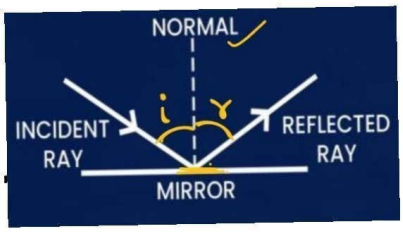
LIGHT REFLECTION AND REFRACTION

Reflection of light

The Bounching back of light when it hits a polished surface like mirror.

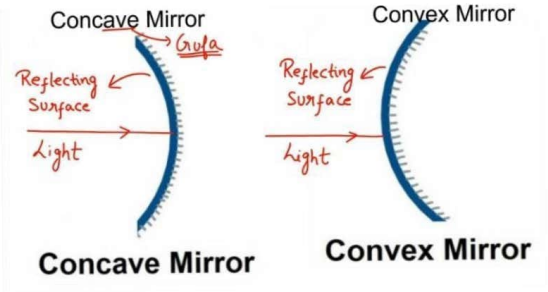
Laws of Reflection



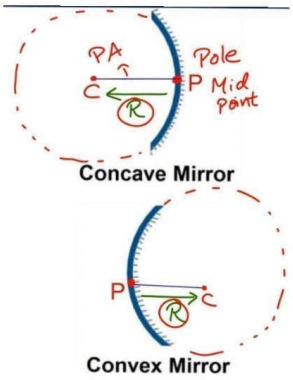
(i) $\angle i = \angle r$
Angle of incidence = Angle of Reflection.

(ii) The incident ray, the reflected ray and the normal all lie in the same plane.

Spherical Mirrors :-

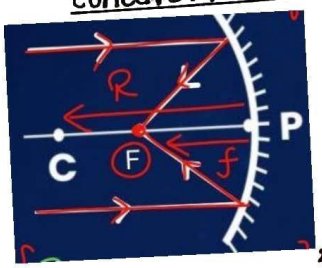


- Pole (P)
- centre of Curvature (C)
- Principal Axis (PA)
- Radius of Curvature (R)



Principle Focus (F) and Focal length (f) :-

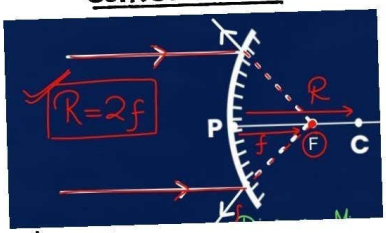
concave Mirror



(converging mirror)

*for spherical mirror in our syllabus
R = 2f

Convex mirror

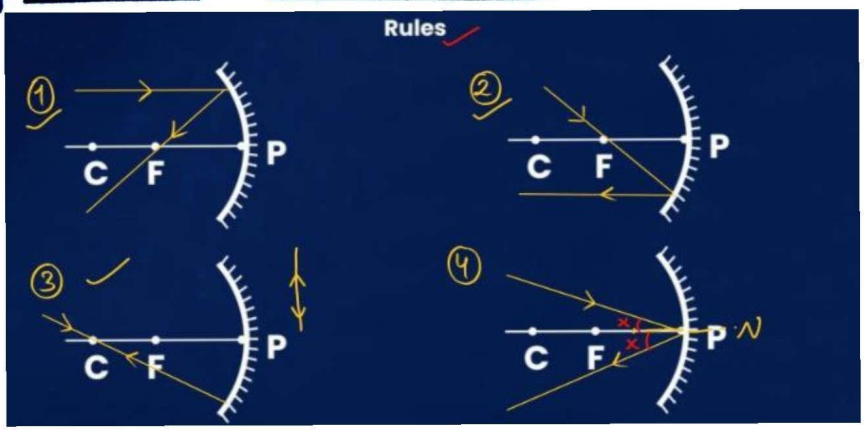


(Diverging mirror)

Image formation and characteristics :-

(1) Atleast two rays of light meet → Image
(2) if rays of light actually meet → Real
(3) if rays of light appear to meet → Virtual

