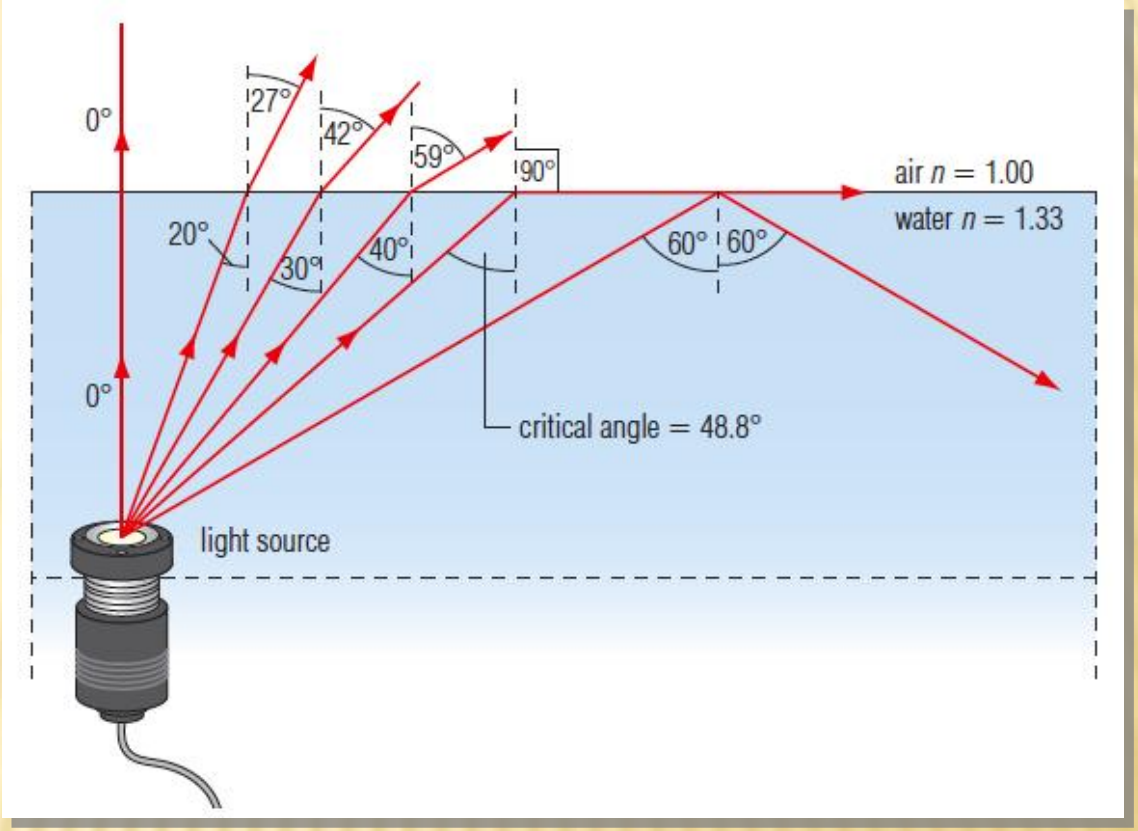
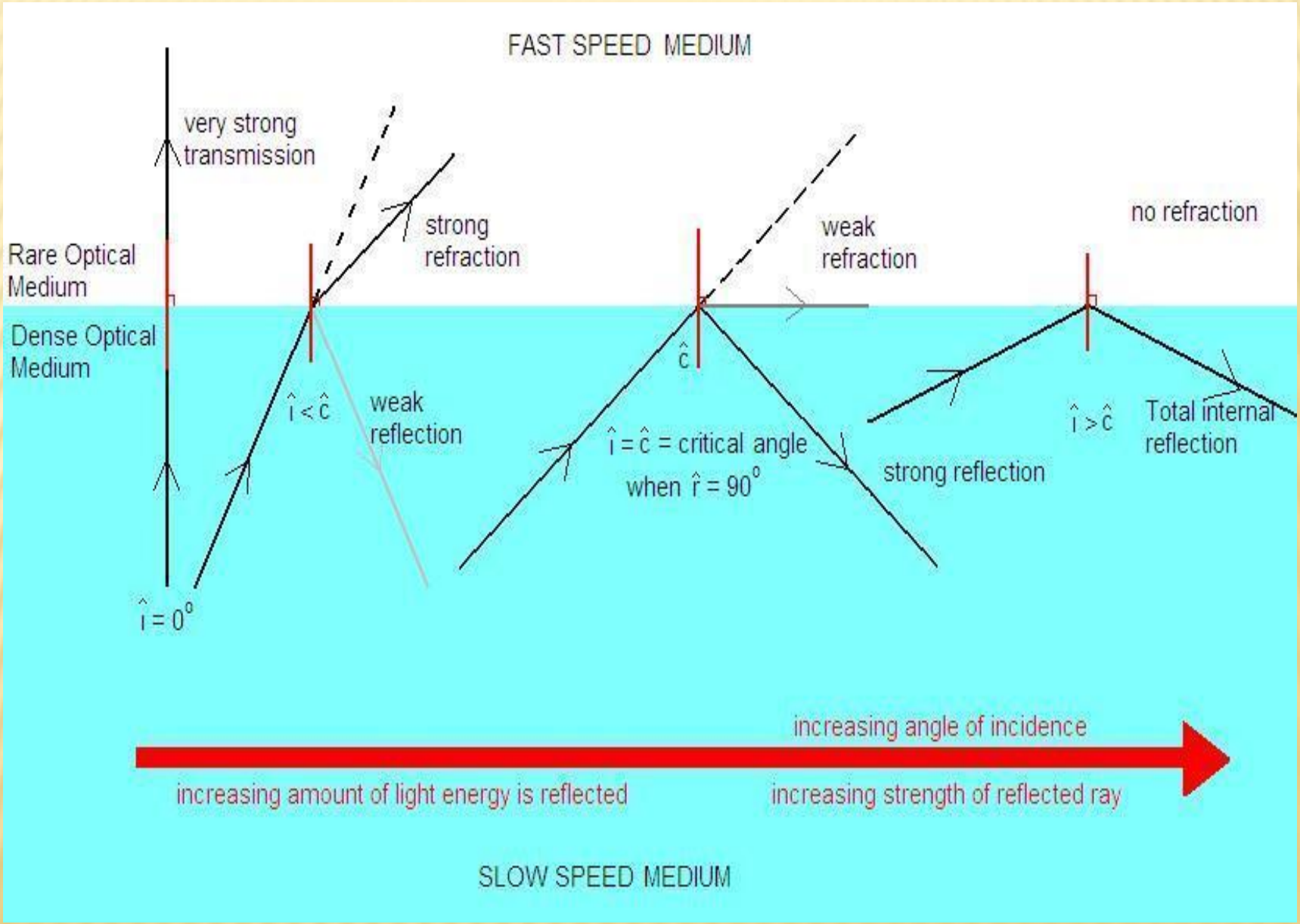
TOTAL INTERNAL REFLECTION and the CRITICAL ANGLE

