Optical Fibre Communication.

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Basic optical laws & definitions.

1. Refractive index :

$$\boxed{n = \frac{c}{v}} = \frac{\text{velocity of light (EM wave) in Vaccum}}{\text{velocity of light (EM wave) in Medium.}}$$

* It's a fundamental property of Light.

$$\boxed{c = f\lambda}$$

Typical values of n :—

$n = 1$, for air
$n = 1.33$, for water
$n = 1.45$, for silica glass
$n = 2.42$, for diamond.

Reflection and Refraction.

* also $\boxed{n = \frac{\sqrt{\mu\epsilon}}{\sqrt{\mu_0\epsilon_0}}} = \sqrt{\mu_r\epsilon_r}$ ⇒ Refractive index.

* For Non-Magnetic Media,
$\mu_r = 1$

$$\therefore \boxed{n = \sqrt{\epsilon_r}}$$

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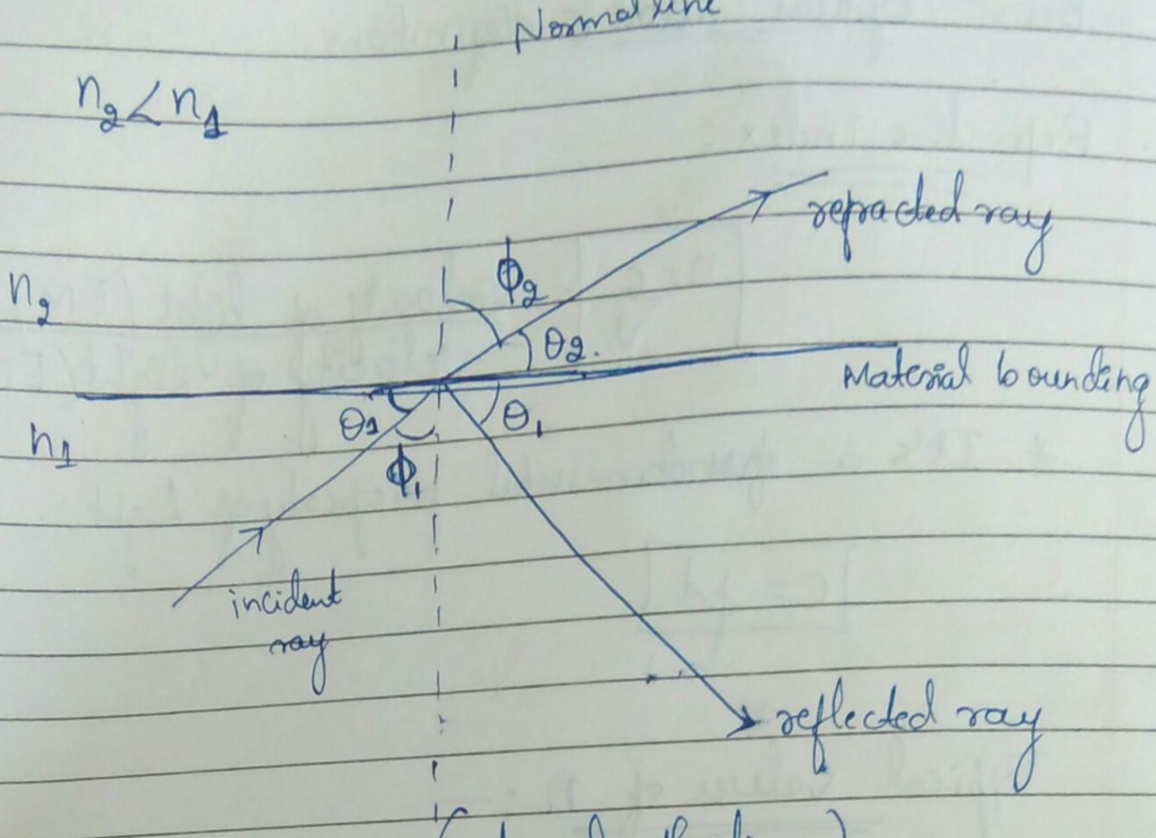

fig: (internal reflection)

* The angle of incidence is equal to angle of reflection.

* Reflection law = angle of incidence = angle of reflection.

* Snell's Law

$$\boxed{n_1 \sin\phi_1 = n_2 \sin\phi_2}$$

or

$$\boxed{n_1 \cos\theta_1 = n_2 \cos\theta_2}$$

TIR

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* The angle ϕ_1 b/w the incident ray and normal to the surface is known as angle of incidence.

* When the light ray encounters, a boundary seperating 2 different media, part of the ray is reflected back into the first medium and the remainder is bend (refracted) as it enters into the 2nd medium.
We assume that $n_2 < n_1$.

* The bending or refraction of the light ray at the interface is the result of the difference in the speed of light that have different refractive indices.

external reflection.