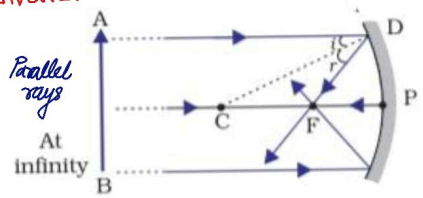
Image Formation - Concave Mirror



object at ∞

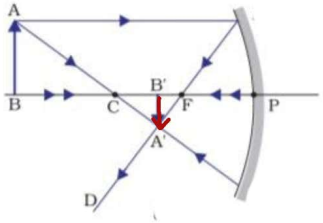
characteristics :- • Image at Focus
• Real, Inverted, Highly dimnished (Point size)

Real Humesha Inverted



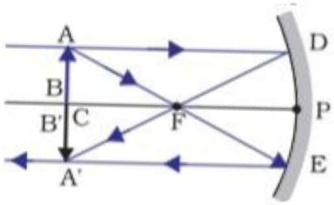
object Beyond C

characteristics :- • Image between C and F
• Real, Inverted, Dimnised



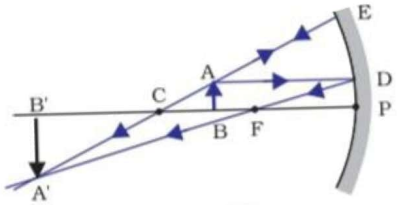
object at C

characteristics :-
• Image at C
• Real, Inverted, same size



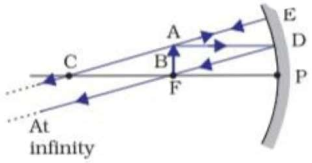
Object between C & F

characteristics :-
Image beyond C
Real, Inverted, Magnified



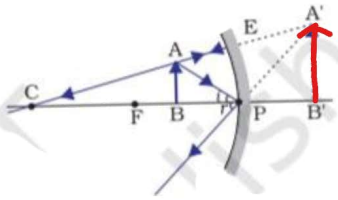
object at F

characteristics :-
Image at ∞
Real, Inverted,
Highly Magnified

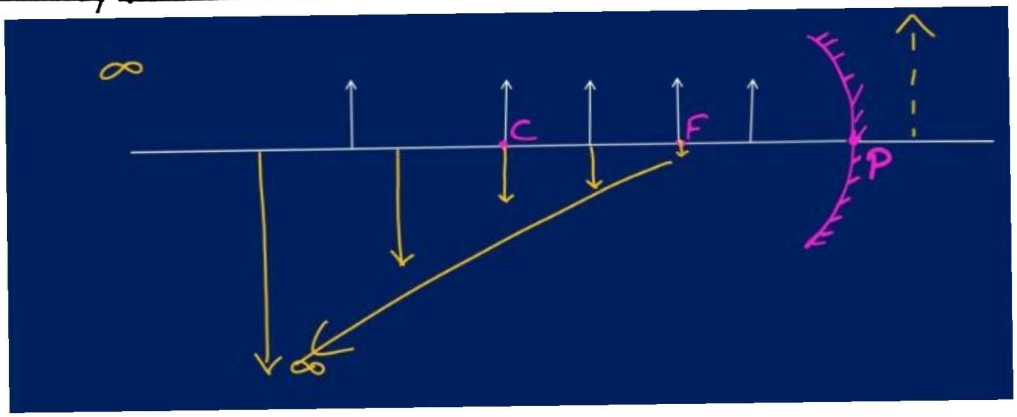


✡✡ objectbetween F and P

characteristics :-
Image behind the mirror.
Virtual, Erect, Magnified (Upright)

