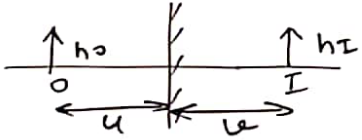
Session-6- Optics - Refraction @ Plane surface

Magnification | Laws of Refraction → Refractive Index → Refraction thru slab → TIR

Refraction thru slab → L.S. / N.S. / A.D.



Magnification → A term defined to comment upon nature & size of image w.r.t. object.

→ Term is used in both reflection and/or refraction

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

(for all mirrors) (for all cases)

for plane mirror,

$$\boxed{m = -1}$$

for plane mirror

Magnification → linear
→ Angular.

obj.
- position of obj. (u)
- size of obj
- nature of obj (real or virtual)

Images
- → position (v)
- → Size of image (small or enlarged)
- → nature of image (real or virtual)
- → orientation (erect or inverted)

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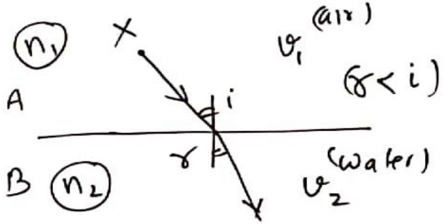
Refraction → Fermat's principle
↳ light takes that path which takes shortest time.

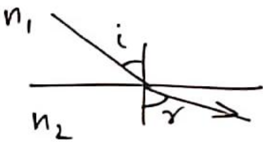


$(r < i)$

$$\boxed{\frac{v_2}{v_1} = \frac{\sin r}{\sin i}} \quad \text{—} (1)$$

$v_2 < v_1$

$v_1 = c/n_1 \quad v_2 = c/n_2$



if $(r < i) \rightarrow v_2 < v_1$
$c/n_2 < c/n_1$
$\Rightarrow n_2 > n_1$

if $(r > i) \rightarrow v_2 > v_1$
$\Rightarrow c/n_2 > c/n_1$
$\Rightarrow n_2 < n_1$

$n \rightarrow$ constant for the medium
↳ refractive index (μ)

Speed of light in a medium $= \dfrac{c}{n}$

If there are two mediums $(n_1 \,\&\, n_2) \rightarrow \dfrac{v_1}{v_2} = \dfrac{c/n_1}{c/n_2} = \dfrac{n_2}{n_1} \Rightarrow \boxed{\dfrac{v_1}{v_2} = \dfrac{n_2}{n_1}}$

Eq (1) becomes →

$\dfrac{n_1}{n_2} = \dfrac{\sin r}{\sin i} \Rightarrow \boxed{n_1 \sin i = n_2 \sin r}$

Session - 6 - Optics - Refraction @ Plane Surface

[Magnification] [Laws of Refraction] → [Refractive Index] → [Refraction thru slab] → [TIR]

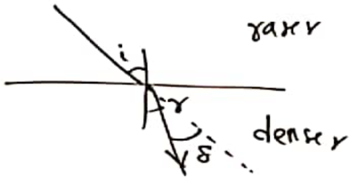
Refraction thru slab → L.S. , N.S. , A.D.

Refractive Index → $n = c/v$

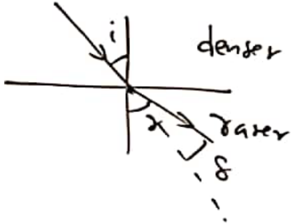
$n \geq 1$

if $n \uparrow \Rightarrow v \downarrow$

$v = c/n$



→ Absolute refractive Index, $n = c/v$



→ Relative —〃——〃—, $\boxed{{}_1n_2} = \frac{n_2}{n_1} = \frac{c/v_2}{c/v_1} = \frac{v_1}{v_2}$

Angle of deviation (δ) – $\boxed{\delta = |i - r|}$

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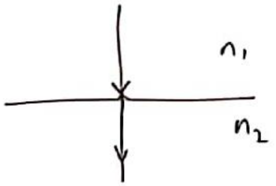
[Magnification] [Laws of Refraction] → [Refractive Index] → [Refraction thru slab] → [TIR]

Refraction thru slab → ∠S. , N.S. , A.D.

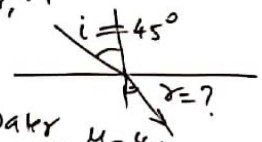
Ex.1.



$n_1 \sin i = n_2 \sin r$

$i = 0 \Rightarrow r = 0$

Ex.2



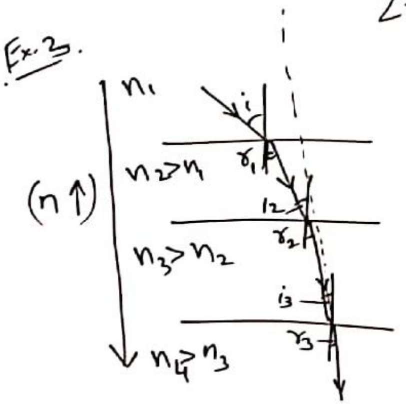
$\mu_1 \sin i = \mu_2 \sin r$

$1 \times \sin 45° = 4/3 \sin r$

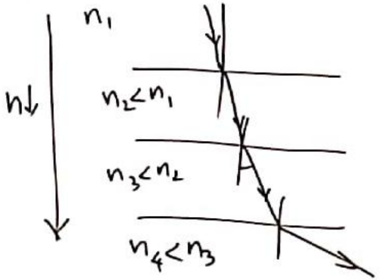
$\Rightarrow \sin r = 3/4\sqrt{2}$

$\Rightarrow r = \sin^{-1}(3/4\sqrt{2})$.

