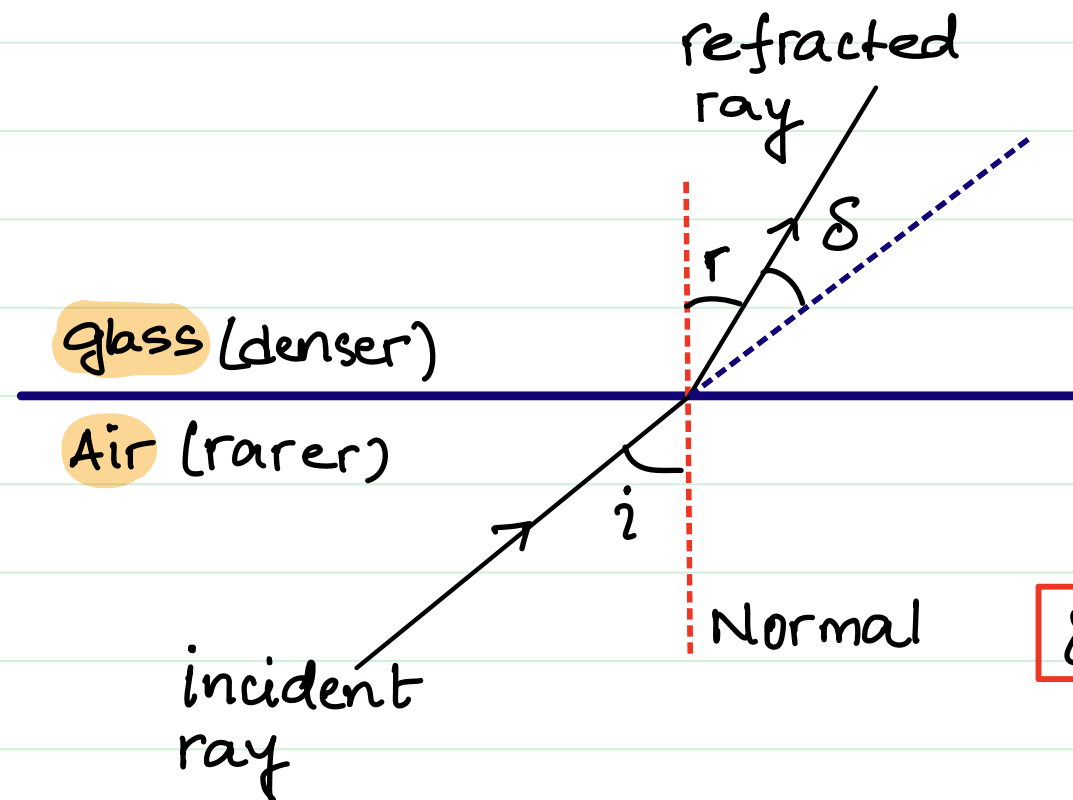


When light travels from rarer to denser medium



Light bends towards the normal.

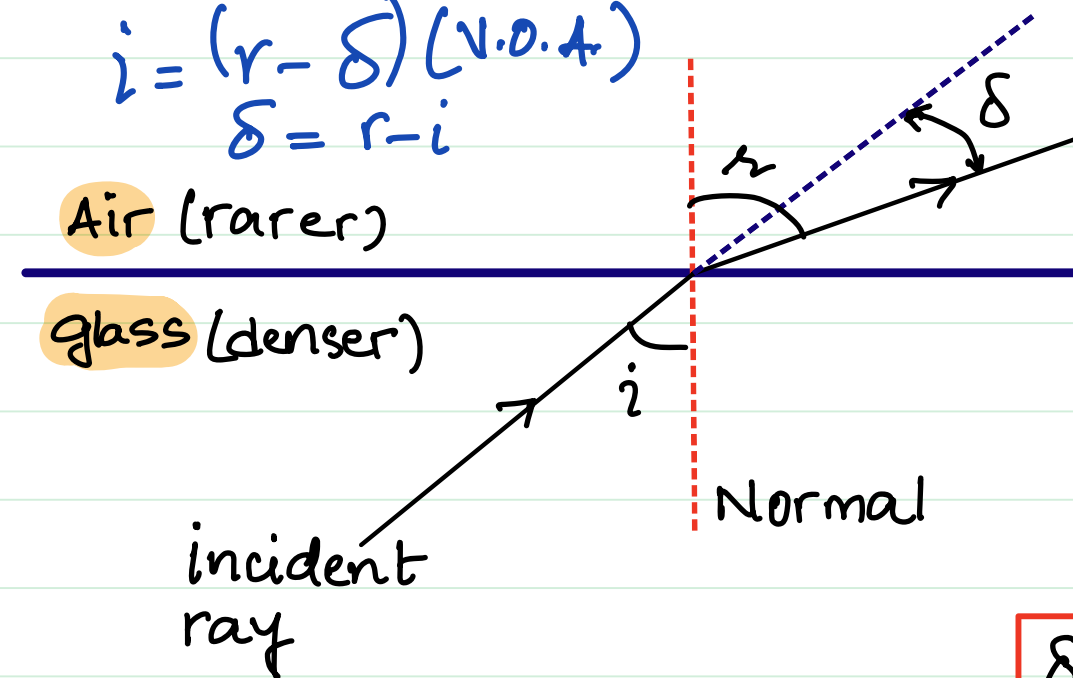
i - angle of incidence
 r - angle of refraction