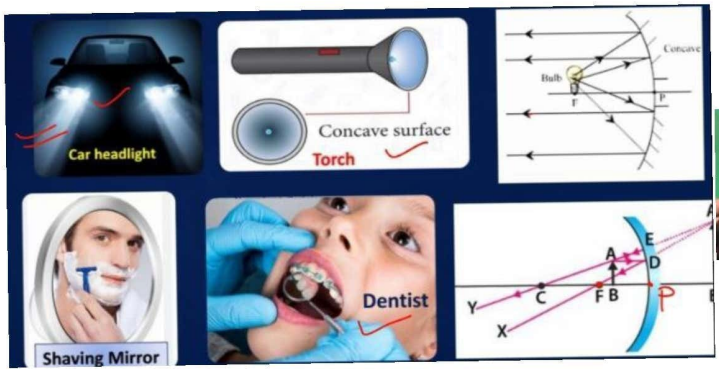


Summary for Concave Mirror :-



Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At the focus F	Highly diminished, point-sized	Real and inverted
Beyond C	Between F and C	Diminished	Real and inverted
At C	At C	Same size	Real and inverted
Between C and F	Beyond C	Enlarged	Real and inverted
At F	At infinity	Highly enlarged	Real and inverted
Between P and F	Behind the mirror	Enlarged	Virtual and erect

Uses of Concave Mirror



To concentrate sunlight to produce heat

↓

Solar Furnace

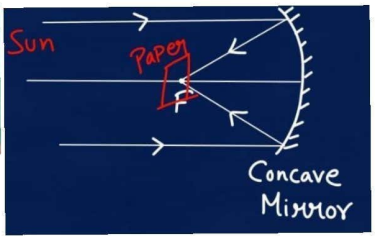
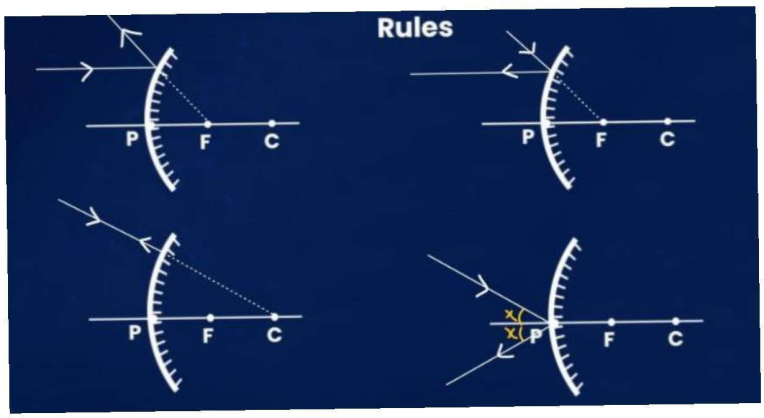


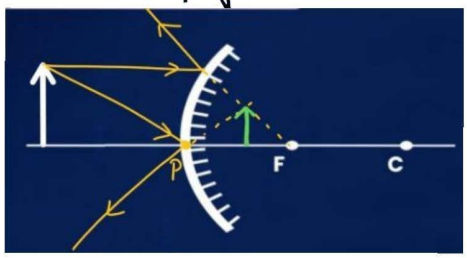
Image Formation: Convex Mirror



object at finite distance (anywhere except ∞)

Image between F and P

Virtual, Erect, Dimnished, Upright



Use of Convex Mirror

▲ Rear-View mirrors

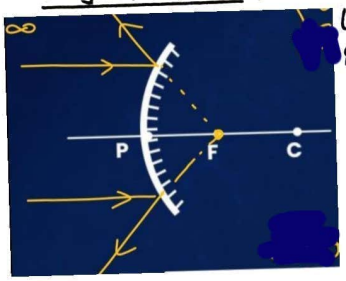
(1) Upright / Erect Image

(2) Wider field of View

summary - convex and Concave Mirror :-

- Concave Mirror
  - Inverted
  - Erect / Virtual upright, Enlarged (seedhi + Badi image)
- Convex Mirror
  - only Erect, Virtual Dimnished (seedhi or chotti image)

Object at ∞ :- Virtual, Upright, Erect



characteristics :-

- Image at F
- Virtual, Erect, Highly Dimnished Point Size

Learn Convex

Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At the focus F, behind the mirror	Highly diminished, point-sized	Virtual and erect
Between infinity and the pole P of the mirror	Between P and F, behind the mirror	Diminished	Virtual and erect

Sign Convention

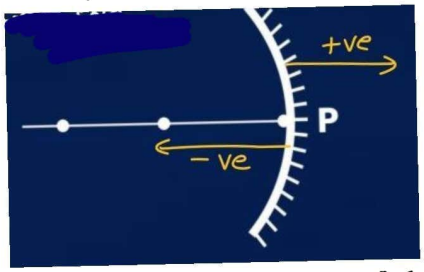
(1) All distances are measured from pole.

