MIND MAP

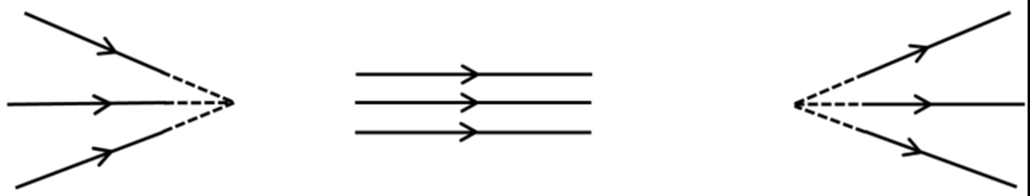
Ray Optics

Beam of Light

A bundle or bunch of rays is called a Beam.

Beam

Converging | Parallel | Diverging



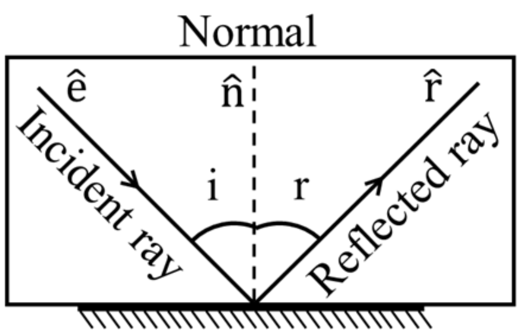
Laws of Reflection

The angle of reflection is equal to the angle of incidence

$\angle i = \angle r$

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

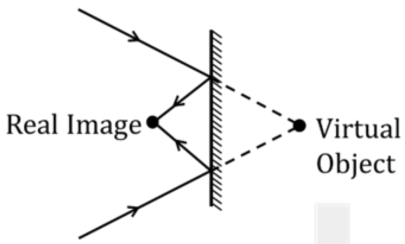
$[\hat{e}\ \hat{r}\ \hat{n}] = 0$



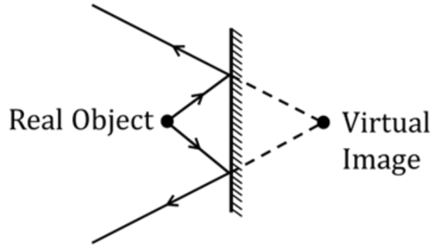
Image

Image

Real Image
Intersection of converging reflected/refracted rays.



Virtual Image
Intersection of diverging reflected/refracted rays.

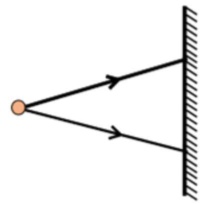


Object

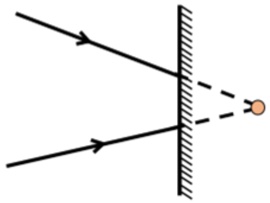
Object is intersection point of incident rays.

Object

Real Object
Intersection of diverging incident rays.



Virtual Object
Intersection of converging incident rays.



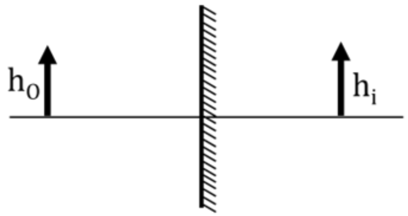
MIND MAP

Ray Optics

Properties of Image Formed by a Plane Mirror

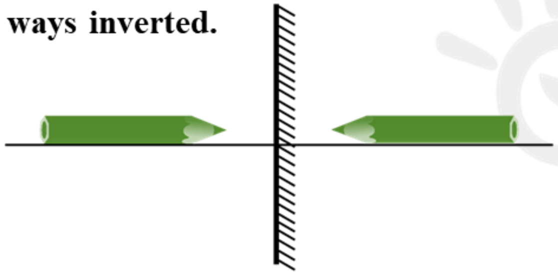
It forms Real Image of Virtual Object and Virtual Image of Real Object.

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

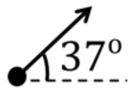


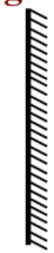
$h_i = h_o$

Image formed by Plane mirror is side-ways inverted.



Velocity of Image





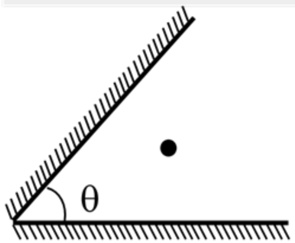
$(\vec{V}_O)_{\parallel} = (\vec{V}_I)_{\parallel}$