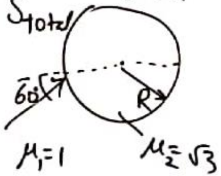
Ex.3.

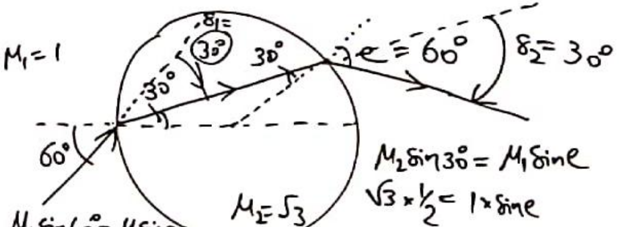


Ex-4.



Ex5. Draw ray diagram & find δ_{total} (30°)





$\mu_1 \sin 60° = \mu_2 \sin r$

$1 \times \sqrt{3}/2 = \sqrt{3} \sin r \Rightarrow$ $r = 30°$

$\mu_2 \sin 30° = \mu_1 \sin e$

$\sqrt{3} \times 1/2 = 1 \times \sin e$

$e = 60°$

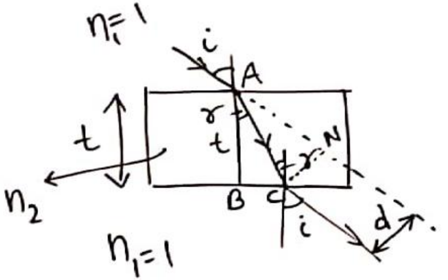
$\delta_{total} = \delta_1 + \delta_2 = 60°$

Session-6 - Optics - Refraction @ Plane Surface

Magnification | Laws of Refraction → Refractive Index → Refraction thru slab → TIR

Refraction thru slab → L.S., N.S. (Ex-4), A.D.

Refraction through a glass slab →



$n_1 \sin i = n_2 \sin r$ —(1)

$n_2 \sin r = n_1 \sin i_1$

$\Rightarrow \boxed{i_1 = i}$

$\delta_{total} = 0$

Lateral shift (d)

$AB = t$

$\angle BAC = r$

$AC = t/\cos r$

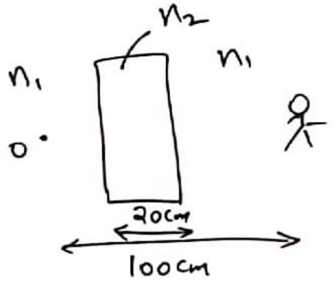
$\Delta ACN \rightarrow$

$CN = AC \sin(\angle CAN)$

$\angle CAN = i - r$

$CN = AC \sin(i - r)$

$$\boxed{d = \frac{t}{\cos r} \sin(i - r)}$$



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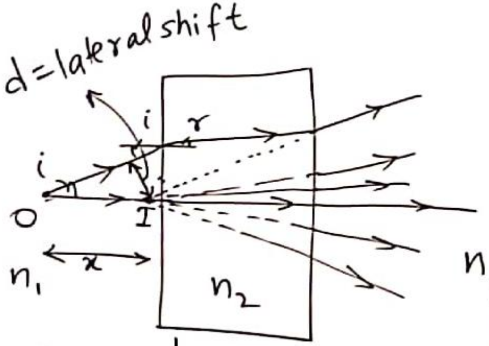
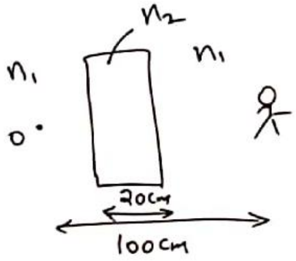
Session-6- Optics- Refraction @ Plane Surface

Magnification | Laws of Refraction → Refractive Index → Refraction thru slab → TIR

Lateral shift, $d = \frac{t}{\cos r}\sin(i-r)$

Normal shift, $x = d\left(1 - \frac{1}{{}_1\mu_2}\right)$





$n_1 \sin i = n_2 \sin r$

$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = {}_1n_2$

$\sin i = \frac{d}{x}$

$x = \frac{d}{\sin i} = \frac{t}{\cos r}\frac{\sin(i-r)}{\sin i}$

$= \frac{t(\sin i\cos r - \cos i\sin r)}{\cos r\sin i} = t\left(1 - \frac{\cos i\sin r}{\sin i\cos r}\right) = t\left(1 - \frac{1}{{}_1n_2}\times\frac{\cos i}{\cos r}\right)$

$= t\left(1 - \frac{1}{{}_1n_2}\right)$ (near normal incidence)

$(i \simeq 0)$
$\cos i \to 1$
$\cos r \to 1$