TOTAL INTERNAL REFLECTION
and the
CRITICAL ANGLE
As the angle of incidence increases, the angle of refraction increases.

**TOTAL INTERNAL REFLECTION**
A diagram illustrating the principles of light refraction and reflection in different optical media.

1. **Very Strong Transmission**
   - Occurs when the angle of incidence is very small.

2. **Strong Refraction**
   - Occurs at angles less than the critical angle.

3. **Weak Refraction**
   - Occurs at angles close to the critical angle.

4. **Critical Angle**
   - The angle at which the light is totally internally reflected.
   - \( \hat{i} = \hat{c} \) when \( \hat{i} \approx 90^\circ \).

5. **Total Internal Reflection**
   - Occurs when the angle of incidence is greater than the critical angle.

The diagram shows how the intensity of reflected light increases with increasing angle of incidence in a slow-speed medium, while the amount of light energy reflected increases. The diagram also highlights the transition between rare, dense, and slow-speed optical media.
Critical angle is the angle at which the refracted ray is at 90°.
Relation between refractive index and critical angle

Rays of light are travelling from denser medium ‘b’ to rarer medium ‘a’.

\[ b \mu_a = \frac{\sin i}{\sin r} \]

\[ b \mu_a = \frac{\sin C}{\sin 90} \]

Where C is the critical angle at which angle of refraction is 90°

\[ a \mu_b = \frac{1}{\sin C} \]

Critical angle for glass is 42°

Critical angle for water is 48°
Total Internal Reflection (TIR)

When a ray of light goes from denser to rarer medium it bends away from the normal and as the angle of incidence in denser medium increases, the angle of refraction in rarer medium also increases and at a certain angle, angle of refraction becomes 90°, this angle of incidence is called critical angle (C). When Angle of incidence exceeds the critical angle than light ray comes back in to the same medium after reflection from interface. This phenomenon is called Total internal reflection (TIR).

Conditions for Total Internal Reflection

(a) The ray must travel from denser medium to rarer medium.
(b) The angle of incidence \( i \) must be greater than critical angle \( C \).
DISTINCTION BETWEEN TOTAL REFLECTION AND REFLECTION FROM A PLANE MIRROR

**Total internal reflection**
- It takes place when light passes from a denser medium to a rare medium when angle of incidence is greater than the critical angle.
- The entire light is reflected.
- There is no loss of energy.
- The image is much brighter and the brightness is permanent.

**Reflection from a plane mirror**
- It takes place when light is incident on a plane mirror from any medium at any angle of incidence.
- Only part of light is reflected while rest is refracted and absorbed.
- The energy of reflected ray is less than that of the incident ray.
- The image is less bright and the brightness gradually decreases.
Total internal reflection in a Prism

A periscope may be used by people
(i) in a submarine to see above the sea surface
(ii) to see over the heads of people in a crowd.

This action of prism is used in a periscope
Deviation through 180 degree

This action of prism is used in binocular
Erecting Prism

This action of prism is used in a slide projector.
Deviation through 60 degree by an Equilateral Prism
Total internal reflection and refraction of light through 30°, 90°, 60° Prism

No total internal reflection

Total internal reflection takes place
CONSEQUENCES OF TOTAL INTERNAL REFLECTION

TIR in Diamonds
Sparkling is due to:
1. Cut of diamond faces
2. High index of refraction which means a very small critical angle ($n = 2.42$, $C = 24.4^\circ$)
   Incident rays can undergo multiple TIR inside a diamond before exiting the top of the diamond.
MIRAGE

LOOMING
Light does not escape as it travels along the fiber optics cable because it undergoes total internal reflection.