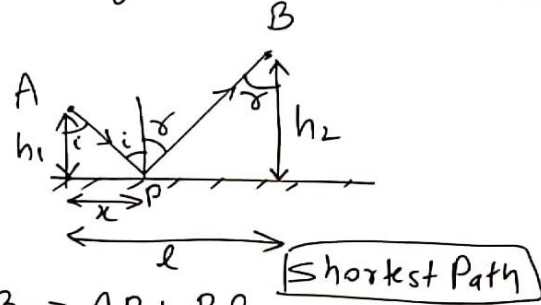


Session-2 (Optics) - Reflection @ plane mirror.

Reflection & Refraction - Fermat's Principle.

Q → Light travels thru shortest path or takes shortest time.



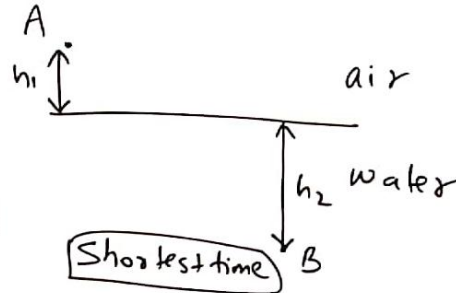
$$APB \rightarrow AP + PB$$

$$= \sqrt{h_1^2 + x^2} + \sqrt{h_2^2 + (l-x)^2}$$

$$\frac{dAPB}{dx} = \frac{1}{2\sqrt{h_1^2 + x^2}} \cdot 2x + \frac{1 \cdot 2(l-x)(-1)}{2\sqrt{h_2^2 + (l-x)^2}} = 0$$

$$\sin i - \sin r = 0$$

$$\boxed{i = r}$$



$$t = t_1 + t_2$$

$$= \frac{AP}{c} + \frac{PB}{c} = \frac{APB}{c}$$

$$= \frac{\sqrt{h_1^2 + x^2} + \sqrt{h_2^2 + (l-x)^2}}{c}$$

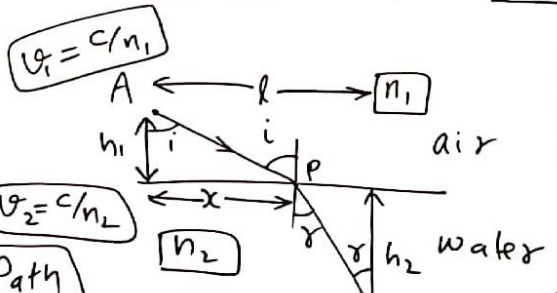
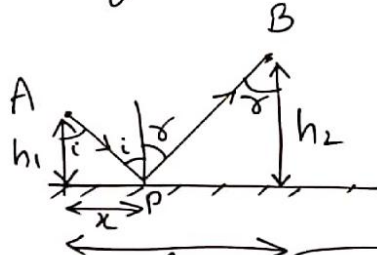
$$\boxed{\frac{dt}{dx} = 0}$$

$$\boxed{\sin i = \sin r}$$

Session-2 (Optics) - Reflection @ plane mirror.

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$$t = t_1 + t_2$$

$$t = n_1 \frac{\sqrt{h_1^2 + x^2}}{c} + n_2 \frac{\sqrt{h_2^2 + (l-x)^2}}{c}$$

$$\frac{dt}{dx} = 0$$

for refraction →

Shortest Path

Shortest time

$$v_1 = c/n_1, v_2 = c/n_2$$

$$\Rightarrow n_1 = c/v_1, n_2 = c/v_2$$

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

$$\Rightarrow \frac{c}{v_1} \sin i = \frac{c}{v_2} \sin r \Rightarrow$$

$$\frac{v_2}{v_1} = \frac{\sin r}{\sin i}$$

$$v_2 < v_1$$

$$r < i$$

$$\Rightarrow \sin r < \sin i$$

$$\Rightarrow \sin r / \sin i < 1$$

gives $i = r$

Not as per observation.