$$\delta = i - r \text{ deviation of ray}$$

When light travels from denser to rarer medium

$$i = (r - \delta) \text{ (V.O.A.)}$$

$$\delta = r - i$$

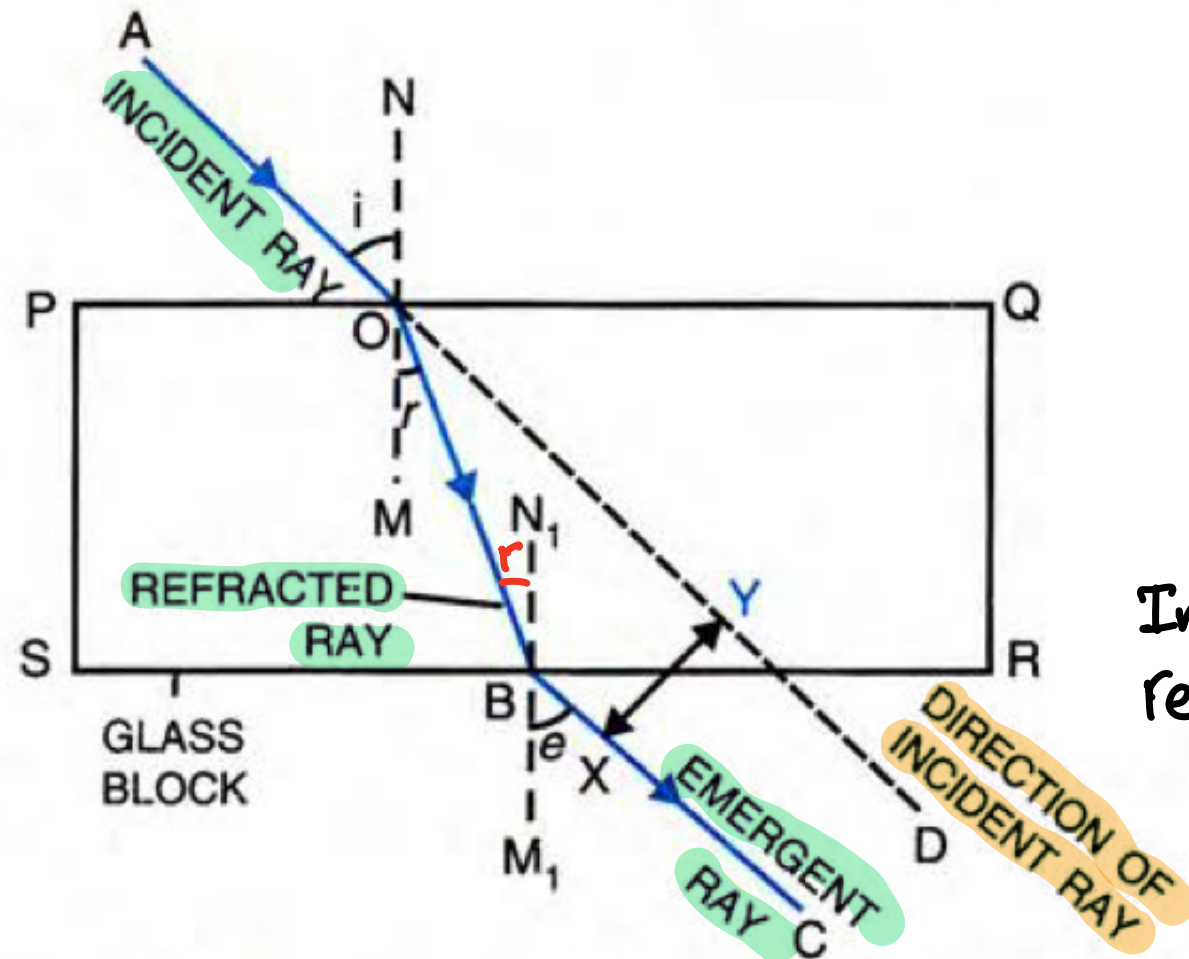


Light bends away from the normal.

