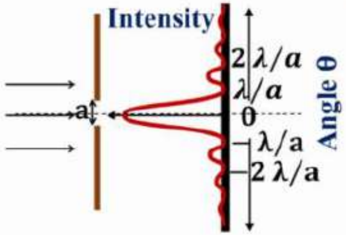
$$\beta = \frac{\lambda_{air} D}{d} \quad \text{No change}$$

Diffraction Through Single Slit

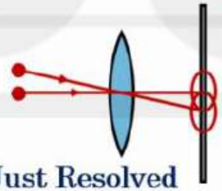
$a\theta =$ 5 Minima

$$a\theta = \left(n + \frac{1}{2}\right)\lambda \quad \text{Maxima}$$





Resolution of Optical Instruments



Just Resolved

(Resolved : seen as separated)

$$\Delta\theta_{min} = \frac{1.22\lambda}{D}$$

Resolving Power of Telescope

$$\text{R.P of Telescope} = \frac{1}{\Delta\theta_{min}} = \frac{D}{1.22\lambda}$$

D = Diameter of Objective Lens.

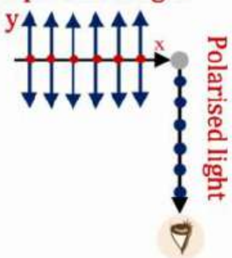
Resolving Power of Microscope

$$\text{R.P of Microscope} = \frac{1}{d_{min}}$$

$$d_{min} = \frac{1.22\lambda}{2\tan\beta} = \frac{1.22\lambda}{2\sin\beta}$$

$$d_{min} = \frac{1.22\lambda}{2\mu\sin\beta} \qquad \tan\beta = \frac{D}{2u}$$

Polarisation by Scattering



Polarisation by Reflection

$\tan(i_B) = \mu$

Brewster's Law

$i_B = \tan^{-1}\mu$

$i_B + r = 90°$

WAVE OPTICS

Thin Film Interference

a) Interference in Reflection

$\Delta x_{opt} = \left(n + \frac{1}{2}\right)\lambda_{air} \rightarrow$ Cons

$2\mu t = \left(n + \frac{1}{2}\right)\lambda_{air} \rightarrow$ Cons

$2\mu t = n\lambda_{air} \rightarrow$ Dest

b) Interference in Transmission

$(\Delta x)_{opt} = 2\mu t$

$2\mu t = \left(n + \frac{1}{2}\right)\lambda_{air} \rightarrow$ Dest

$2\mu t = n\lambda_{air} \rightarrow$ Cons

$(\Delta x)_{opt} = 2\mu t$

$2\mu t = \left(n + \frac{1}{2}\right)\lambda \rightarrow$ Cons

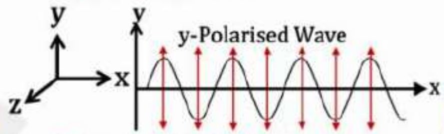
$2\mu t = n\lambda \rightarrow$ Des

$(\Delta x)_{opt} = 2\mu t$

$2\mu t = \left(n + \frac{1}{2}\right)\lambda_{air} \rightarrow$ Cons

$2\mu t = n\lambda_{air} \rightarrow$ Dest

Polarisation

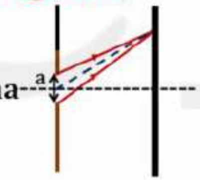


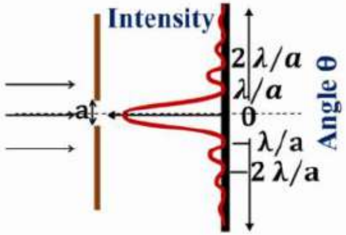
Unpolarised Wave

Diffraction Through Single Slit

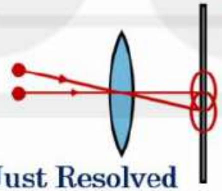
$a\theta = n\lambda$ Minima

$a\theta = \left(n + \frac{1}{2}\right)\lambda$ Maxima





Resolution of Optical Instruments



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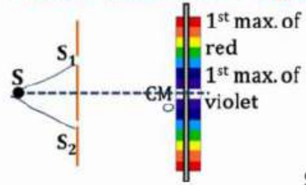
Resolving Power of Microscope

R.P of Microscope $= \frac{1}{d_{min}}$

$d_{min} = \frac{1.22\lambda}{2\tan\beta} = \frac{1.22\lambda}{2\sin\beta}$

$d_{min} = \frac{1.22\lambda}{2\mu\sin\beta}$ $\tan\beta = \frac{D}{2u}$

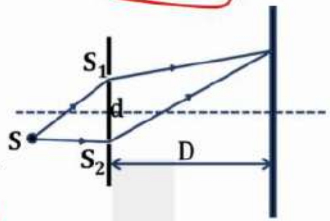
YDSE with white light



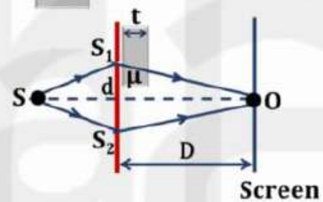
$\beta = \frac{\lambda D}{d}$

Variations in YDSE

In this case CM shifts but fringe width remains same.



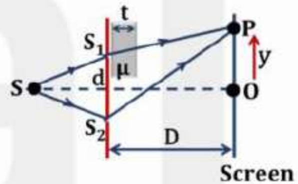
Optical path $= \mu t$



Phase difference at O

$\Delta x = (\mu - 1)t$

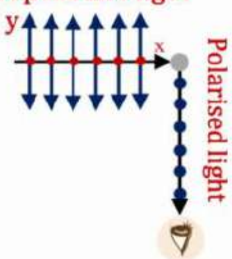
$\beta = \frac{\lambda_{air}D}{d}$ No change



$(\Delta x) = (\mu - 1)t - \left(\frac{yd}{D}\right)$

$\beta = \frac{\lambda_{air}D}{d}$ No change

Polarisation by Scattering



Polarisation by Reflection

$\tan(i_B) = \mu$

Brewster's Law

$i_B = \tan^{-1}\mu$

$i_B + r = 90°$

Electromagnetic Waves

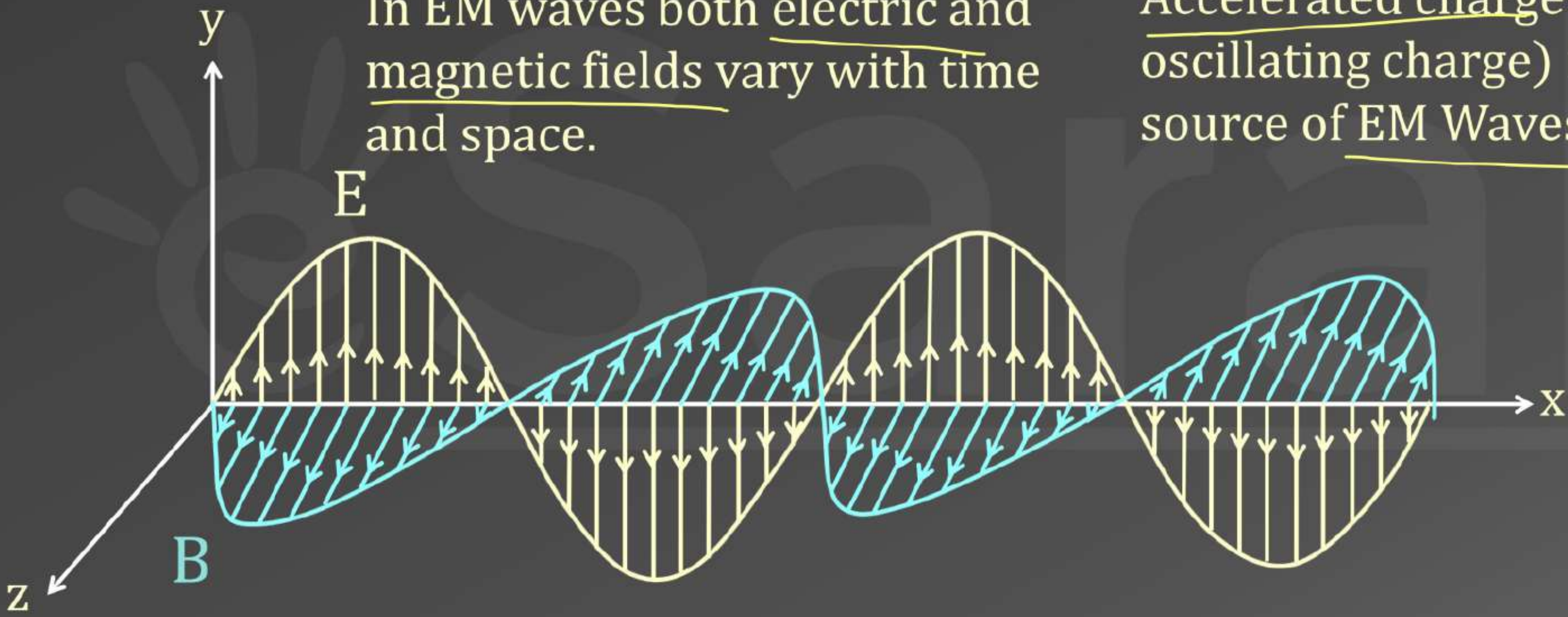
1 Formula

Superfast Revision

Electromagnetic Waves

In EM waves both electric and magnetic fields vary with time and space.