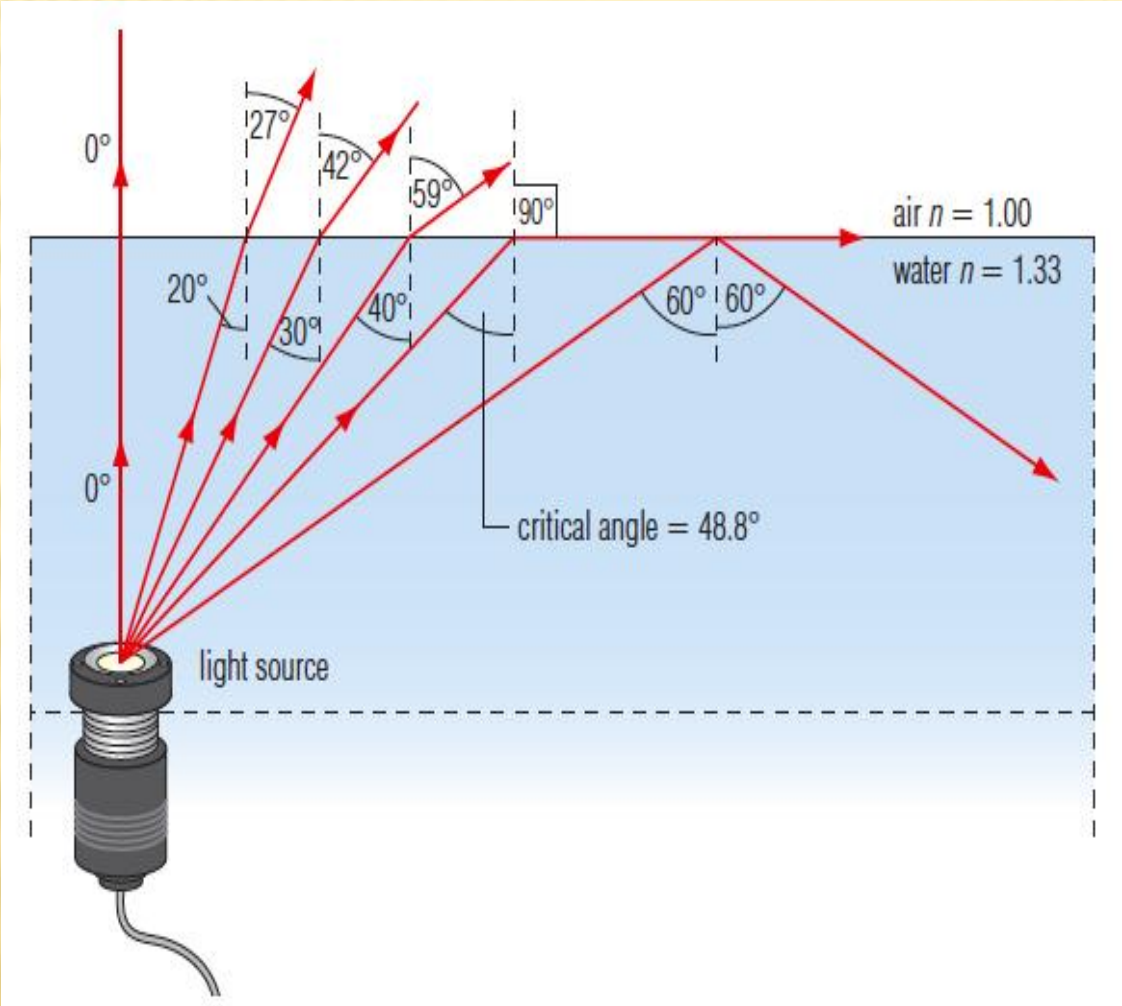
As the angle of incidence **increases**, the angle of refraction **increases**