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

Mirrors at an Angle

$$\boxed{\frac{360}{\theta} = N}$$

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



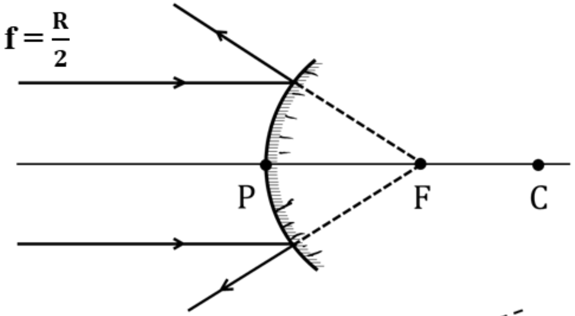
Spherical Mirrors

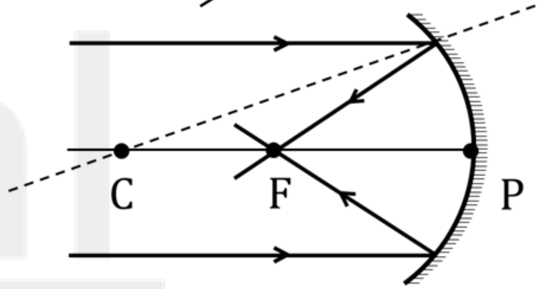
Principle Axis : Line joining C and P

Focal Length

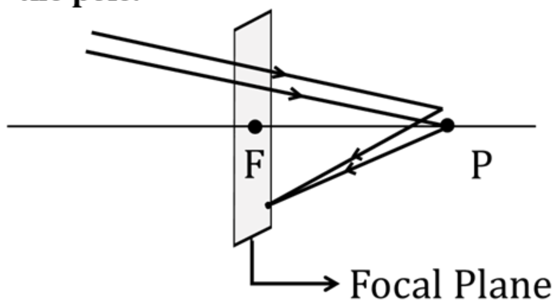
Focal Plane is the plane passing through focus and perpendicular to principal axis.

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





Focal length is the distance of focus from the pole.



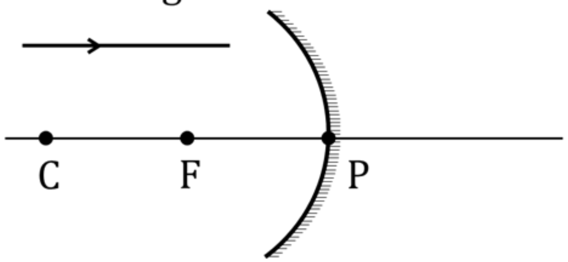
MIND MAP

Ray Optics

Sign−Convention

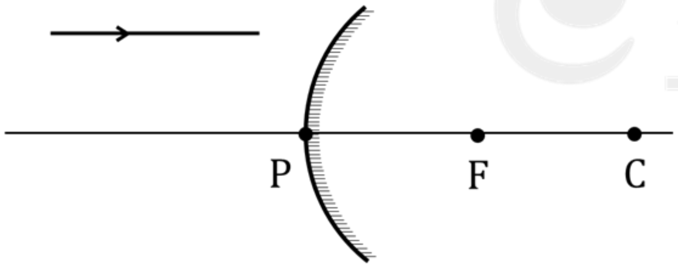
Along principal axis, distances are measured from the pole.

Incident Light



Coordinates of C and F are −ve

Incident Light



Coordinates of F and C are +ve

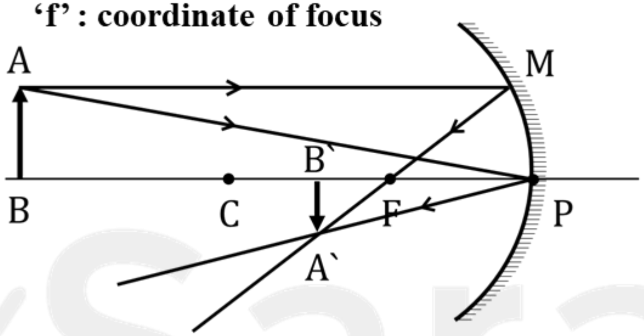
Mirror Equation

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

'u' : coordinate of object

'v' : coordinate of image

'f' : coordinate of focus



Magnification

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

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)

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

$|m|>1$ Enlarged

$m<0$ (-ve) Inverted

$|m|<1$ Diminished

$m>0$ Erect

Net Magnification

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

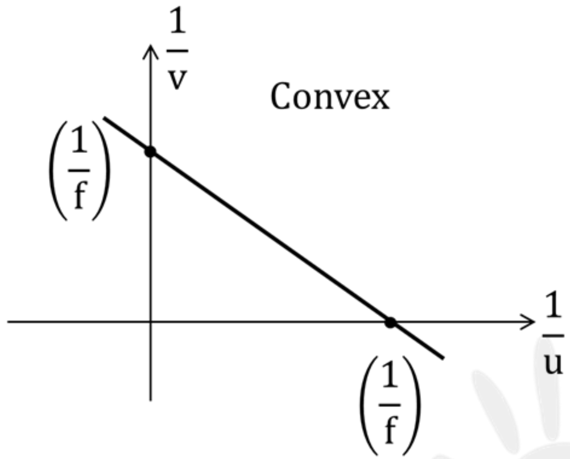
$$m_{net}=\frac{h_{I_1}}{h_0}\times\frac{h_{I_2}}{h_{I_1}}\times\frac{h_{I_3}}{h_{I_2}}\times\ldots=\frac{h_{I-final}}{h_0}$$