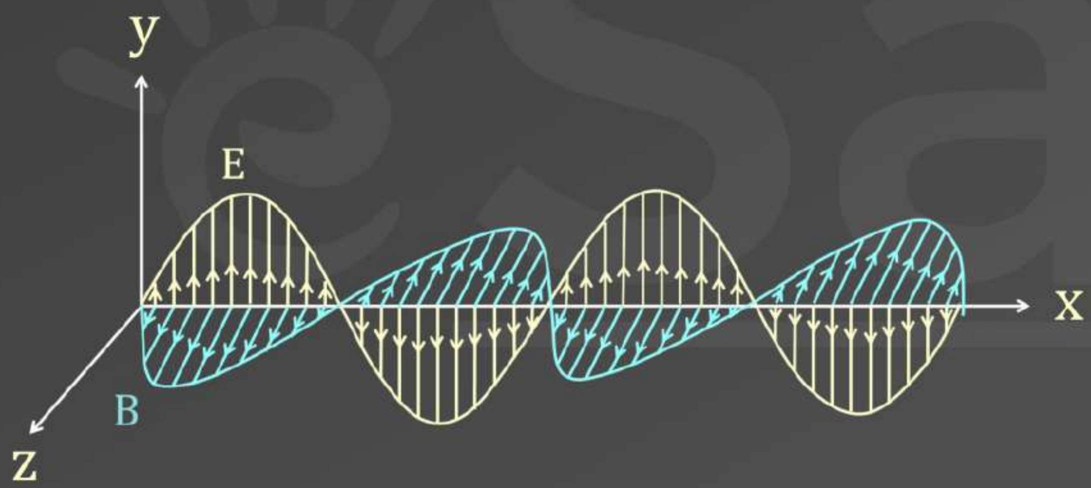
Accelerated charge (e.g. a oscillating charge) is a source of EM Waves.



Electromagnetic Waves

$$E = Bc$$ TRICK

$$\hat{E} \times \hat{B} = \hat{v}$$



$\vec{E}$ and $\vec{B}$ are perpendicular to each other and are also perpendicular to direction of propagation of wave.

Q) A plane electromagnetic wave of frequency 25 MHz travels in free space along the x-direction. At a particular point in space and time, $\vec{E} = 6.3\,\hat{j}$ V/m. What is $\vec{B}$ at this point?

Sol. $E = Bc$

$$B = \frac{E}{c} = \frac{6.3}{3 \times 10^8} = 2.1 \times 10^{-8}\ T$$

$$\hat{E} \times \hat{B} = \hat{v}$$

$$\hat{j} \times \hat{k} = \hat{i}$$

$$\vec{B} = 2.1 \times 10^{-8}\ \hat{k}\ T$$

Electromagnetic Waves

Energy Density (Energy/vol^m) in form of $\vec{E}$ $= \frac{1}{2} \epsilon_0 E_{rms}^2$

||

" $\vec{B}$ $= \frac{B_{rms}^2}{2\mu_0}$

Electromagnetic waves can be polarized.

Energy is equally divided in electric and magnetic field.

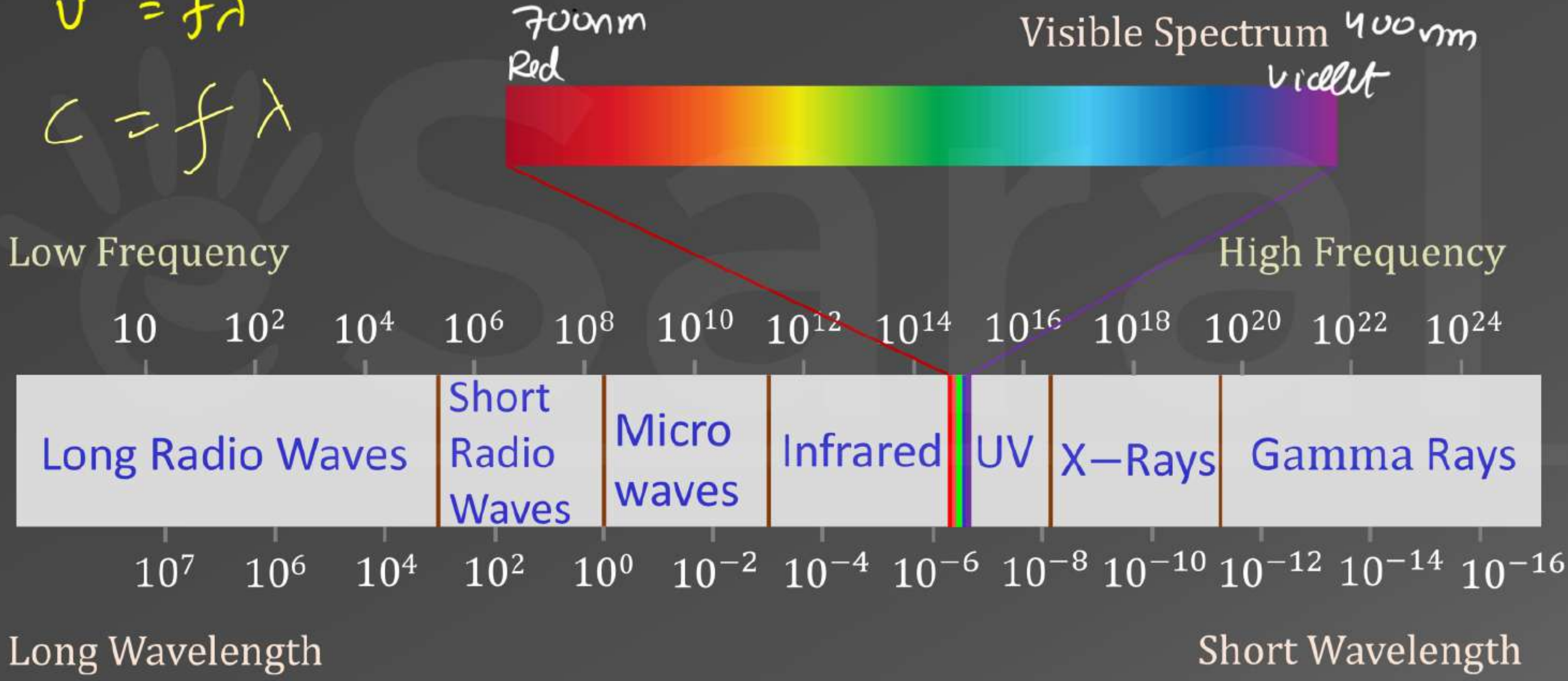
Total Energy density $= \epsilon_0 E_{rms}^2 = \frac{B_{rms}^2}{\mu_0}$

Intensity of EM waves $= \varepsilon_0 c\, E_{rms}^2$

Electromagnetic Spectrum

$v = f\lambda$

$c = f\lambda$



Type	Wavelength range	Uses
Radio Waves	> 0.1 m	Radio and television communication
Microwave	10^{-1}m to 10^{-3}m 0.1 m to 1 mm	Microwave Oven, Radar System
Infrared (Produced by hot bodies)	1mm to 700nm	Remote Switches and Household electronic devices

Type	Wavelength range	Uses
Visible Rays	700 nm to 400nm	To see objects
Ultraviolet	400 nm to 1nm	Eye surgery, Water purifier
X-rays	1nm (10^{-9}m) to 10^{-3} nm (10^{-12}m)	Medical diagnosis
Gamma rays (Produced in Nuclear Reactions)	$< 10^{-3}$ nm	Medical treatment (to destroy cancer cells)

Electromagnetic Waves

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$ vaceum ☆☆

$$v = \frac{1}{\sqrt{\mu \varepsilon}} = \frac{1}{\sqrt{\mu_r \mu_0 \varepsilon_r \varepsilon_0}} = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$$

medium

μ_0 - Permeability of free space (vacuum)

ε_0 - Permittivity of free space (vacuum)

μ - Permeability of medium

ε - Permittivity of medium

Q) The dimensions of $(\mu_0\epsilon_0)^{-\frac{1}{2}}$ are

(1) $[L^{1/2}T^{-1/2}]$ (2) $[L^{-1}T]$ (3) $[LT^{-1}]$ (4) $[L^{-1/2}T^{-1/2}]$

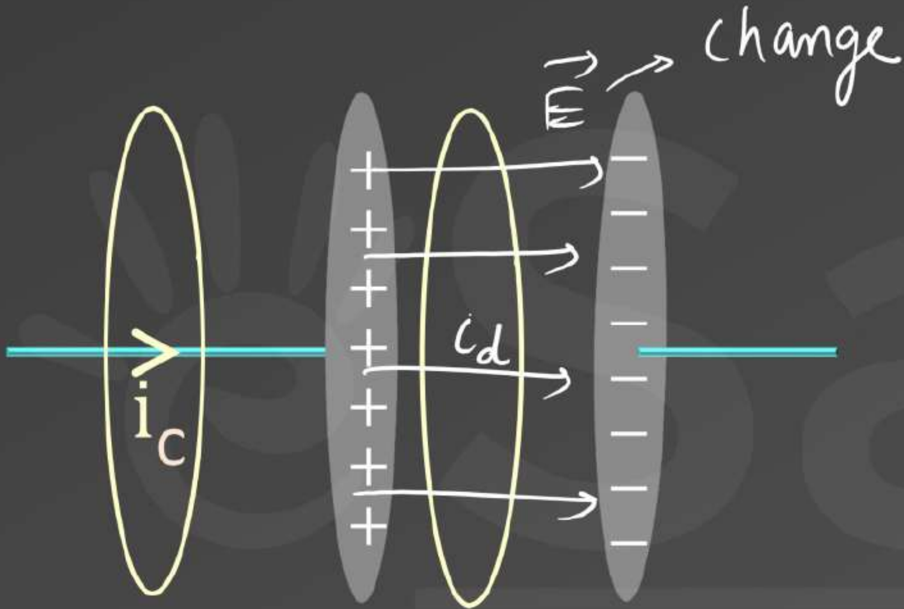
Sol.