(2) → +x axis +ve

← −x axis −ve

(3) h = +ve (↑)

h = −ve (↓)



Mirror formula

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

u = object distance

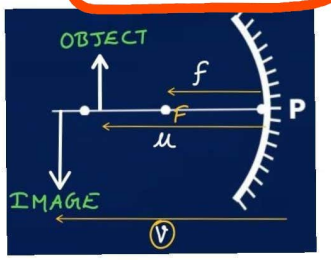
V = Image distance

Note

u → −ve Always

f → +ve convex

convex → +



Magnification (m)

$$m = \frac{h_i}{h_o} \qquad m = \frac{-V}{u}$$

Magnification (m) and Nature of image :-

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

$h_i = m \times h_o$

$m = 2$

$h_i = 2 \times h_o$

$m = 3$

$h_i = 3 \times h_o$

$m = -4$

$h_i = -4 \times h_o$

$m_{value} > 1$ magnified

$m = \frac{1}{2}(0.5)$

$h_i = \frac{1}{2} h_o$

$m_{value} < 1$ Dimnished

$m = -\frac{1}{3}(0.3)$

$h_i = -\frac{1}{3} h_o$

$m = -2$

$h_i = -2 h_o$

↑o ↓I Inverted

$m = +3$

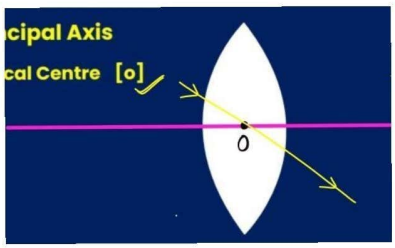
$h_i = +3 h_o$

↑o ↑I Erect

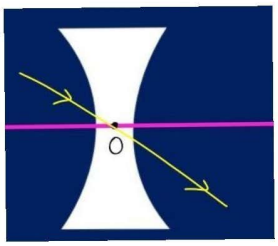
Spherical lenses :-

Principal axis

Optical Centre [o]



convex lens
(Thick in middle)

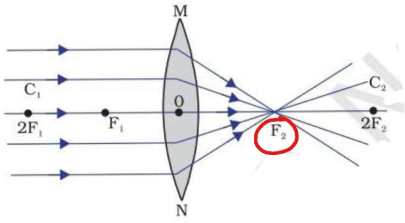


Concave lens
(Thin in middle)

Principal Focus (F) and Focal length (f)