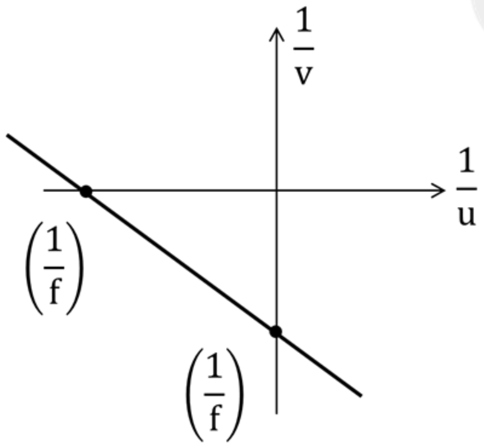
MIND MAP

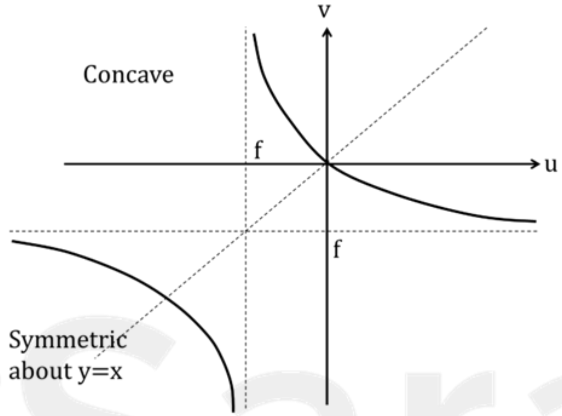
Ray Optics

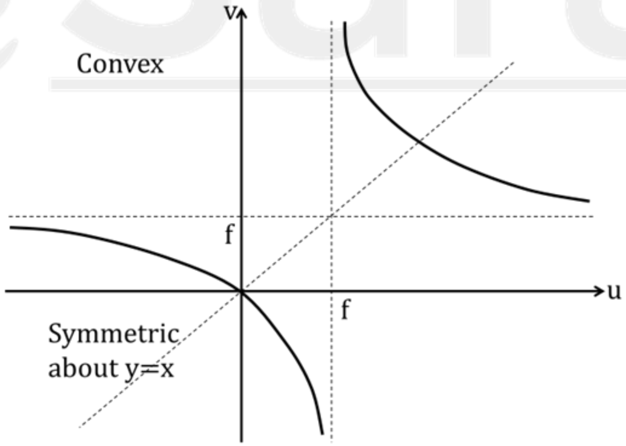
Graphs

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





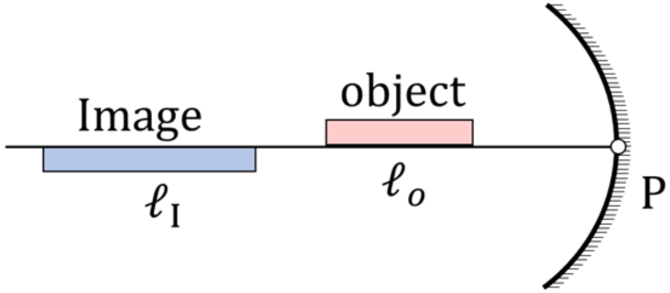




Longitudinal Magnification

$$LM = -m^2 = \frac{l_I}{l_0}$$

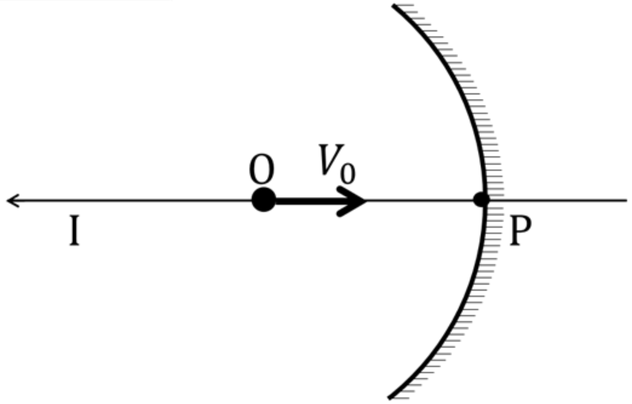
where m is (TM)



Velocity of Image of Moving Object (Spherical mirror)

Along PA

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



MIND MAP

Ray Optics

Refraction

Refractive index of medium (μ)

$$\mu = \frac{c}{v_m} \quad \begin{matrix} \rightarrow \text{Vacuum} \\ \rightarrow \text{Medium} \end{matrix}$$