speed

$$c = \frac{1}{\sqrt{\mu_0\epsilon_0}} = (\mu_0\epsilon_0)^{-1/2}$$

$$LT^{-1} = [(\mu_0\epsilon_0)^{-1/2}]$$

Displacement Current



$i_d = \epsilon_0 \dfrac{d\phi_E}{dt}$ Electric flux

Ampere-Maxwell Law

$$\oint \vec{B}.\overrightarrow{d\ell} = \mu_0\,(i_c + i_d)$$

$$\oint \vec{B}.\overrightarrow{d\ell} = \mu_0 i_c + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$$

QUIZ TIME

ELECTROMAGNETIC WAVES

Maxwell's Equation

1) $\oint \vec{E}\cdot\vec{dA} = \frac{Q}{\epsilon_0}$ Gauss's Law for electricity

2) $\oint \vec{B}\cdot\vec{dA} = 0$ Gauss's Law for magnetism

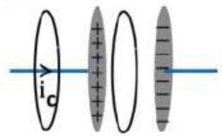
3) $\oint \vec{E}\cdot\vec{d\ell} = -\frac{d\phi_B}{dt}$ Faraday's Law

4) $\oint \vec{B}\cdot\vec{d\ell} = \mu_0 i_c + \mu_0\epsilon_0\frac{d\phi_E}{dt}$ Ampere-Maxwell Law

$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$ μ_0 - Permeability of free space (vacuum)
ε_0 - Permittivity of free space (vacuum)

$v = \frac{1}{\sqrt{\mu\,\varepsilon}}$ μ - Permeability of medium
ε - Permittivity of medium

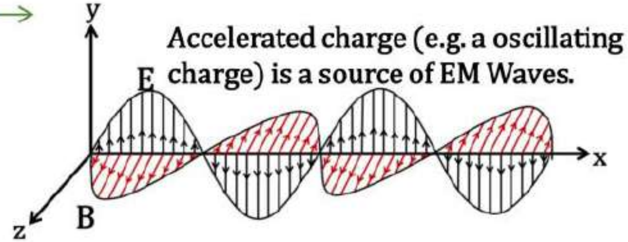
Displacement Current



Ampere-Maxwell Law

$$\oint \vec{B}\cdot\vec{d\ell} = \mu_0\,(i_c + id)$$

$$\oint \vec{B}\cdot\vec{d\ell} = \mu_0 i_c + \mu_0\epsilon_0\frac{d\phi_E}{dt}$$



Accelerated charge (e.g. a oscillating charge) is a source of EM Waves.

- In EM waves both electric and magnetic fields vary with time and space.

1

- $\vec{E}$ and $\vec{B}$ are perpendicular to each other and are also perpendicular to direction of propagation of wave.
- Electromagnetic waves can be polarized.
- Energy is equally divided in electric and magnetic field.
- Energy Density $= \frac{1}{2}E_0E_{rms}^2 = \frac{B_{rms}^2}{2\mu_0}$
- Total Energy Density $= E_0E_{rms}^2 = \frac{B_{rms}^2}{\mu_0}$

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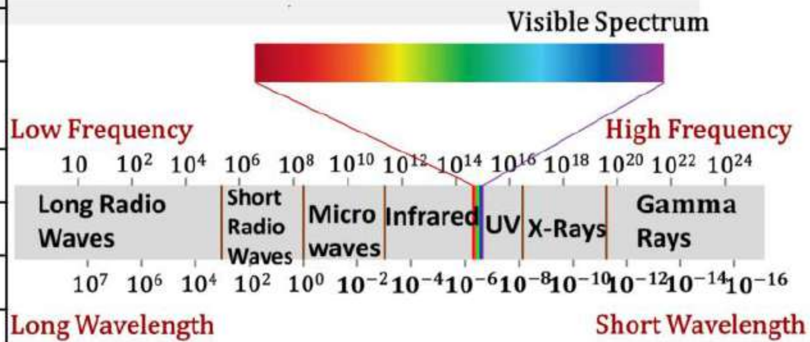

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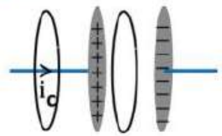
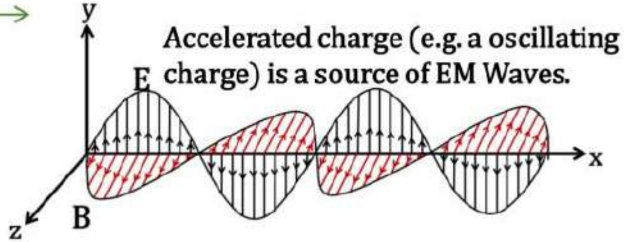


Ampere-Maxwell Law

$\oint \vec{B}\cdot\vec{d\ell} = \mu_0\,(i_c + i_d)$

$\oint \vec{B}\cdot\vec{d\ell} = \mu_0 i_c + \mu_0\epsilon_0 \dfrac{d\phi_E}{dt}$

ELECTROMAGNETIC WAVES



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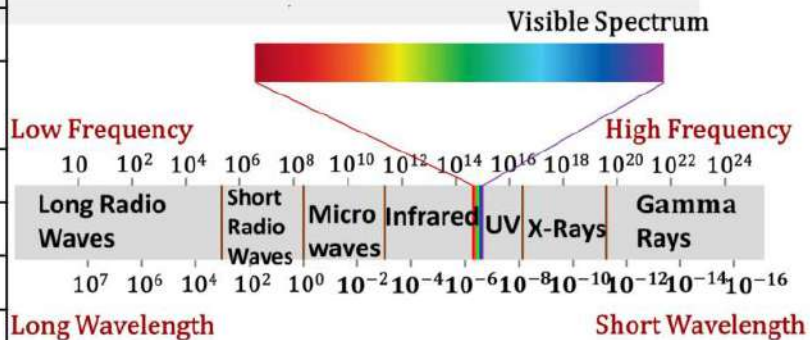


Rounding Off

Error

Superfast Revision

3 Min Break

Errors

- Systematic Errors
- Random Errors

Absolute Error

$A \pm \Delta A$

$50\ kg \pm 5kg$

45kg to 55kg

1mm

.1 cm

Least Count :– The smallest value that can be measured by the measuring instrument is called its Least Count.

Least Count Error :– If the instrument has known least count, the absolute error is taken to be equal to the least count unless otherwise stated.

Relative (or Fractional) Error

$$\text{Relative Error} = \frac{\text{Absolute error in a measurement}}{\text{Size of the measurement}}$$

$50\text{kg} \pm 5\text{kg}$

$$\text{Relative Error} = \frac{5\text{kg}}{50\text{kg}} = \frac{1}{10}$$

$A \pm \Delta A$

$$\text{Relative Error} = \frac{\Delta A}{A}$$

Percentage Error

50 kg ± 5 kg

50kg ± 10%

$$\frac{\Delta A}{A} \times 100 =$$

$$PE = \frac{5}{50} \times 100 = 10\%$$

$$\text{Percentage Error} = \frac{\text{Absolute error in a measurement}}{\text{Size of the measurement}} \text{ X } 100$$

Addition and Subtraction Rule

A ΔB

$A \pm \Delta A$ $\quad$ $B \pm \Delta B$

$+$ $\quad$ $-$

$R \pm \Delta R$ $\quad$ $R \pm \Delta R$

$R = A + B$ $\quad$ $R = A - B$

$\Delta R = \Delta A + \Delta B$ $\quad$ $\Delta R = \Delta A + \Delta B$

Absolute error adds

A: 20 ± 2 $\quad$ B: 10 ± 5

A + B =

(+) :– 30 ± 7

A – B

(–) :– 10 ± 7

Product and Quotient Rule

$A \times B^{-1}$

$R = A \times B$

$$\frac{\Delta R}{R} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$$

Divide $R = A / B$

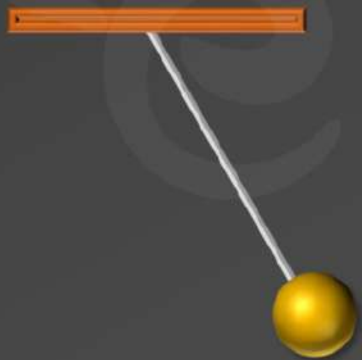
$$\frac{\Delta R}{R} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$$

Power Rule

$$R = \frac{A^p B^q}{C^s D^t}$$

$$\frac{\Delta R}{R} = p\frac{\Delta A}{A} + q\frac{\Delta B}{B} + s\frac{\Delta C}{C} + t\frac{\Delta D}{D}$$

Measurement of 'g' using a Simple Pendulum



Time of 1 osc.