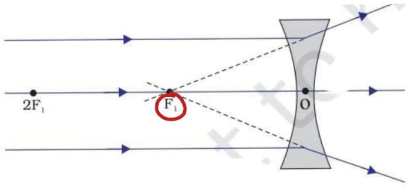
(1) convex lens

Note: They have two F F_1 and F_2 due to curved surfaces



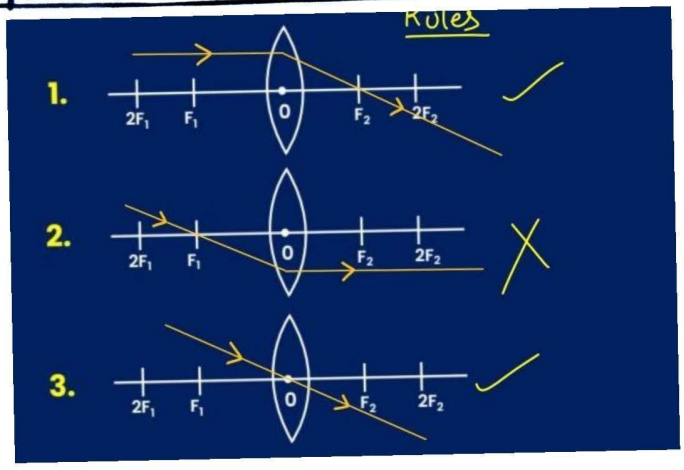
converging lens

(2) concave lens



Diverging lens

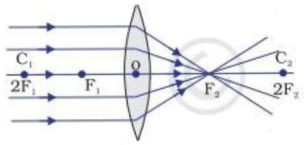
image formation → convex lens



object at ∞

characteristics of image :-

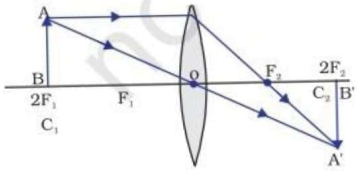
- Image at F_2
- Real, Inverted, Highly Dimnished → Point size



Object at $2F_1$

characteristics of image :-

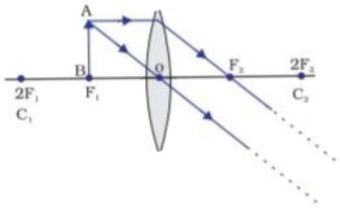
- Image at $2F_2$
- Real, Inverted, samesize



Object at F_1

characteristics of image :-

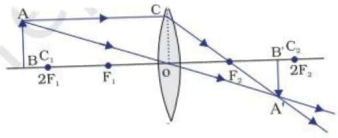
- Image at ∞
- Real, Inverted, Highly magnified



object Beyond 2F

characteristicsof image :-

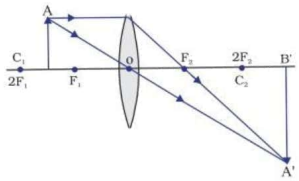
- Image between F_2 and $2F_2$
- Real, Inverted, Dimnished



object Between $2F_1$ & F_1

characteristics of image :-

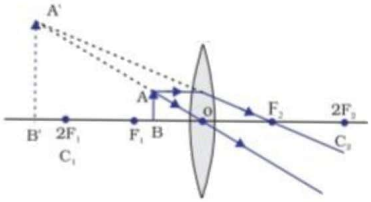
- Image Beyond $2F_2$
- Real, Inverted, Magnified

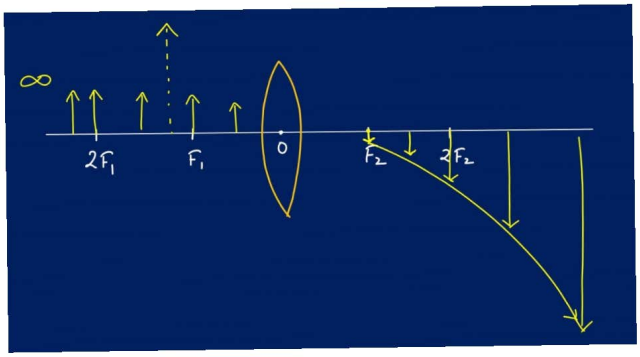


object Between F_1 & O

characteristicsimage :-

- Image on same side of object.
- Virtual, erect, Magnified.

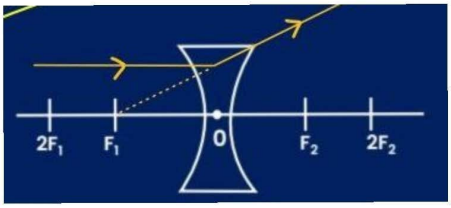




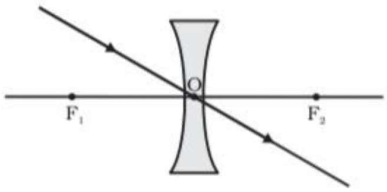
Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_2	Highly diminished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erect

Image Formation → Concave lens

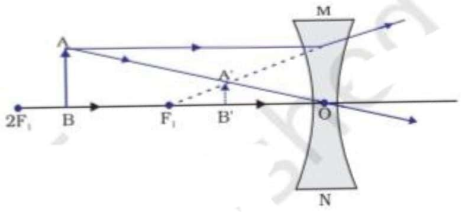
(i)