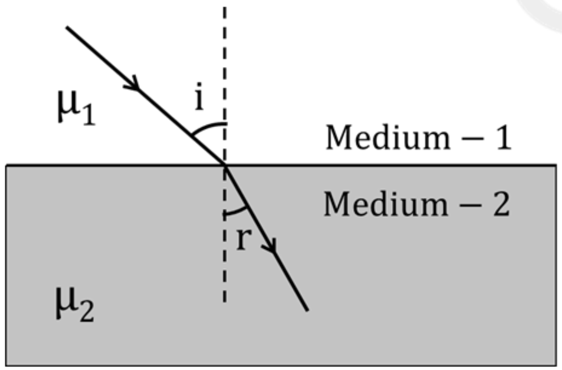
Relative Refractive index of medium(1) w.r.t medium (2) is defined as

$$\mu_1/_2 = \frac{\mu_1}{\mu_2}$$

$$v = f\lambda$$

$$\frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{\mu_2}{\mu_1} \quad \mu \uparrow v \downarrow \lambda \downarrow$$

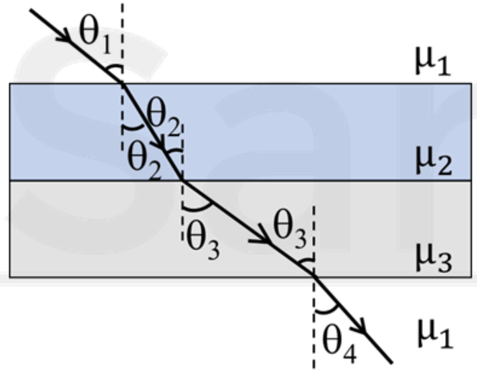
When light from same source enters different medium then its speed and wavelength changes but frequency remains same.



Laws of Refraction

(i) Incident ray, refracted ray and normal to surface always lie in the same plane.
In vector form
$[\hat{e} \ \ \hat{n} \ \ \hat{r}] = 0$

(ii) Snell's Law
$\mu_1 \sin i = \mu_2 \sin r$



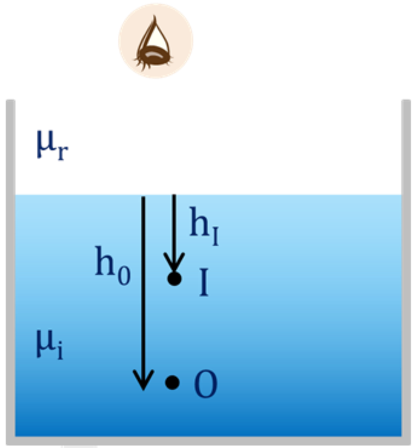
$$\mu_1 \sin\theta_1 = \mu_2 \sin\theta_2 = \mu_3 \sin\theta_3 = \mu_1 \sin\theta_4$$

Apparent Depth

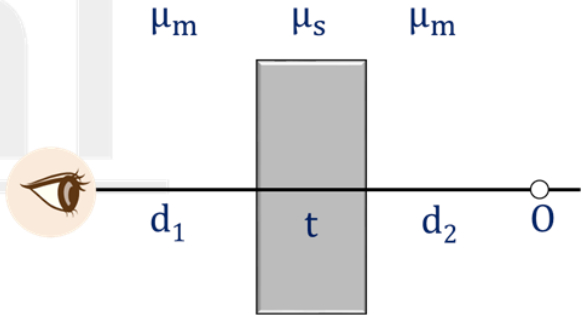
$$h_I = \frac{h_0}{\mu_{i/\gamma}} \quad \text{Shift} = h_0 - h_I$$

$$= h_0\left(1 - \frac{1}{\mu_i/r}\right) = h_0\left(1 - \frac{1}{\mu}\right)$$

Velocity of Image Formed due to Refraction from Plane Surface



Refraction through Parallel Slab

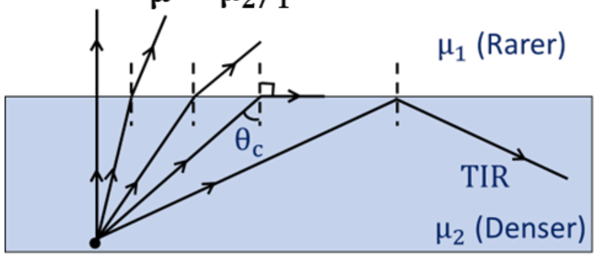


$$\text{shift} = t\left(1 - \frac{1}{\mu_{0/m}}\right)$$

in dircection of in udent Ray

Total Internal Reflection

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



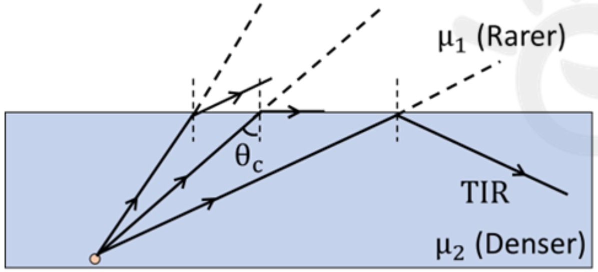
Critical Angle (θ_C) : Angle of incident at which angle of refraction becomes 90°.