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$g = 4\pi^2\frac{L}{T^2}$$

$$\frac{\Delta g}{g} = \frac{\Delta L}{L} + \frac{2\Delta T}{T}$$

Rules for Determining the Number of Significant Digits

For numbers with indicated decimal

1. All nonzero digits (1-9) are to be counted as significant.

2. Zeros that have any nonzero digits anywhere to the left of them are considered significant zeros.

3. All other zeros not covered in rule (2) above are NOT considered significant zeros.

	Sig. Digits
125.0 mm	4
12.50 cm	4
0.006000	4
250.0050	7
0.0003	1

Rules for Determining the Number of Significant Digits

For numbers with no indicated decimal

1. All nonzero digits (1-9) are to be counted as significant.

2. The terminal or trailing zero(s) are not significant.

	Sig Dig
13700 cm	3
1205000	4
7812 cm	4

Scientific Notation

$a \times 10^b$

'a' is a number between 1 and 10

12.50 cm

1.250×10^1 cm

$= 1.250 \times 10^2$ mm

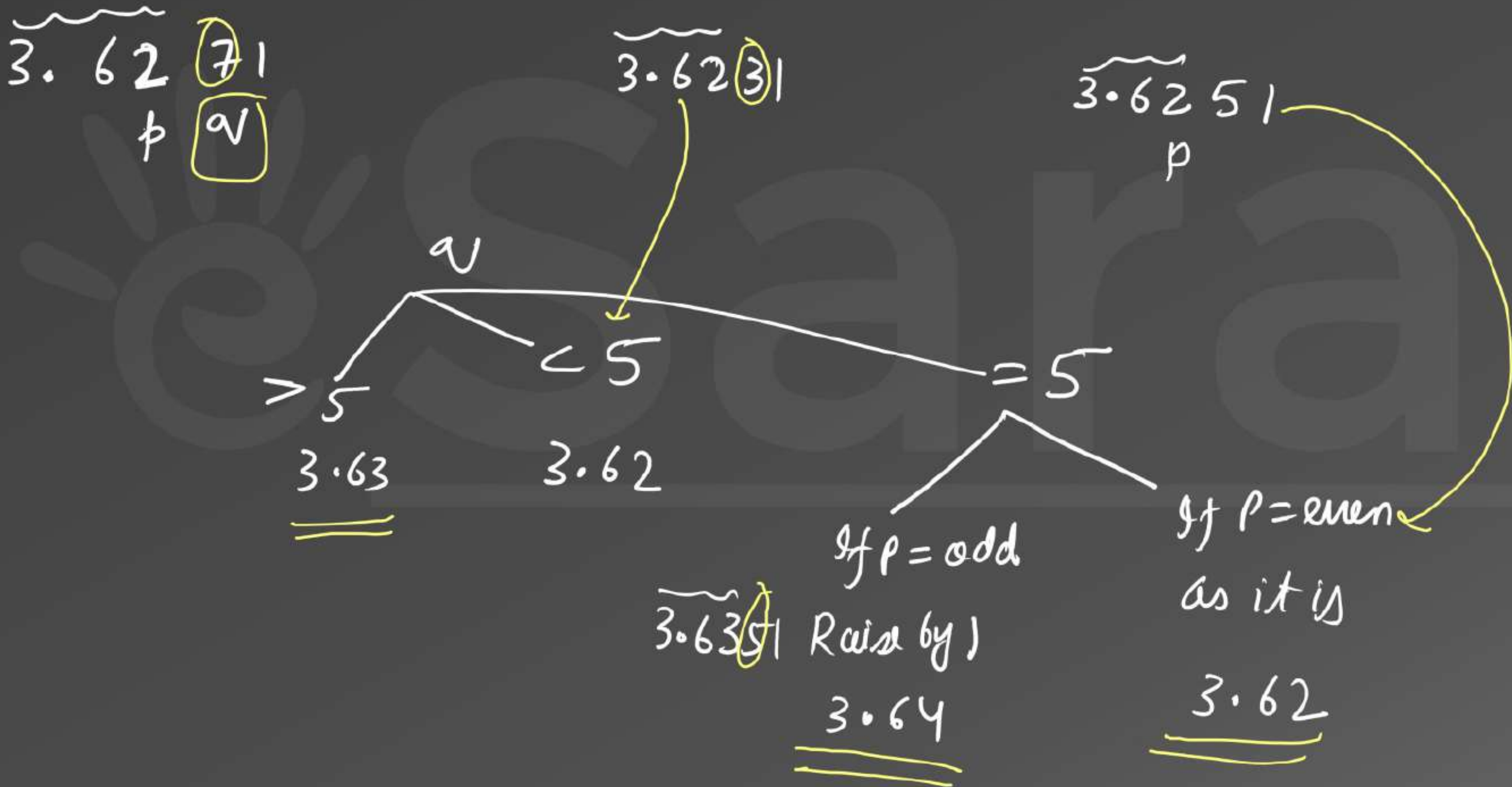
$= 1.250 \times 10^5$ μm

$= 1.250 \times 10^{-1}$ m

Order of Magnitude

$= 1.2 \times 10^7$ m

Rules for Rounding off



Arithmetic Operations

Multiplication or Division

The final result should retain as many significant digits as are there in the original numbers with the least significant digits.

$$\frac{8.000}{4.0} = 2.0$$

$$3.00 \times 800.0 = 2400 = 2.40 \times 10^3$$

$$1.23 \times 2.234 \times 2.6421 = 7.260015$$

$$= 7.26$$

Arithmetic Operations

Addition or Subtraction

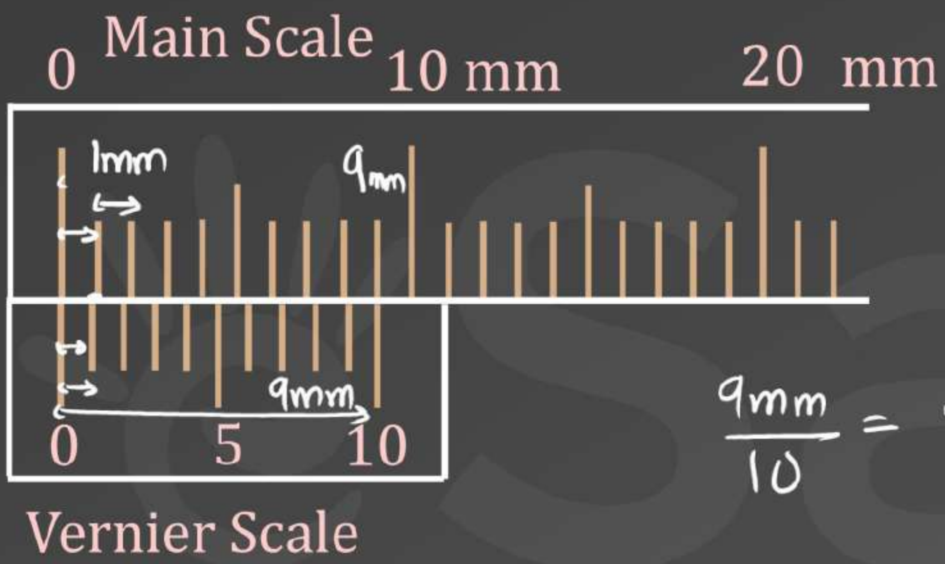
The final result should retain as many decimal places as are there in the original numbers with the least decimal places.