* When a light travelling @ a certain media is reflected off, an optically denser material, this process is referred as external reflection.

* The reflection of light of less optical denser material is called internal reflection.

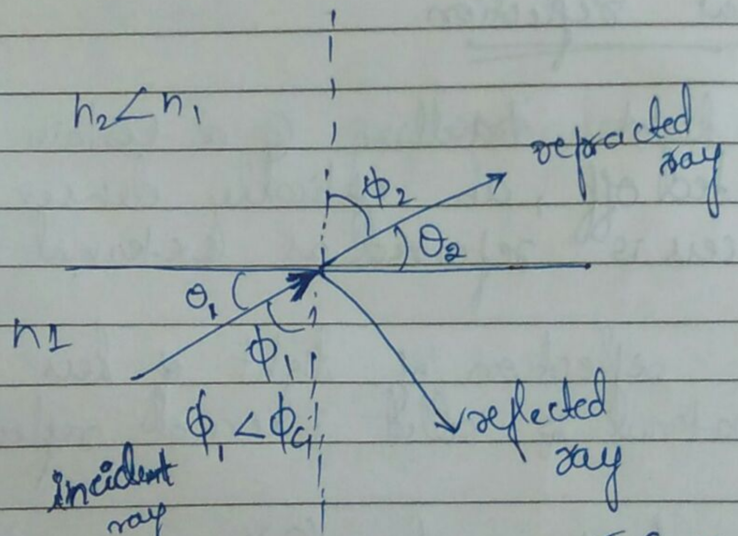
* As angle of incidence (θ_1) is an optically denser medium because larger, the reflected approaches $\pi/2$, beyond this point there is no refraction is possible.
and the light ray becomes "totally internal reflection".

* When applying TIR condition to Snell's law

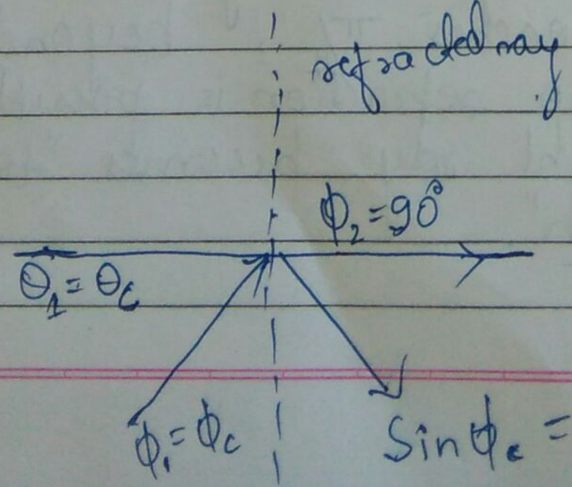
$$\boxed{\phi_1 = \sin^{-1}\left(\frac{n_2}{n_1}\sin\phi_2\right)}$$

* If the angle of incidence (θ_1) is increased, a point eventually increase where the light ray is $\parallel^{le}$ to material bounding face (ex: glass surface). This point is called the ~~angle~~ critical angle of incidence (ϕ_c).

* When angle of incidence (θ_1) is greater than critical angle, the condition for TIR is satisfied.
  ↳ There is no refraction, all becomes reflected.



I Case.



II Case.

$$\sin\phi_c = \frac{n_2}{n_1}$$

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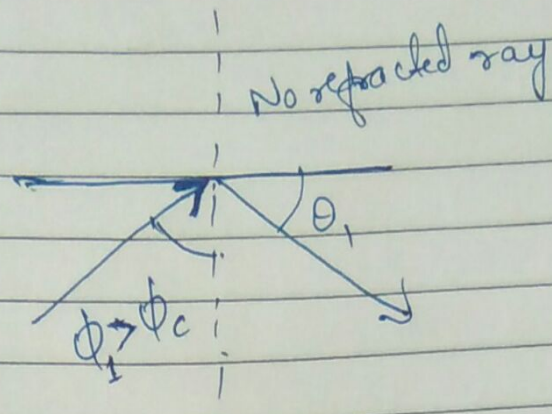

~~When θ_1 < ||~~ ||| case.

* when $\theta_1 < \frac{\pi}{2} - \phi_c$

$$\tan\frac{\delta_N}{2} = \sqrt{\frac{n^2\cos^2\theta_1 - 1}{n\sin\theta_1}}$$

$$\tan\frac{\delta_P}{2} = n\frac{\sqrt{n^2\cos^2\theta_1 - 1}}{\sin\theta_1}$$

where $\boxed{n = \frac{n_1}{n_2}}$

* δ_N & δ_P are the phase shifts of the electric field components normal & $\|^{le}$ to the plane of incidence respectively.

~~Where~~

for ex: glass air interface ($n = 1.45$)

$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1}\left(\frac{1}{1.45}\right)$$

$$\boxed{\theta_c = 43.6^\circ}$$ //.