(ii)



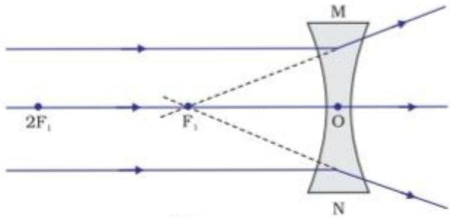
object at infinite distance (anywhere except ∞)



characteristics of image

- Image between F1 & O
- Virtual, Erect, Dimnished

object at ∞



characteristics of image

- Image at F1
- Virtual, Erect, Highly Dimnished → pointsize

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_1	Highly diminished, point-sized	Virtual and erect
Between infinity and optical centre O of the lens	Between focus F_1 and optical centre O	Diminished	Virtual and erect

summary of convex and concave lens

convex lens
- Inverted
- Erect/ upright magnified

Concave lens
- Erect/Upright
- Dimnished
- seedhi + chotti

Sign Convention, Lens formula and Magnification

(1) Here all distances are measured from O [optical Centre]

(2) Rest all same rule for sign.

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

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

$u \longrightarrow -ve$

convex $\longrightarrow +ve$

$f = +ve$

same rule

Power of a lens :-

- Ability of a lens to converge or Diverge Rays of light.
- it is defined as Reciprocal of focal length.

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

Unit → Diaptore (D)

always in metre → $\frac{cm}{100}$

convex lens $\rightarrow +ve$

$f \rightarrow +ve$

$P \rightarrow +ve$

Power of combination

$$P = P_1 + P_2 + \cdots$$

$$P = \frac{1}{f_1} + \frac{1}{f_2} \cdots$$

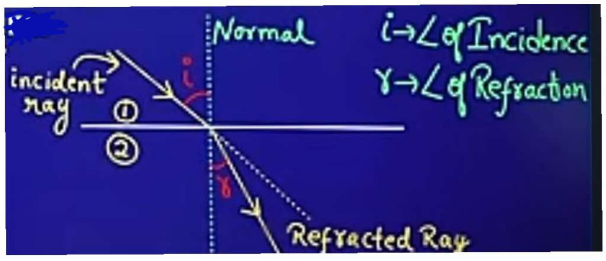
D $\qquad$ f_1 f_2 → in metres

Refraction of light :-

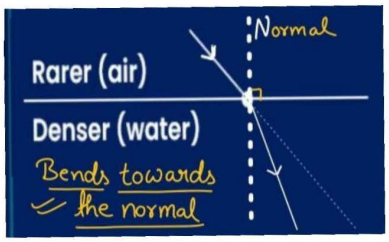
The bending of light ray when it travels from one medium to another

cause of refraction?

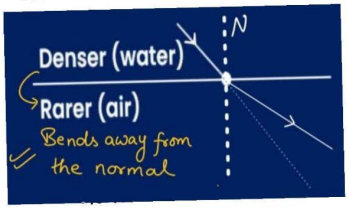
Refraction occurs because light travel with different speed in different medium



Rarer to Denser Medium



Denser to Rarer Medium



No change in medium
No Bending

✡ Denser → Jisme speed of light कम होती

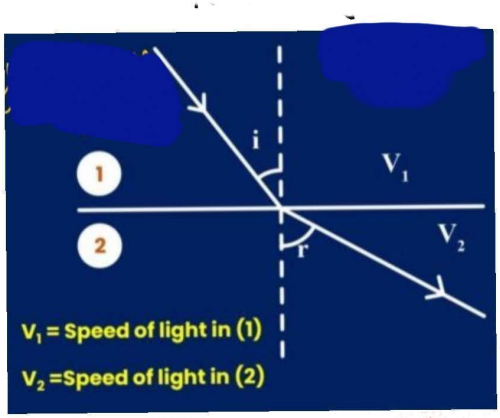
Refractive Index (R.I) (n) → kitna Dense ?? [optically]

R.I of ${}^{g}_{2}$ w.r.t ${}^{w}_{1}$

$$n_{12} = \frac{n_2}{n_1} = \frac{V_1}{V_2}$$

$$n_{wg} = \frac{n_g}{n_w} = \frac{V_w}{V_g}$$

$$n_{yx} = \frac{n_x}{n_y} = \frac{V_y}{V_x}$$



Absolute Refractive Index (R.I) :-

When 1st medium is Air, 2nd medium is any medium.