115.33

100.23 + 15.1 = 115.3

100.270 + 1.1 − 10.21 = 91.160 = 91.2

Vernier Caliper



$$\frac{9mm}{10} = .9mm$$

1 Main Scale Division (MSD) = 1mm

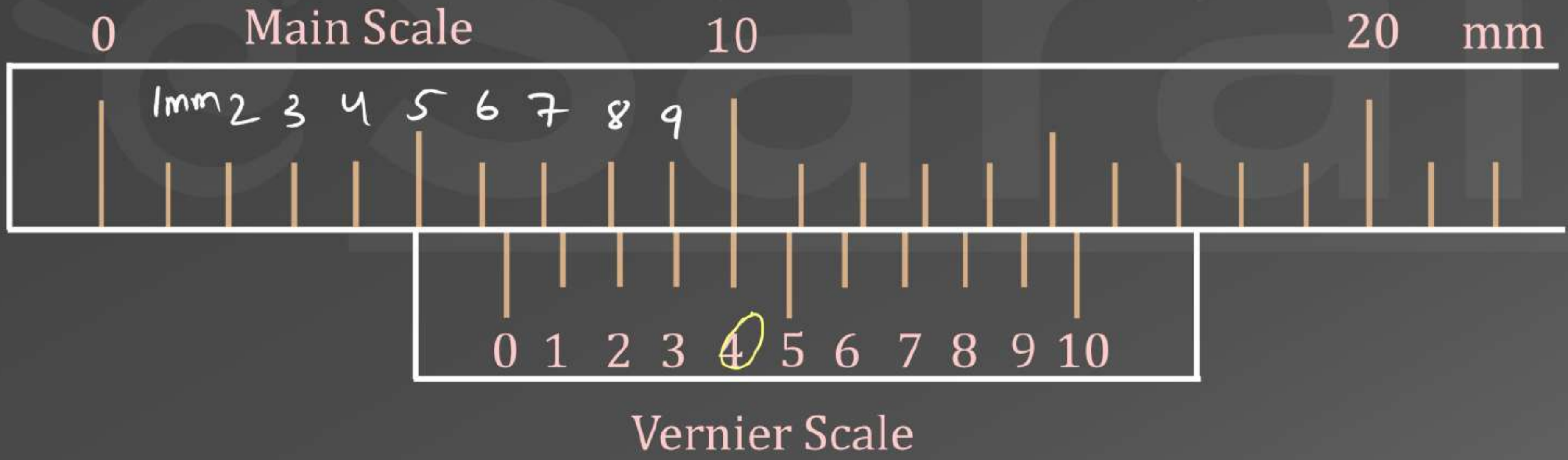
1 Vernier Scale Division (VSD) = 0.9 mm

Least Count of Vernier Calipers = 1 MSD – 1 VSD = 0.1 mm

Vernier Caliper

$$6mm + (0.1mm) \times 4 = 6.4mm$$

Length = MS Reading + Least Count of Vernier X VS division Coinciding with MS



Zero Error

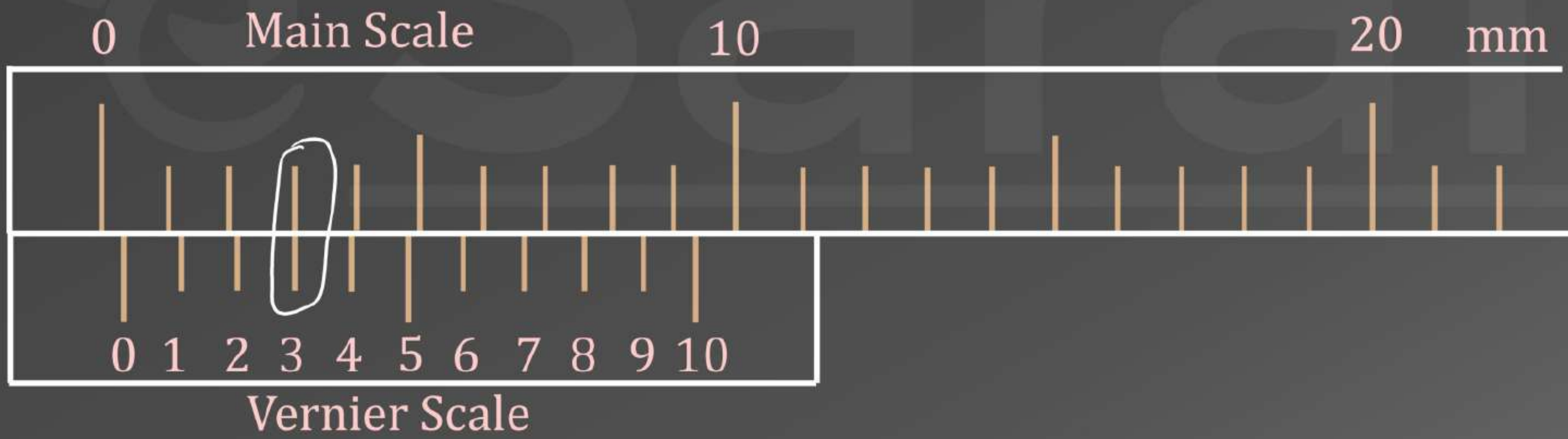
Positive Zero Error: If nothing is placed and zero of VS is to the RIGHT of zero of MS , then the zero error is positive.

Zero Error is subtracted from the reading to get the corrected value.

measured = 52.9 mm

corrected = 52.9 − .3 mm
= 52.6

0 + .1 × 3 = .3 mm



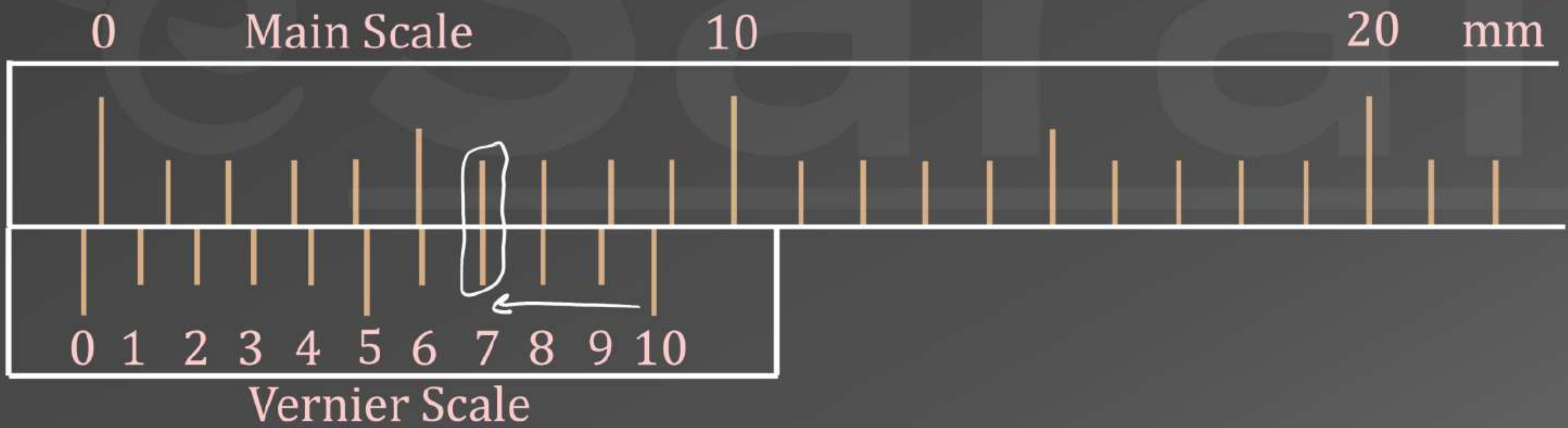
Zero Error

Negative Zero Error: If nothing is placed and zero of VS is to the **LEFT** of zero of MS , then the zero error is negative.

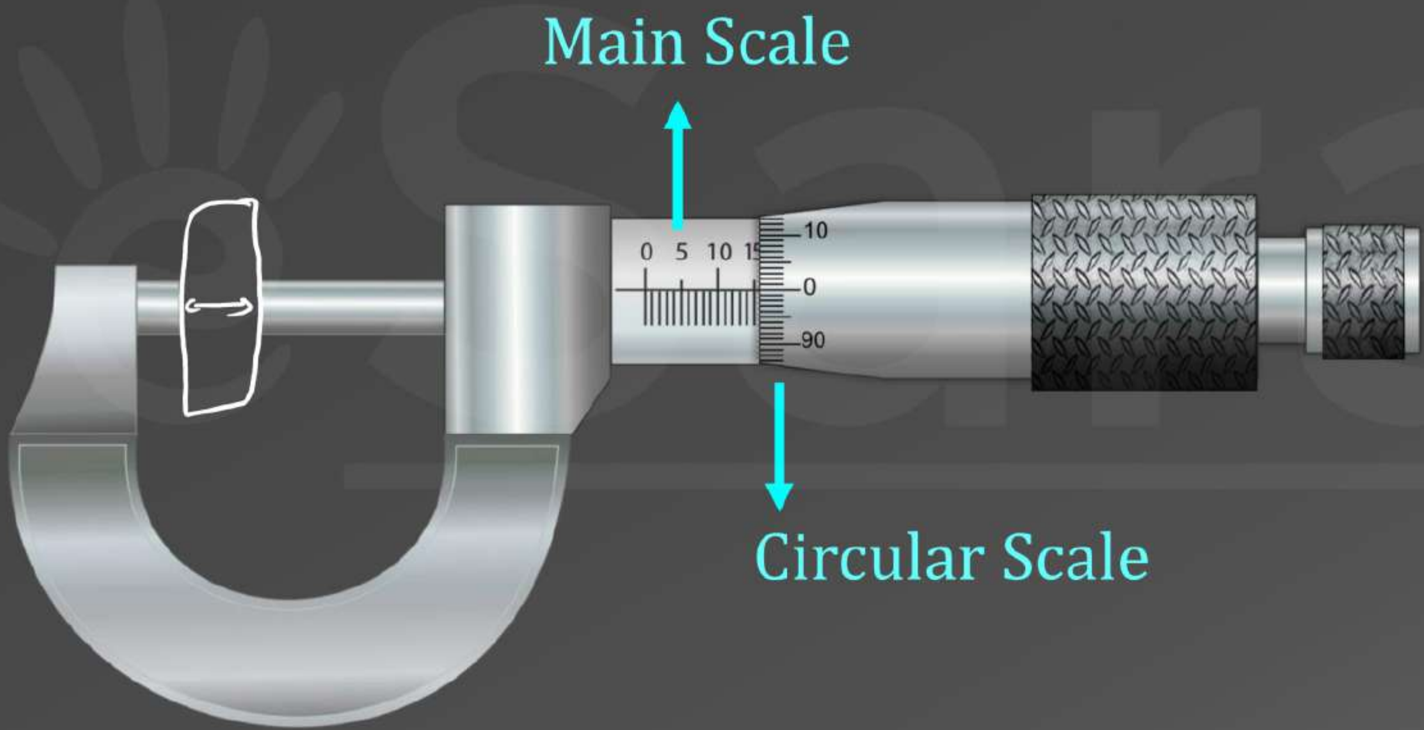
Zero Error is subtracted from the reading to get the corrected value.