$$\Rightarrow \frac{n_1}{c} \cdot \frac{1}{\sqrt{h_1^2 + x^2}} + \frac{n_2}{c} \cdot \frac{-1}{\sqrt{h_2^2 + (l-x)^2}} = 0$$

$$\Rightarrow n_1 \frac{x}{\sqrt{h_1^2 + x^2}} - n_2 \frac{(l-x)}{\sqrt{h_2^2 + (l-x)^2}} = 0$$

$$\Rightarrow n_1 \sin i - n_2 \sin r = 0$$

$$\Rightarrow \boxed{n_1 \sin i = n_2 \sin r} \rightarrow \text{Snell's Law.}$$

Session-2 (Optics) - Reflection @ plane mirror.

Reflection & Refraction - Fermat's Principle

- Light chooses that path b/w two fixed pts. A & B, such that the time taken is least.
- Laws of reflection & refraction → derived through pure geometry & Calculus.
- Assumption → Light travels in straight line.

$\lambda_{\text{light}} \ll (\text{size})_{\text{object/molecules.}} \Rightarrow$ the wave nature is highly diminished.
 \Rightarrow Light wave can be treated as a ray.

Geometrical or Ray Optics

Session-2 (Optics) - Reflection @ plane mirror.

Reflection & Refraction - Fermat's Principle

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→ (speed of light) ↓ in denser medium

Geometrical or Ray Optics

Ray optics

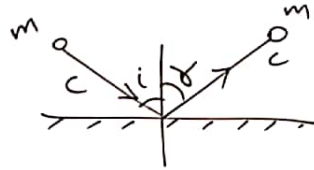
← reflection, refraction, dispersion, scattering, interference, diffraction, polarization → wave optics

wave nature increasing

Particle nature → PEE, absorption, emission spectra

Session-2 (Optics) - Reflection @ plane mirror.

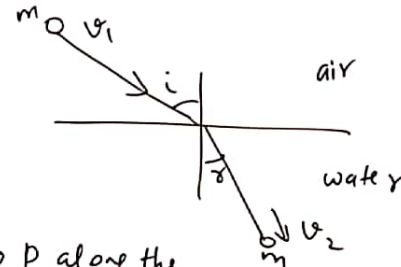
Reflection & Refraction - Corpuscles theory by Newton.



→ Momentum of light particle along the mirror → constant.

$$m c \sin i = m c \sin r$$

$$\Rightarrow \boxed{\sin i = \sin r}$$



→ p along the surface → const.

$$\Rightarrow m v_1 \sin i = m v_2 \sin r$$

$$\Rightarrow \boxed{v_2 = v_1 \frac{\sin i}{\sin r}}$$

$$\Rightarrow \boxed{v_2 > v_1}$$

$$i > r$$

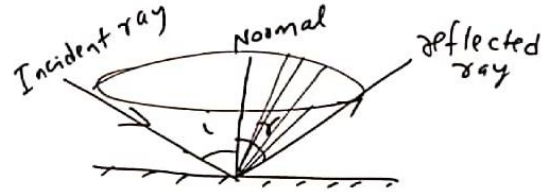
$$\frac{\sin i}{\sin r} > 1$$

Speed of light doesn't increase in denser medium as predicted by Corpuscles theory by Newton

Session-2 (Optics) - Reflection @ plane mirror.

Reflection @ plane mirror.

- ① Laws of reflection → 1). $\angle i = \angle r$
 2). incident ray, reflected ray & normal, all lie in the same plane.

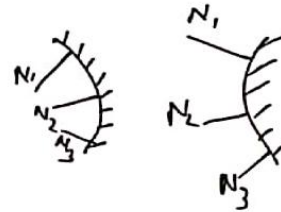


- ②. Terminology → a). Mirror



- b). normal to mirror
 (\perp to surface)

- c). Sign convention → (Dirⁿ of incident ray → +ve)



- d). Ray diagram
 e). object & image.

