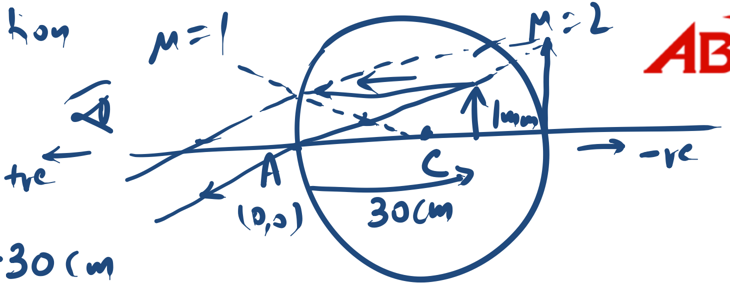
Session 21: Ray Optics – Refraction @ curved surfaces – Principal Focii & Lenses

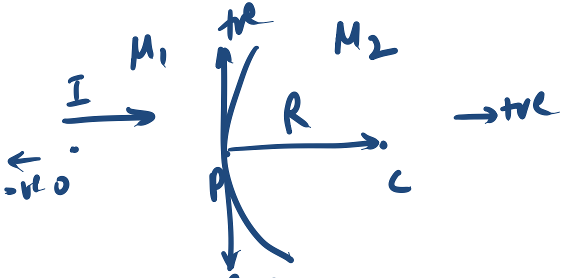
- Recap
- Principle focii
- Velocity of image
- Lenses (nature & types)
- Lens maker's formula
- Rules for drawing ray diagram

Ex. What will be image position & magnification?



R = 20cm

$$\boxed{\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}}$$



R → +ve

$$m = \left(\frac{v/\mu_2}{u/\mu_1}\right) = \left(\frac{v-R}{u-R}\right)$$

$u = -30\text{ cm}$

$R = -20\text{cm}$

$\mu_1 = 2$

$\mu_2 = 1$

$$\frac{1}{v} - \frac{2}{-30} = \frac{1-2}{-20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{15}$$

$$= \frac{-5}{20 \times 15}$$

$$\boxed{v = -60\text{ cm}}$$

$$m = \frac{v/\mu_2}{u/\mu_1} = \frac{-60/1}{-30/2}$$

$$= 4 = \frac{h_I}{h_o}$$

$$\boxed{h_I = 4\text{ mm}}$$

Img → erect.
↳ virtual
↳ larger.

Velocity of image (Single refraction thru curved surface)

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$ → for both concave & convex surfaces ($R \to D$ or $D \to R$)

Diff. w.r.t time, t.

$$\mu_2\left(\frac{-1}{v^2}\right)\frac{dv}{dt} - \mu_1\left(\frac{-1}{u^2}\right)\frac{du}{dt} = 0$$

$$\boxed{\frac{dv}{dt} = \frac{v^2}{u^2}\cdot\left(\frac{\mu_1}{\mu_2}\right)\frac{du}{dt}}$$

$$v_{I/s} = \frac{v^2}{u^2}\left(\frac{\mu_1}{\mu_2}\right) v_{o/s}$$

$$\boxed{v_{I/s} = m^2\left(\frac{\mu_2}{\mu_1}\right) v_{o/s}}$$

$$m = \left(\frac{v/\mu_2}{u/\mu_1}\right)$$

$$\frac{v^2}{u^2} = \frac{(v/\mu_2)^2 \times \mu_2^2}{(u/\mu_1)^2 \times \mu_1^2} = m^2 \frac{\mu_2^2}{\mu_1^2}$$

$m = 1$ (for refraction thru plane surfaces)

$$\boxed{v_I = \frac{\mu_2}{\mu_1} v_o}$$

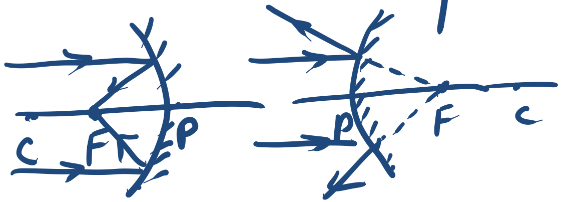
→ Velocity of image is always along vel. of obj.

Principal Foci – First Focus (F_1) & Second Focus (F_2)

In Mirrors → focus →

→ parallel incident rays converge to a pt → focus

→ Incident rays from a pt. after reflection become parallel.



First Focus (F_1) (Object pt.)

(u? s.t. $v \to \infty$)

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$v \to \infty$

$$u = f_1 = \frac{-\mu_1 R}{(\mu_2 - \mu_1)}$$

→ (+ve or −ve)

$|f_1| > R$

Second Focus (F_2) (Image pt.)

($u \to \infty$, v?)