i - angle of incidence
 r - angle of refraction

$$\delta = r - i \text{ deviation of ray}$$

Refraction through a rectangular glass block



Refraction #1 @ PQ

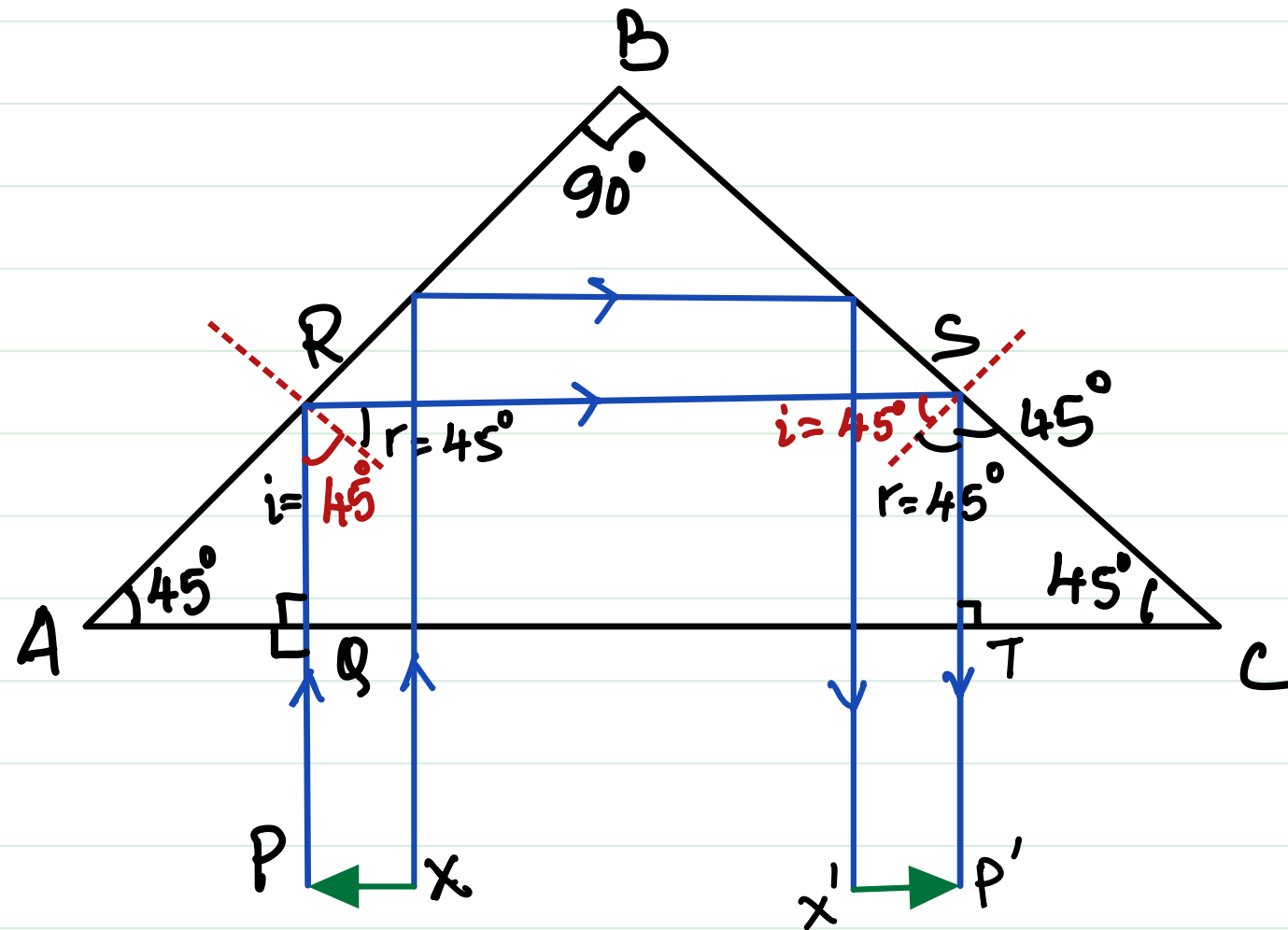
Incident ray: AO ; i - ang. of incidence
Refracted ray: OB ; r - " " refraction.
($\angle MOB$)

Refraction #2 @ SR ($\angle NBO$)

Incident ray: OB ; r - ang. of incidence
Refracted ray: BC ; e - ang. of refraction

- Note: $\angle MOB = \angle NBO$ ($\because$ Alternate Interior $\angle$ s)
- By Principle of reversibility of the path of light $i = e$
ie angle of incidence i = angle of emergence e
 $\Rightarrow$ Incident ray is parallel to the emergent ray
- Lateral Displacement** : The perpendicular distance b/w the emergent ray and the direction of incident ray is known as Lateral displacement X

b) Deviate a light ray through 180°



Here $i = 45^\circ > 42^\circ$ (critical angle)
 $\therefore$ Total Internal reflection occurs
 Here, r = angle of reflection