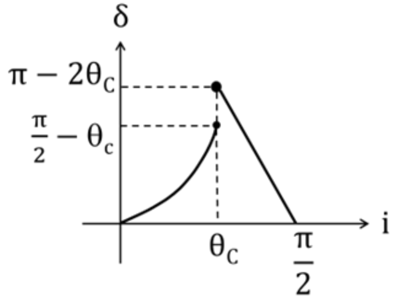
Angle of Deviation

Total internal Reflection

Refraction : $\delta = r - i$

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





MIND MAP

Ray Optics

Angle of Deviation

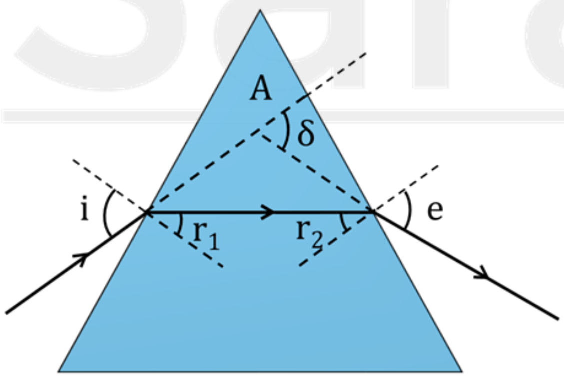
$1 \sin i = \mu \sin r_1$

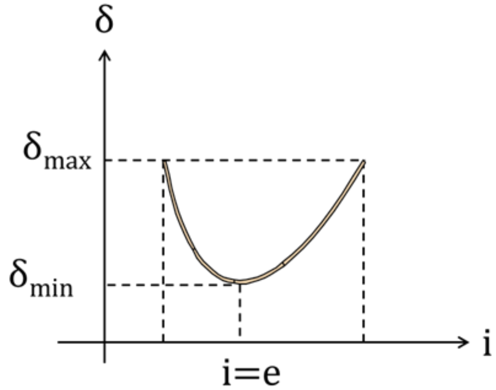
$\mu \sin r_2 = 1 \sin e$

$A = r_1 + r_2$

$\delta = i + e - A$

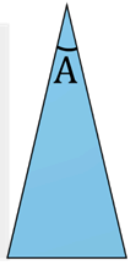
$$\delta = i + e - A \quad \mu = \frac{\sin\left(\frac{\delta_{min} + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$



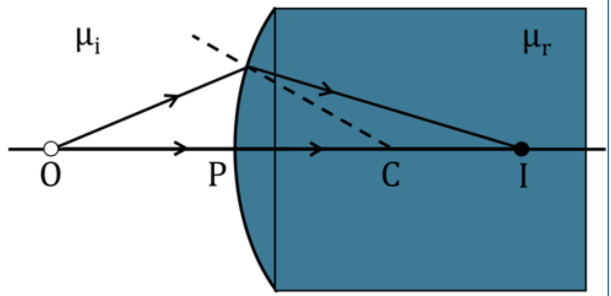


Thin Prism

Thin Prism have very small angle of prism.



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



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

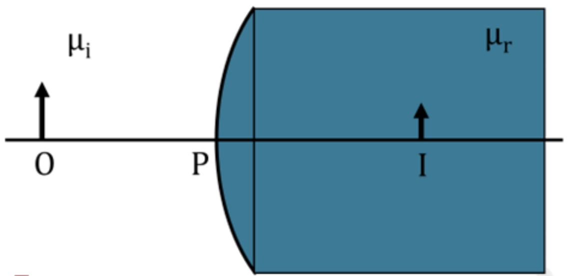
MIND MAP

Ray Optics

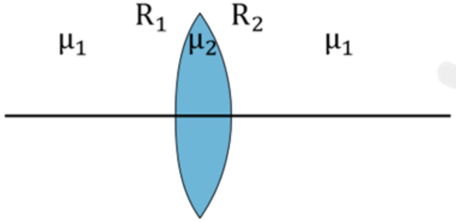
Transverse Magnification

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

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



Lens



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

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

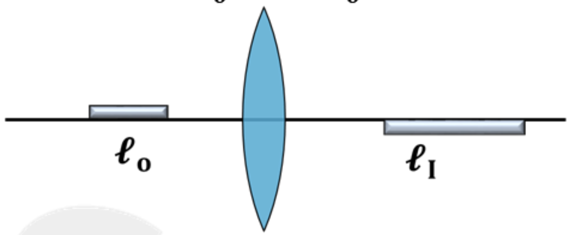
(Lens Maker's formula)