Zero = (10 − 7) × .1 = −.3 mm

52.9 − (−.3mm) = 53.2

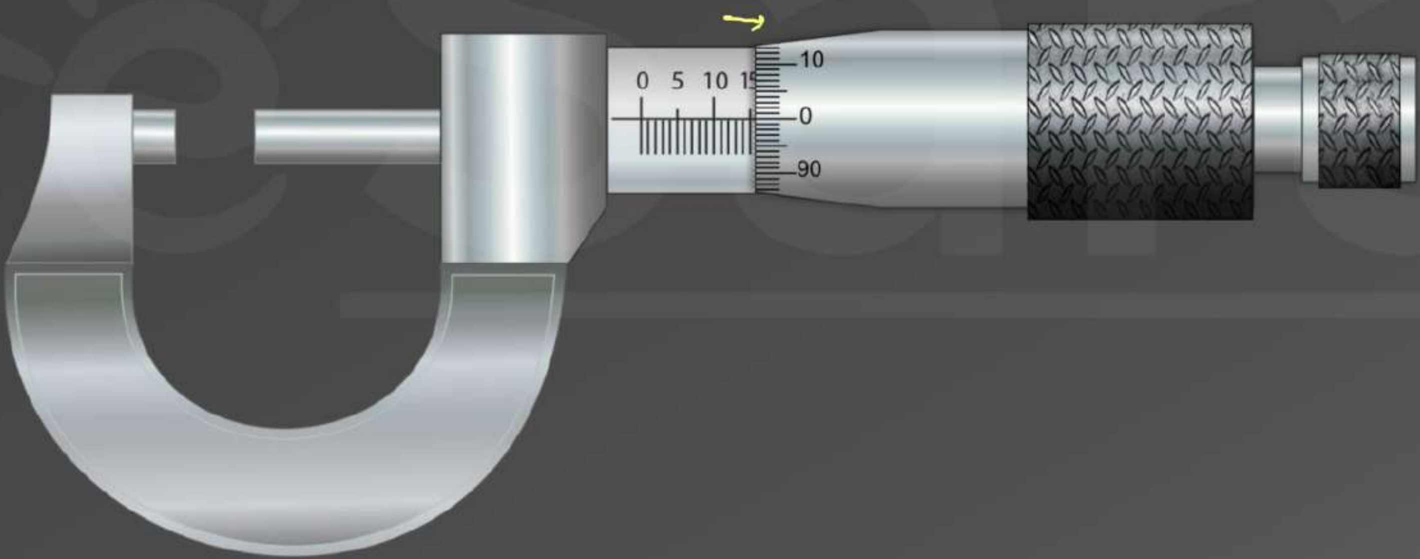


Screw Gauge



Pitch

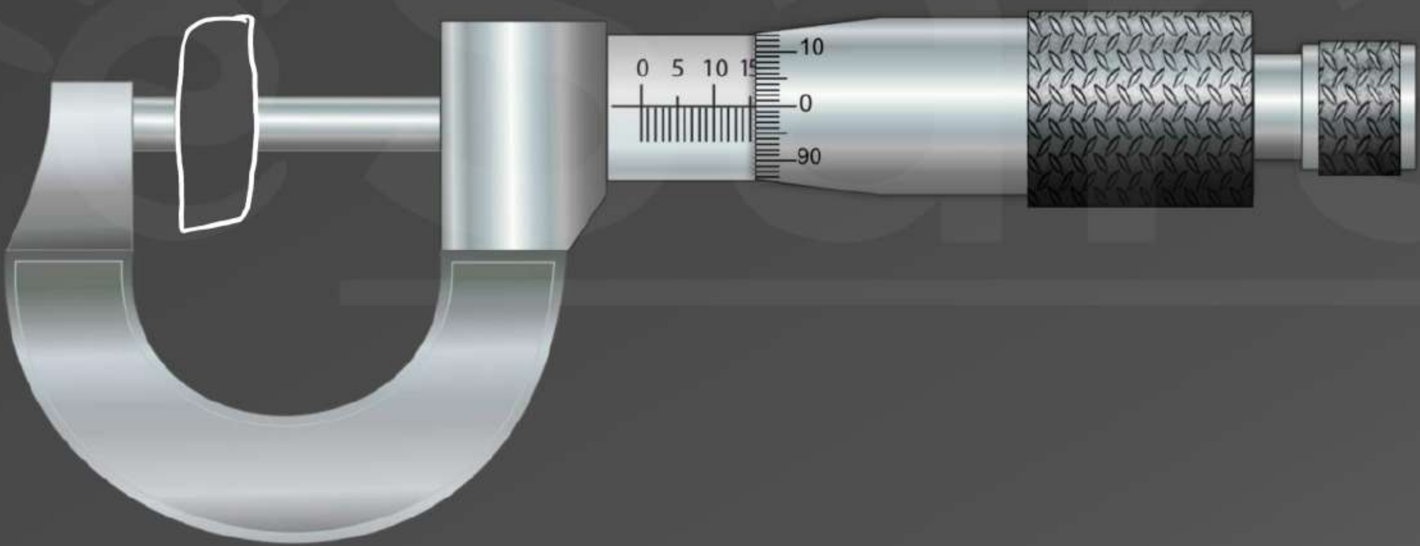
The pitch of screw gauge is the distance between two consecutive threads of the screw, which is equal to the distance moved by the screw due to one complete rotation of the cap.



Least Count

It is equal to pitch divided by the total divisions on the circular scale.

$$\text{Least Count} = \frac{\text{pitch}}{\text{No. of div on cir scale}} = \frac{1\text{mm}}{100} = 0.01\text{mm}$$

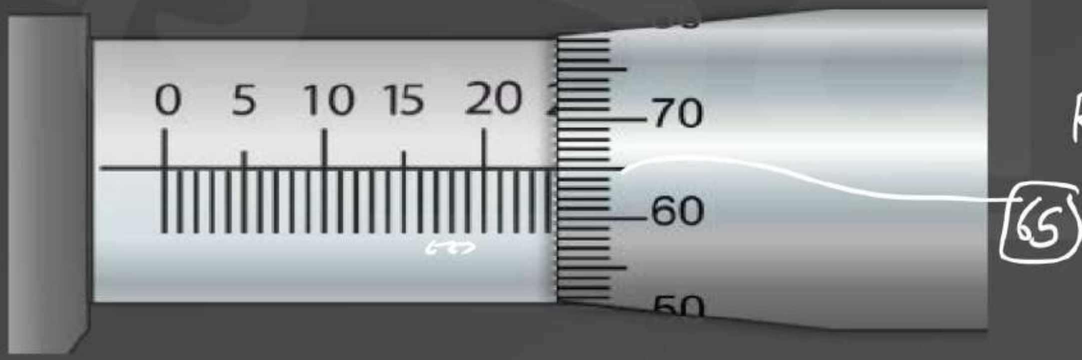


Screw Gauge

Reading = Main Scale Reading + Cir scale Cont

= 24 × 1mm + 65 × .01mm

= 24mm + .65 = 24.65mm



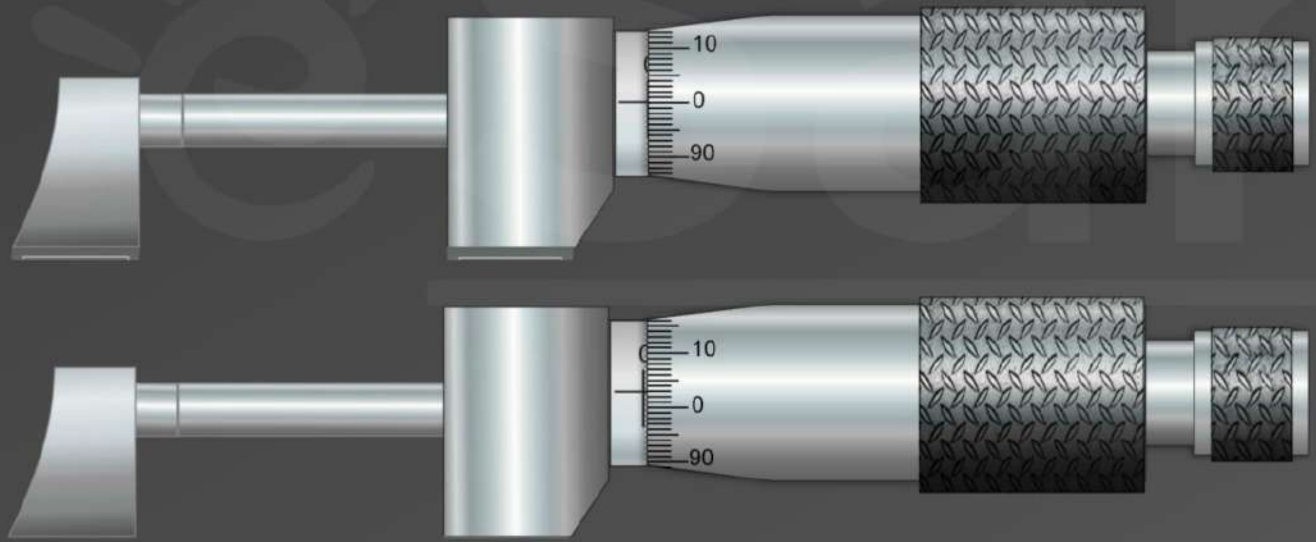
Reading = MS Reading + CS Cont

= (MS div × 1MSD) + (CS division Coinciding × LC)

Zero Error

Positive Zero Error: If nothing is placed and zero of circular scale is BELOW the line of MS , then the zero error is positive.