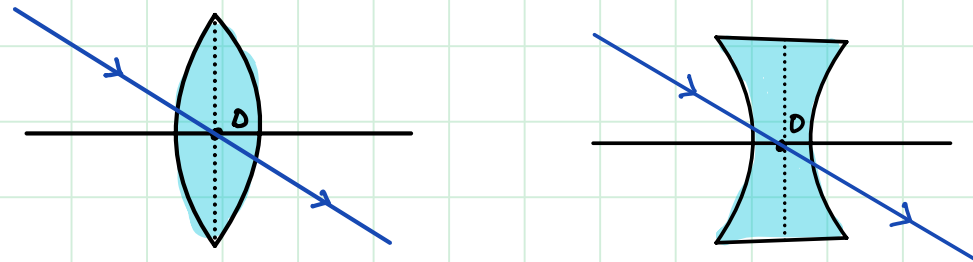
- Beam of light from object Px is incident normal to AC (hypotenuse), and enters undeviated.
- Beam is incident on the glass-air interface AB at $i = 45^\circ (> c)$, therefore the beam suffers total internal reflection.
- The reflected beam now strikes the glass-air interface BC at $i = 45^\circ (> c)$ to suffer another total internal reflection.
- The beam is now incident normal to AC and emerges undeviated to form the inverted image $P'x'$.

Use : In binoculars & camera to invert image without loss of intensity.

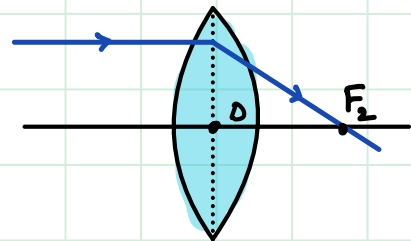
(B) Formation of Image by Lens

Rules for Geometric construction of images

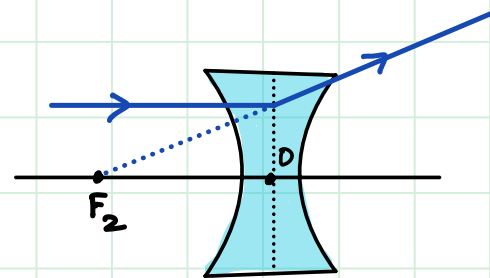
1. Ray of light through optical centre passes undeviated.



2. Ray of light incident parallel to principal axis after refraction,

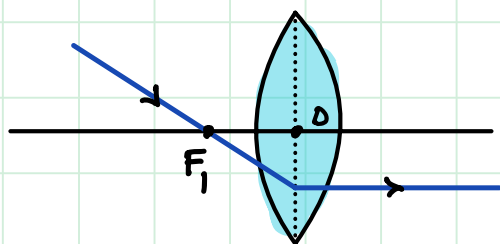


In a convex lens converges at second focus F_2

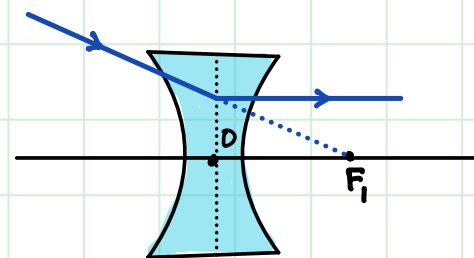


In a concave lens, appears to come from second focus F_2

3. A ray of light passing through the first focus (Convex lens) or directed towards first focus (concave lens), after refraction



becomes parallel to the principal axis.



Distinction between a real and a virtual image

Real image	Virtual image
1. A real image is formed due to actual intersection of the rays refracted by the lens.	1. A virtual image is formed when the rays refracted by the lens appear to meet if they are produced backwards.
2. A real image can be obtained on a screen.	2. A virtual image can not be obtained on a screen.
3. A real image is inverted with respect to the object.	3. A virtual image is erect with respect to the object.
<i>Example:</i> The image of a distant object formed by a convex lens.	<i>Example:</i> The image of an object formed by a concave lens.

14. The power of a lens is -2.0 D. Find its focal length and its kind. **Ans.** 50 cm, concave

15. The magnification by a lens is -3 . Name the lens and state how are u and v related ? **Ans.** Convex lens, $v = -3u$

16. The magnification by a lens is $+0.5$. Name the lens and state how are u and v related ?

(14.) $P = -2D$
 $f = \frac{1}{P} = \frac{1}{-2} = -0.5m \Rightarrow$ focal length = $-50cm$; Concave lens

(15.) $m = -3$ **Convex lens** ($\because$ Concave lens has 'm' always $\pm$)
 $m = \frac{v}{u} \Rightarrow -3 = \frac{v}{u} \Rightarrow v = -3u$

(16.) $m = +0.5$ **Concave lens** ($\because$ Only in case of Concave will the Image be diminished with 'm' $\pm$)
 $\frac{v}{u} = 0.5 \Rightarrow v = 0.5u$