R.I of glass w.r.t air

$$n_{ag} = \frac{n_g}{n_a} = \frac{V_a}{V_g}$$

$n_a \simeq 1$, $V_a = c$

$$n_g = \frac{V_a}{V_g}$$

$$n_g = \frac{c}{V_g}$$

R.I of water w.r.t air

$$n_{aw} = \frac{n_w}{n_a} = \frac{V_a}{V_w}$$

$n_a \simeq 1$, $V_a \to c$

$$n_w = \frac{c}{V_w}$$

Ab RI medium x

$$n_x = \frac{c}{V_x}$$

Ab R.I of Gudiya

$$n_{AG} = \frac{n_G}{n_A} = \frac{V_A}{V_G}$$

$$n_\gamma = \frac{c}{V_\gamma}$$

$n_A \simeq 1$, $V_A \to c$

$$n_G = \frac{c}{V_G}$$

Concept building :-

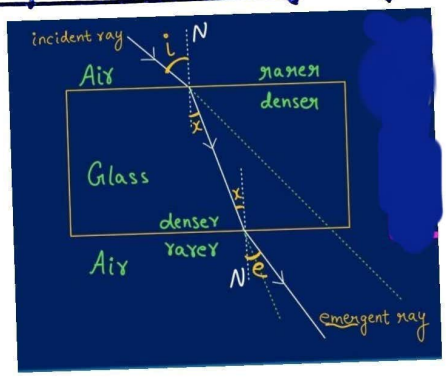
R.I of glass is 1.5

R.I of water is 1.33

- Which is more dense ? → Glass
- In which light travels faster → water
- find relation between V_g and V_w.

$$n_{wg} = \frac{n_g}{n_w} = \frac{V_w}{V_g}$$

Refraction through a glass slab :-



To remember

① emergent ray is parallel to incident ray.

② $\angle e = \angle i$

Laws of Refraction :-

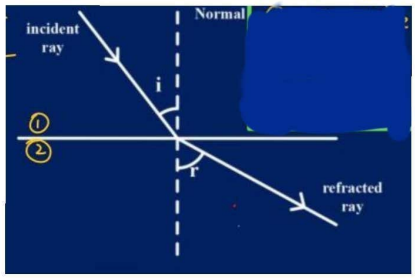
① The incident ray, Normal and the refracted ray lies on the same plane.

② The ratio of sine of Angle of incidence to the sine of angle of refraction remains for a given pair of media.

Snell's law :—

$$\frac{\sin i_1}{\sin r_1} = \frac{\sin i_2}{\sin r_2}$$

$$\frac{\sin i}{\sin r} = \text{constant}$$

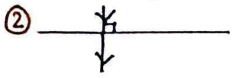


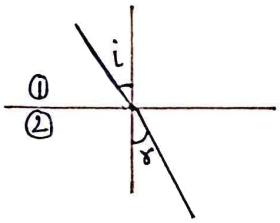
$i \longrightarrow$ change $\quad i_1\ r_1$

$r \longrightarrow$ change $\quad i_2\ r_2$

No Bending

① Medium same

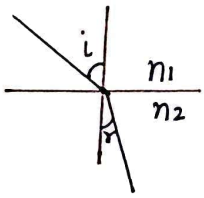
② 



$$\frac{\sin i}{\sin r} = \text{constant} = n_{12}$$

$i, r \longrightarrow$ change

$$\frac{\sin i}{\sin r} = n_{12}$$



$$n_1 \sin i = n_2 \sin r$$

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = n_{12}$$