Corrected Value = Reading − Zero Error



Zero Error

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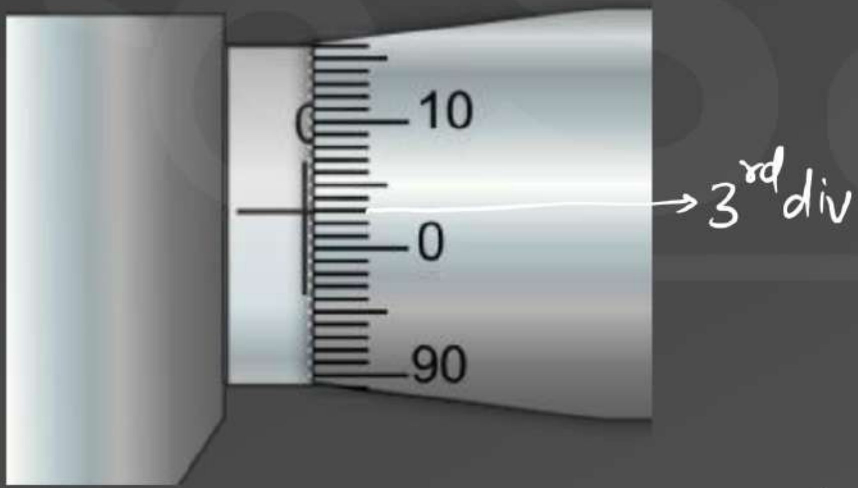


Zero Error = 0 + 3 × .01 mm

= .03 mm

62.53 mm = Reading

Corrected Value = 62.53 − 0.03 = 62.50 mm

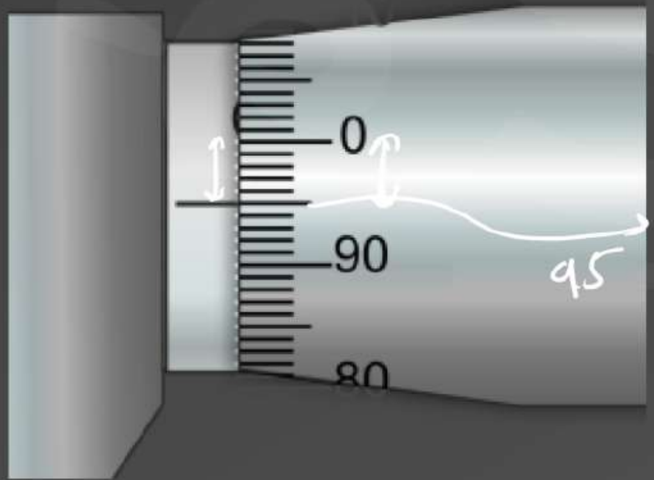
Zero Error

Negative Zero Error: If nothing is placed and zero of circular scale is ABOVE the line of MS , then the zero error is negative.

Corrected Value = Reading − Zero Error

$-[(100 - 95)\times .01]$

$-\left((\text{Total on Cir scale} - \text{coinciding})\times LC\right)$



Zero Error $= -(5 \times .01) = -.05\,mm$

62.85 mm Reading

Corrected Value $= 62.85 - (-0.05\,mm)$

$= 62.90\,mm$

QUIZ TIME

ERROR IN MEASUREMENT

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Addition and Subtraction Rule

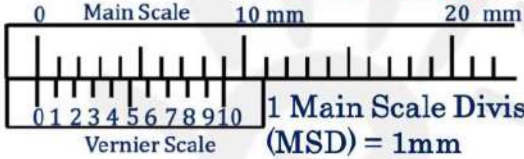
$A \pm \Delta A \qquad B \pm \Delta B$

+	−
$R = A + B$	$R = A - B$
$\Delta R = \Delta A + \Delta B$	1

Product and Quotient Rule

$R = A \times B$	$R = A/B$
$\dfrac{dR}{R} = \dfrac{dA}{A} + \dfrac{dB}{B}$	$\dfrac{\Delta R}{R} = \dfrac{\Delta A}{A} + \dfrac{\Delta B}{B}$
$\dfrac{\Delta R}{R} = \dfrac{\Delta A}{A} + \dfrac{\Delta B}{B}$	

Vernier Caliper



1 Main Scale Division (MSD) = 1mm

1 Vernier Scale Division (VSD) = 0.9 mm

Length = MS Reading + Least Count of Vernier × VS division Coinciding with MS

Least Count of Vernier Calipers = 1 MSD – 1 VSD = 0.1 mm

Zero Error is subtracted from the reading to get the corrected value.

Power Rule

$$R = \frac{A^p B^q}{C^s D^t}$$

$$\frac{\Delta R}{R} = p\frac{\Delta A}{A} + q\frac{\Delta B}{B} + s\frac{\Delta C}{C} + t\frac{\Delta D}{D}$$

Errors: Systematic Errors, Random Errors

Screw Gauge

PITCH: Distance between two consecutive threads of the screw.

$$\text{Least Count} = \frac{\text{Pitch}}{\text{No. of division on circular Scale}}$$

Reading = Main Scale Reading + Circular Scale Count

Corrected Value = Reading – Zero Error

Error Measurement contains some Uncertainty which is called Error

Accuracy is a measure of how close the measured value to the true value of the quantity.

Precision is to what resolution or limit the quantity is measured.

Absolute Error -The magnitude of the difference between the individual measurement and the true value of the quantity.

Least Count :– The smallest value that can be measured by the measuring instrument

Relative Error (or Fractional) Error $= \dfrac{\text{Absolute error in a measurement}}{\text{Size of the measurement}}$

Scientific Notation $a \times 10^b$ 'a' is a number between 1 and 10

Percentage Error $= \dfrac{\text{Absolute error in a measurement}}{\text{Size of the measurement}} \times 100$

Rules for Determining the Number of Significant Digits

For numbers with no indicated decimal

1. All nonzero digits (1-9) are to be counted as significant.
2. The terminal or trailing zero(s) are 2

For numbers with indicated decimal

1. All nonzero digits (1-9) are to be counted as significant.
2. Zeros that have any nonzero digits anywhere to the left of them are considered significant zeros.
3. All other zeros not covered in rule (2) above are NOT considered significant zeros.

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ERROR IN MEASUREMENT

Addition and Subtraction Rule

$A \pm \Delta A$ $\quad$ $B \pm \Delta B$

$R = A + B$ $\quad$ $R = A - B$

$\Delta R = \Delta A + \Delta B$ $\quad$ $\Delta R = \Delta A + \Delta B$

Product and Quotient Rule

$R = A \times B$

$\frac{dR}{R} = \frac{dA}{A} + \frac{dB}{B}$

$\frac{\Delta R}{R} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$

$R = A/B$

$\frac{\Delta R}{R} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$

Power Rule

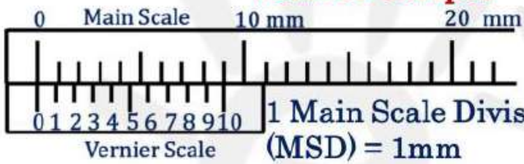
$$R = \frac{A^p B^q}{C^s D^t}$$

$$\frac{\Delta R}{R} = p\frac{\Delta A}{A} + q\frac{\Delta B}{B} + s\frac{\Delta C}{C} + t\frac{\Delta D}{D}$$

Errors

- Systematic Errors
- Random Errors

Vernier Caliper



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Rules for Determining the Number of Significant Digits

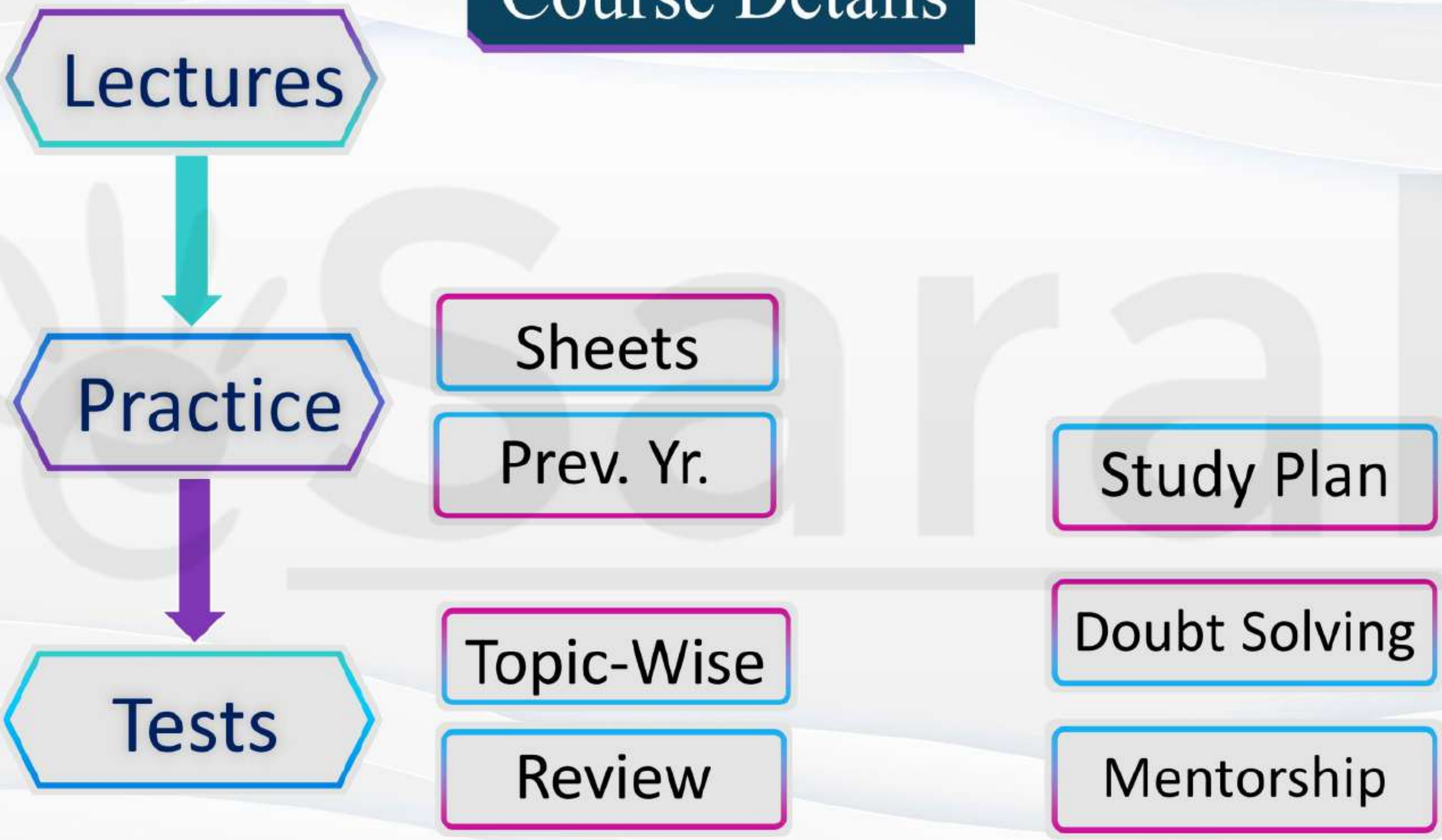
For numbers with no indicated decimal

1. All nonzero digits (1-9) are to be counted as significant.
2. The terminal or trailing zero(s) are not significant.

For numbers with indicated decimal

1. All nonzero digits (1-9) are to be counted as significant.
2. Zeros that have any nonzero digits anywhere to the left of them are considered significant zeros.
3. All other zeros not covered in rule (2) above are NOT considered significant zeros.