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$u \to \infty$

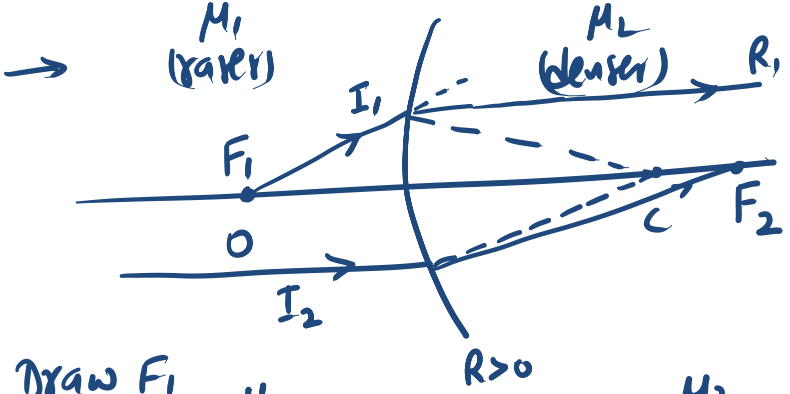
$$v = f_2 = \frac{\mu_2 R}{(\mu_2 - \mu_1)}$$

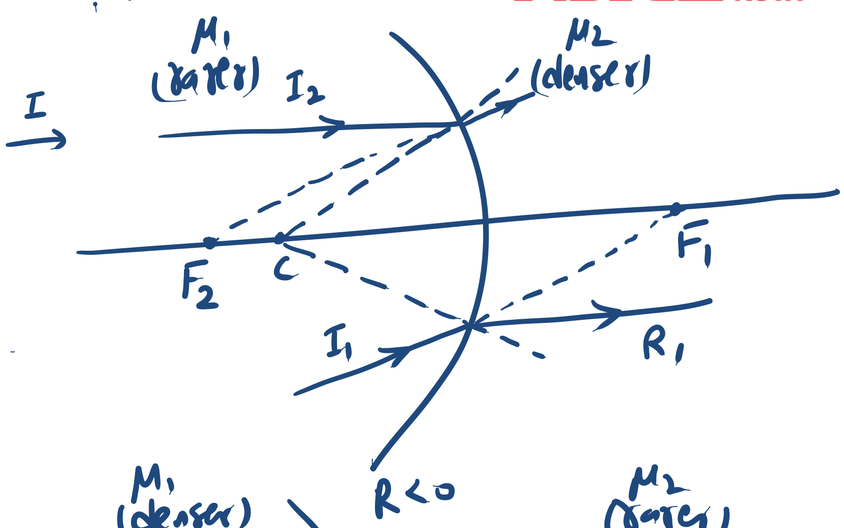
→ (+ve or −ve)

$|f_2| > R$.

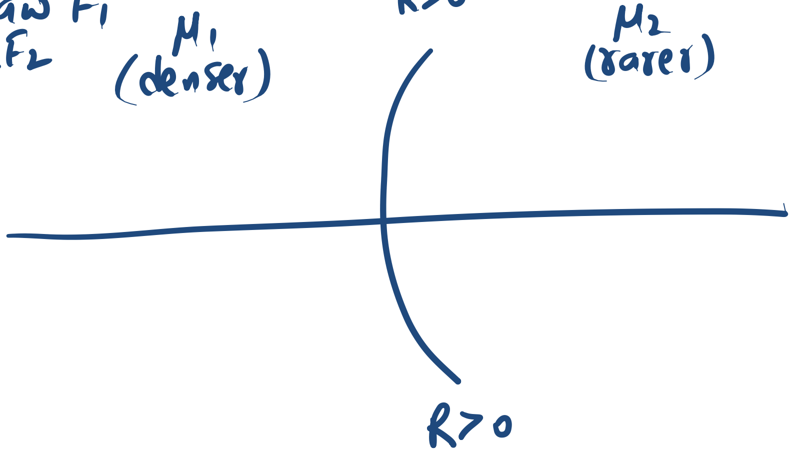
always opp in sign

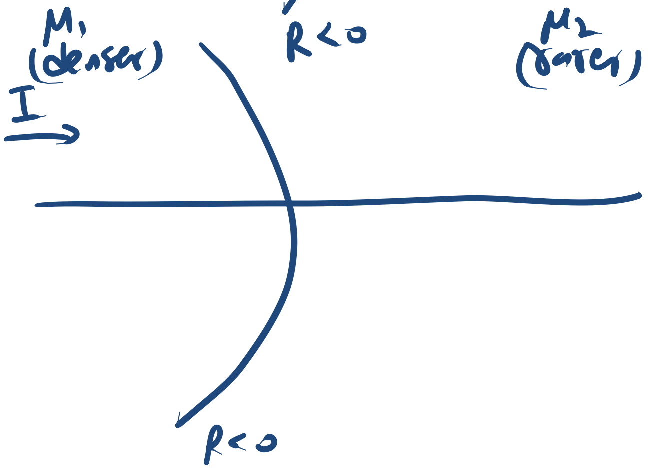
4 - cases of refraction through single surface :-





Q. Draw F_1 & F_2





Refraction through Lenses

ABLES KOTA

1. Types of lenses & nature of lenses.
2. Principal focii
3. Lens maker's formula
4. Rules for Ray diagram
5. Ray diagrams
   - Concave
   - Convex
6. Combination of lenses & mirror.
7. Displacement method.
8. Dispersion thru lenses.