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

u, v, f, R_1, R_2 are coordinates

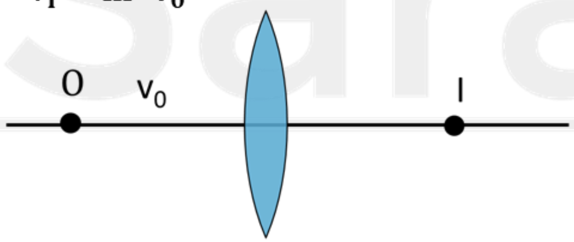
Longitudinal Magnification in Lens

$$LM = m^2 = \frac{\ell_1}{\ell_0} \quad m = \frac{h_1}{h_0} = \frac{V}{u}$$



Velocity of Image

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



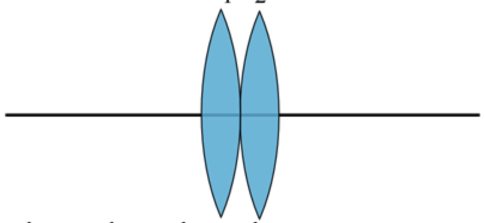
Power of Lens

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

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

Power is negative for diverging lens and positive for converging

Lenses Kept Very Close to Each Other

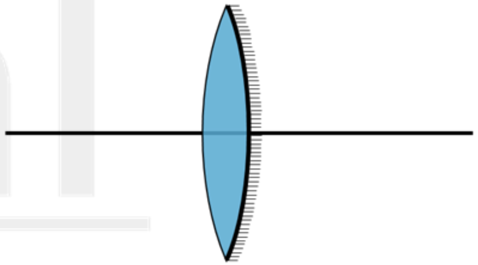


$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \cdots$$

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

With sigh

Silvering of Lens



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

Mirrer $P_{eq} = P_1 + P_2 + P_3 + \cdots$.

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

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

MIND MAP

Ray Optics

Dispersion

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

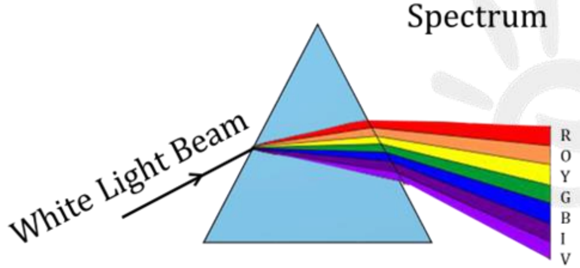
The pattern of colour component of light is called spectrum of light.

Cauchy's eq.

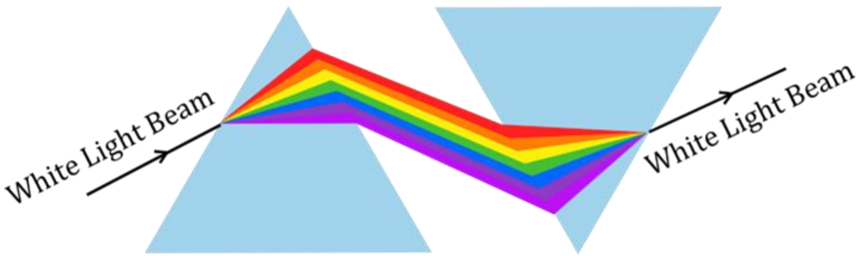
$$\mu = A + \frac{B}{\lambda^2}$$

V I B G Y O R

Most deviation — Least deviation



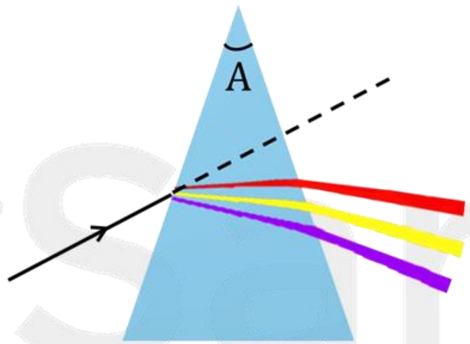
Achomatic (combination



$\delta_v = (\mu_v - 1)A$ $\quad \delta = (\mu - 1)A$

$\delta_y = (\mu_y - 1)A$ $\quad \mu_y \approx \frac{\mu_V + \mu_R}{2}$

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

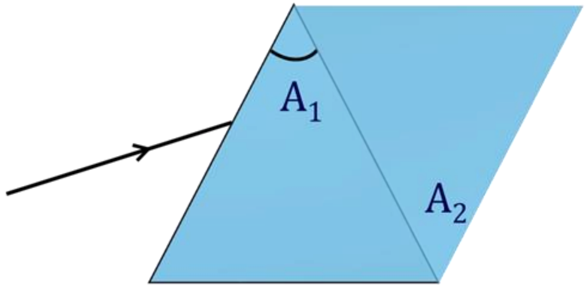


Angular dispersion $(\theta) = (\mu_V - \mu_R)A$

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

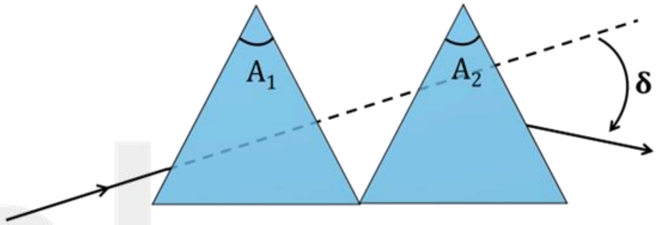
Dispersive power $\omega = \frac{\theta}{\delta_y} = \frac{(\mu_V - \mu_R)}{(\mu_y - 1)}$