Course Details

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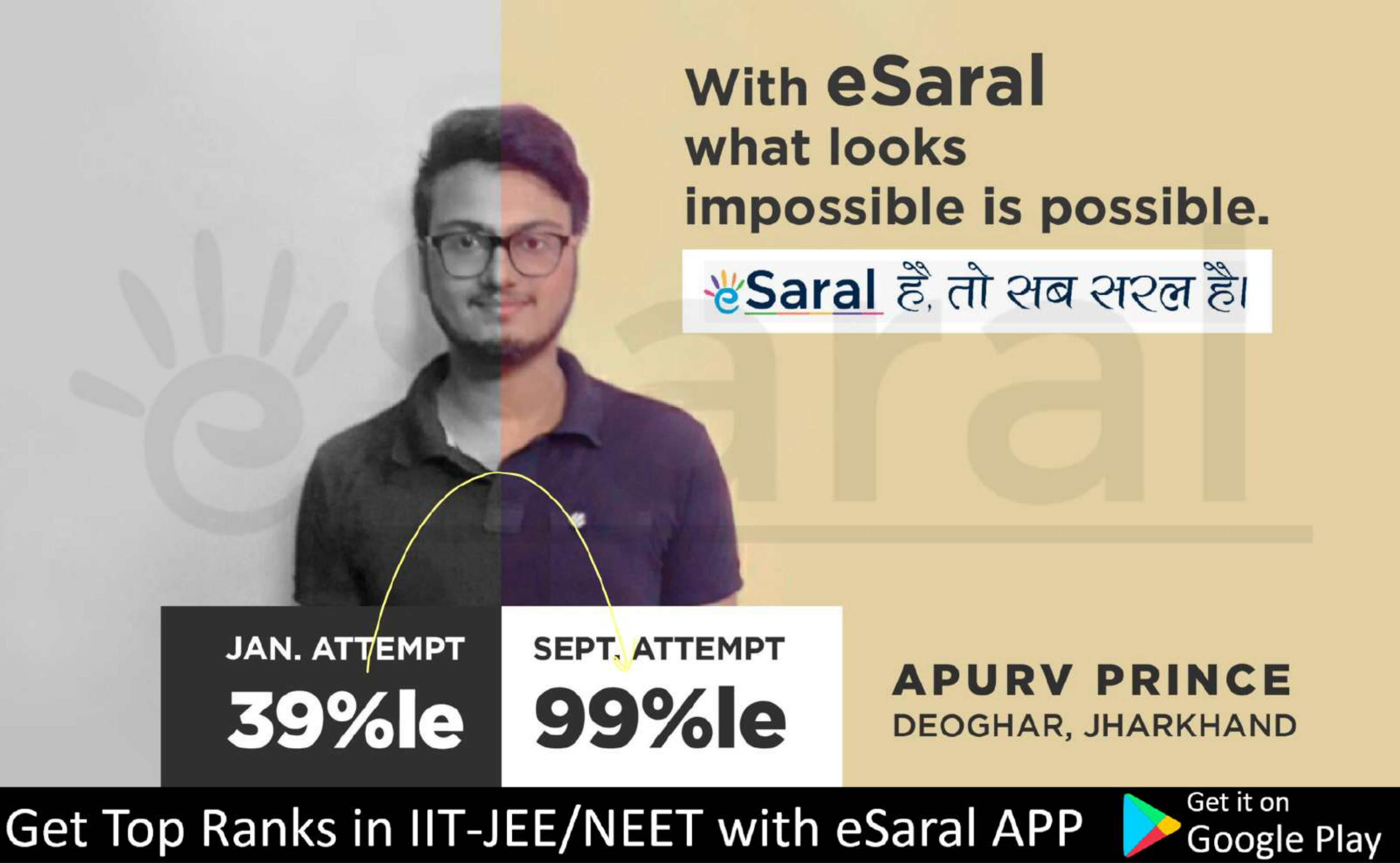
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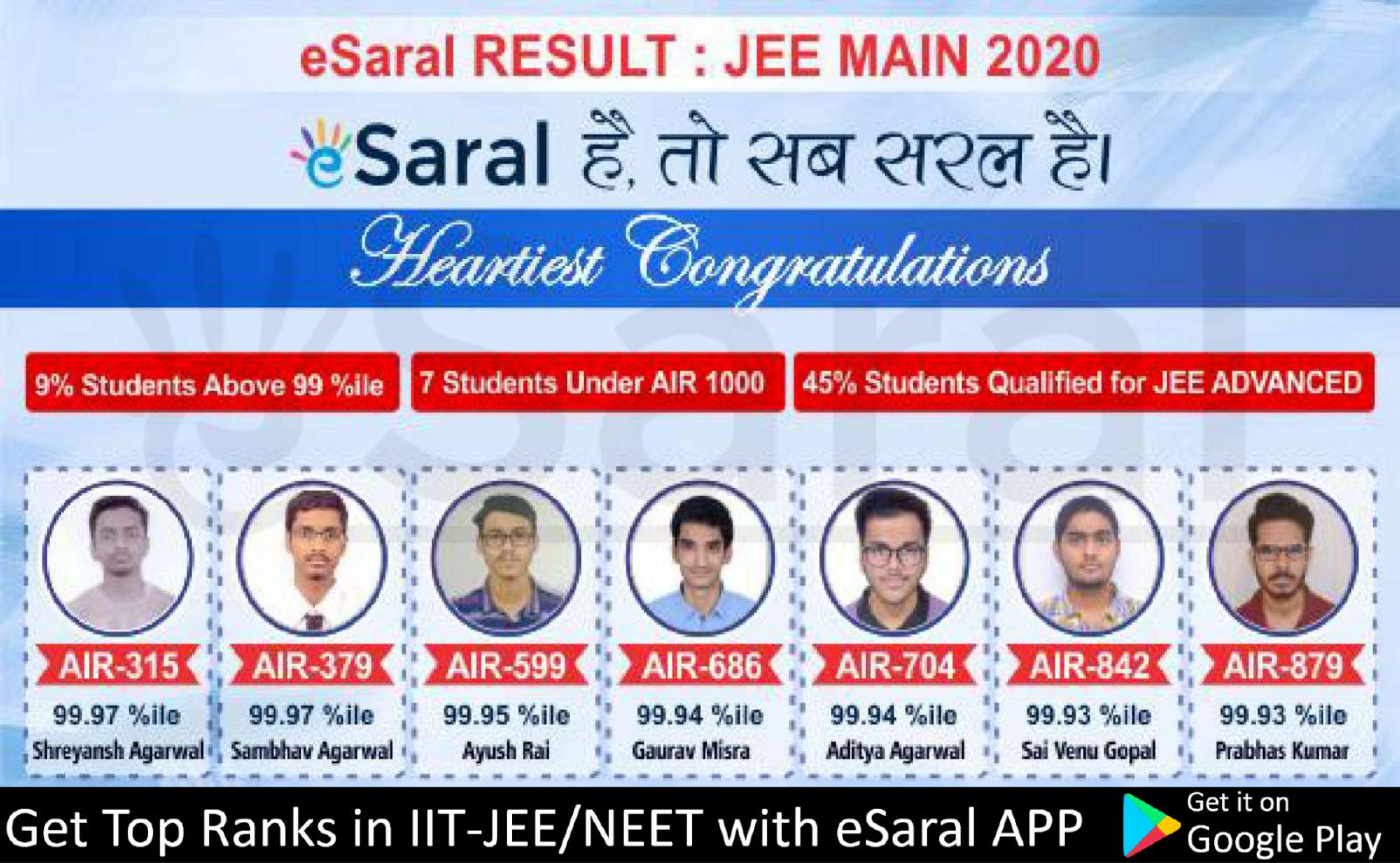
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15 Feb
Electrostatics
Current electricity
Capacitor
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16 Feb
Calorimetry
Elasticity
Thermal Expansion
Heat Transfer
KTG
Thermodynamics
Fluid Mechanics

17 Feb
Magnetic effect of current
Magnetism and matter
Emi
AC

18 Feb
UD
Vector
Kinematics 1D
Kinematics 2D
NLM
Friction
Circular motion
Work power energy
COM

19 Feb
Ray optics
Optical Instruments
Wave optics
EM Waves
Errors in measurement

20 Feb
Rotation motion
Gravitation
SHM
Wave on string
Sound wave

21 Feb
Atomic structure
Dual nature of radiation
X-rays
Nuclear physics
Radioactivity
Semi conductor
Communication system

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