Application

1). Microscope
2). Telescopes
3). Defects of vision.

- **Lenses** → Two refracting surfaces
  - → atleast one is curved
  - → thin lenses.

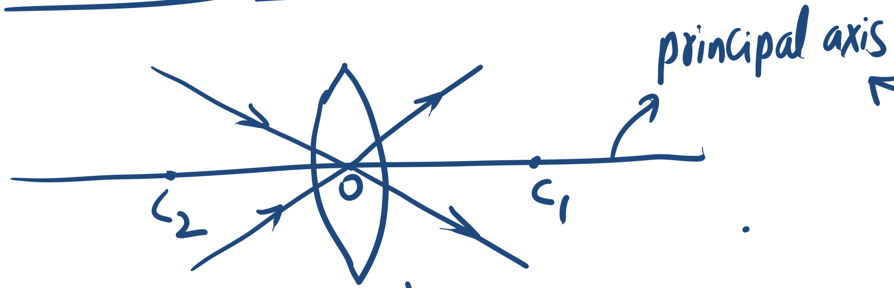
Converging lens ($\mu_{rel} > 1$) (Convex)

Diverging lens. ($\mu_{rel} < 1$) (Concave)

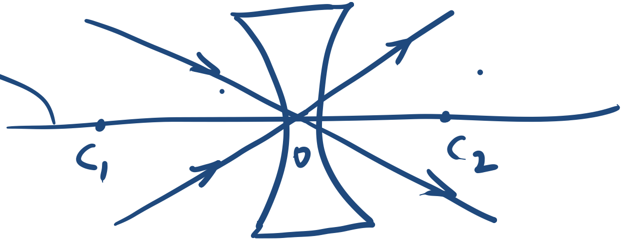
Biconvex   equiconvex   planoconvex   Concavoconvex

Biconcave   equiconcave   planoconcave   convexoconcave

Refraction thru lenses



(Convex)



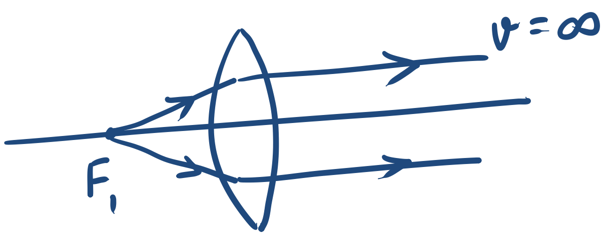
(Concave)

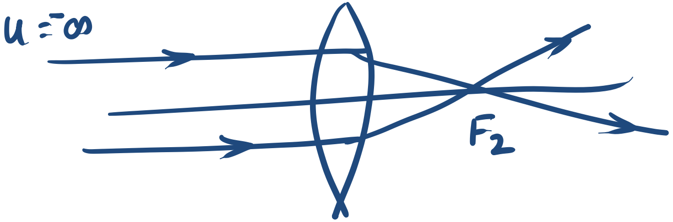
Centre of lens → optical centre.

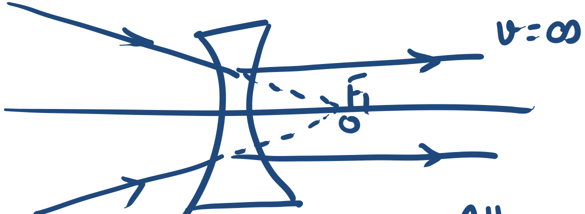
ABLES® KOTA

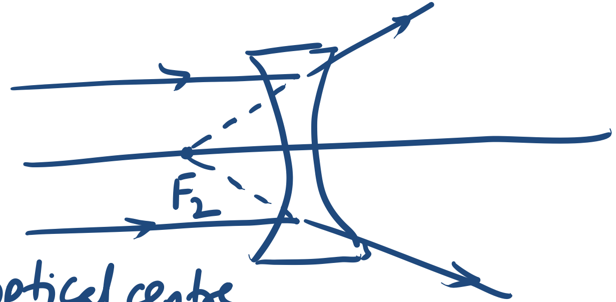
Principal Focii & Rules for Ray diagram →

↳ obj pt. & img pt.
(F_1) (F_2).









Rules for Ray diagram →

1). All rays thru optical centre will go undeviated.

2). Rays || to principal axis pass thru F_2.

3). Rays thru F_1 become parallel to principal axis after refraction.