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



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

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



Dispersion But Not Average Deviation

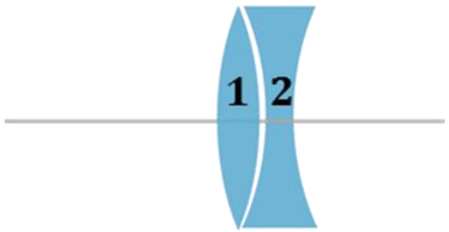
$\delta_{net} = 0$

Average Deviation But No Dispersion

$\theta_{net} = 0$

Achromatic Combination

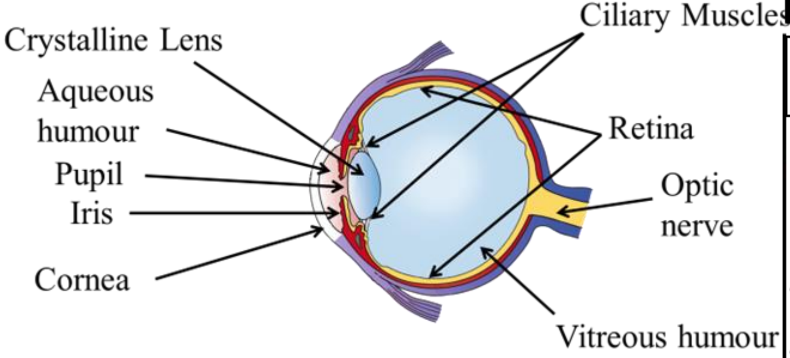
$$\frac{\omega_1}{f_{x_1}} + \frac{\omega_2}{f_{x2}} = 0$$

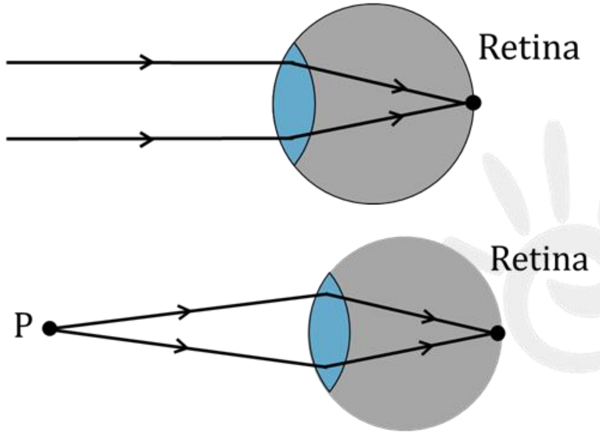


MIND MAP

Ray Optics

Human Eye





Accommodation

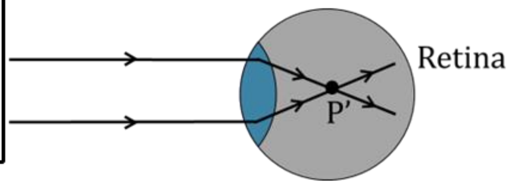
Far Point at ∞

Near Point at 25cm

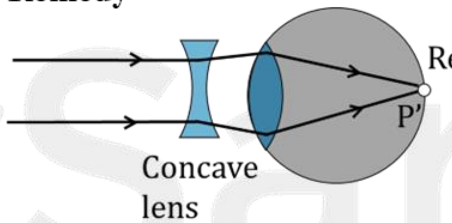
Least Distance for Distinct Vision

Defects of Eyes

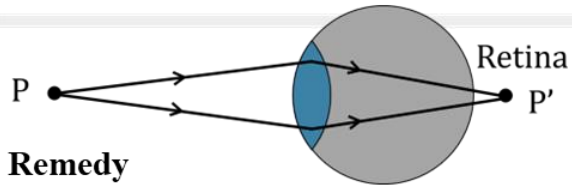
1. Nearsightedness : (Myopia)



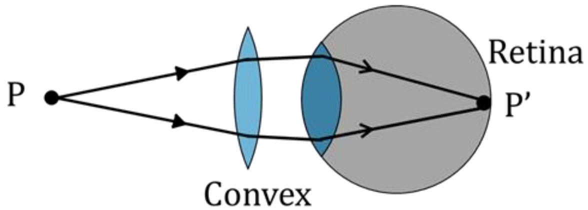
Remedy



2. Farsightedness : (Hypermetropia)

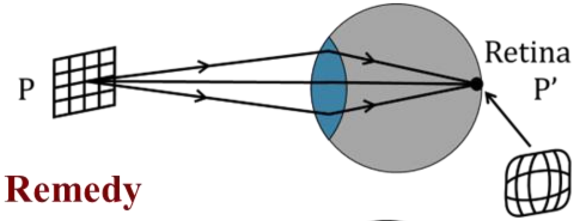


Remedy

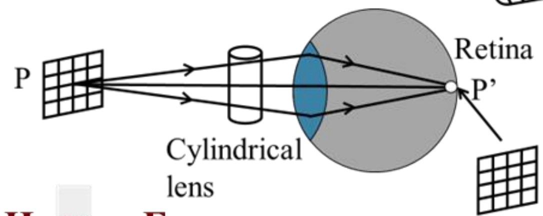


Defects of Eyes

3. Astigmatism: When Cornea not spherical in shape



Remedy



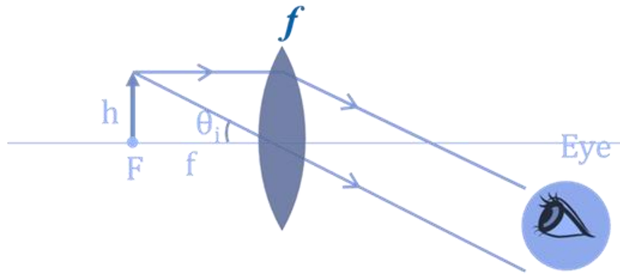
Human Eye

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 $= \frac{D}{f}$

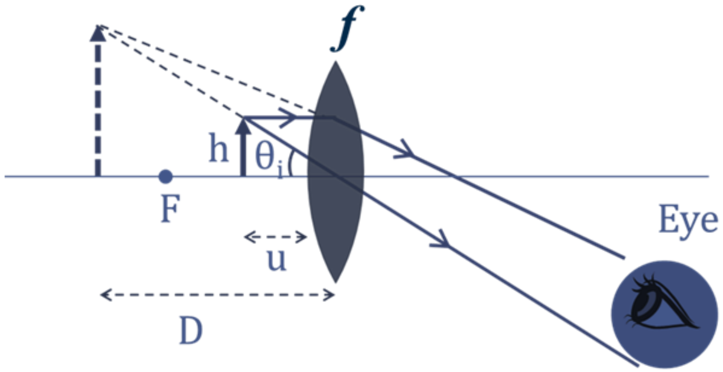


MIND MAP

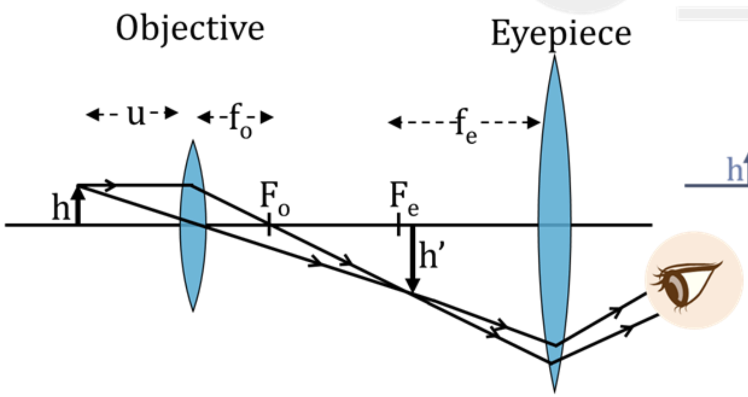
Ray Optics

Image at Least Distance of Distinct Vision

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



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)

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

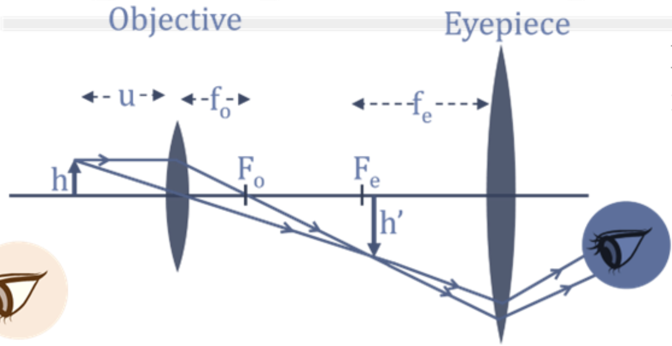


Image at Least Distance of Distinct Vision

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

Telescope

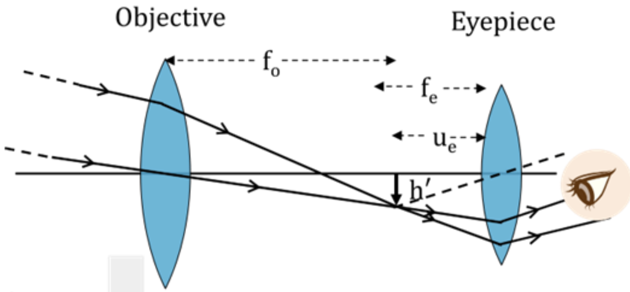


Image at ∞ (Normal Adjustment)

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