TOTAL INTERNAL REFLECTION

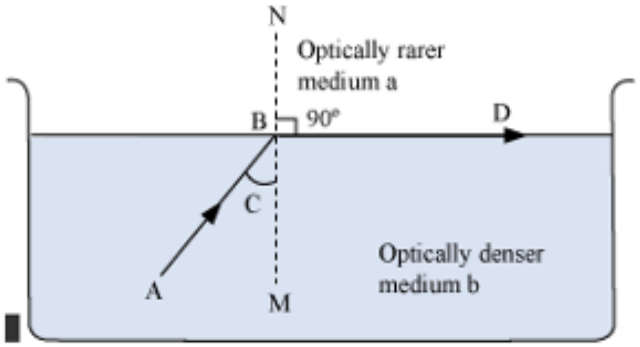

FAST SPEED MEDIUM
very strong transmission
strong refraction
weak refraction
no refraction
Rare Optical Medium
Dense Optical Medium
$\hat{i} < \hat{c}$
weak reflection
$\hat{c}$
$\hat{i} = \hat{c}$ = critical angle
when $\hat{r} = 90^{o}$
strong reflection
$\hat{i} > \hat{c}$
Total internal reflection
$\hat{i} = 0^{o}$
increasing angle of incidence
increasing amount of light energy is reflected
increasing strength of reflected ray
SLOW SPEED MEDIUM

Critical Angle



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°

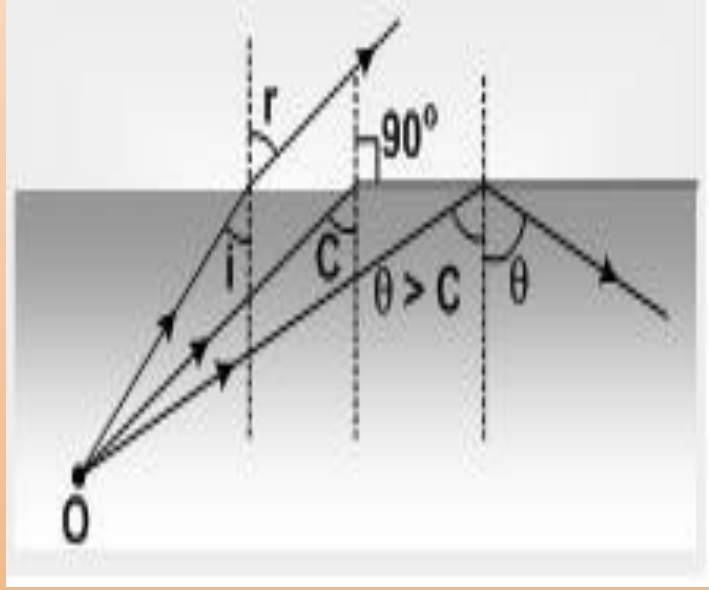
$$ {}^{a}\mu_{b} = \frac{1}{\sin C} $$

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

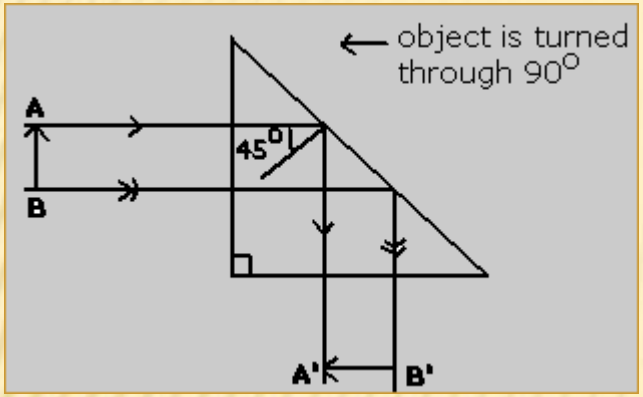
Total internal reflection

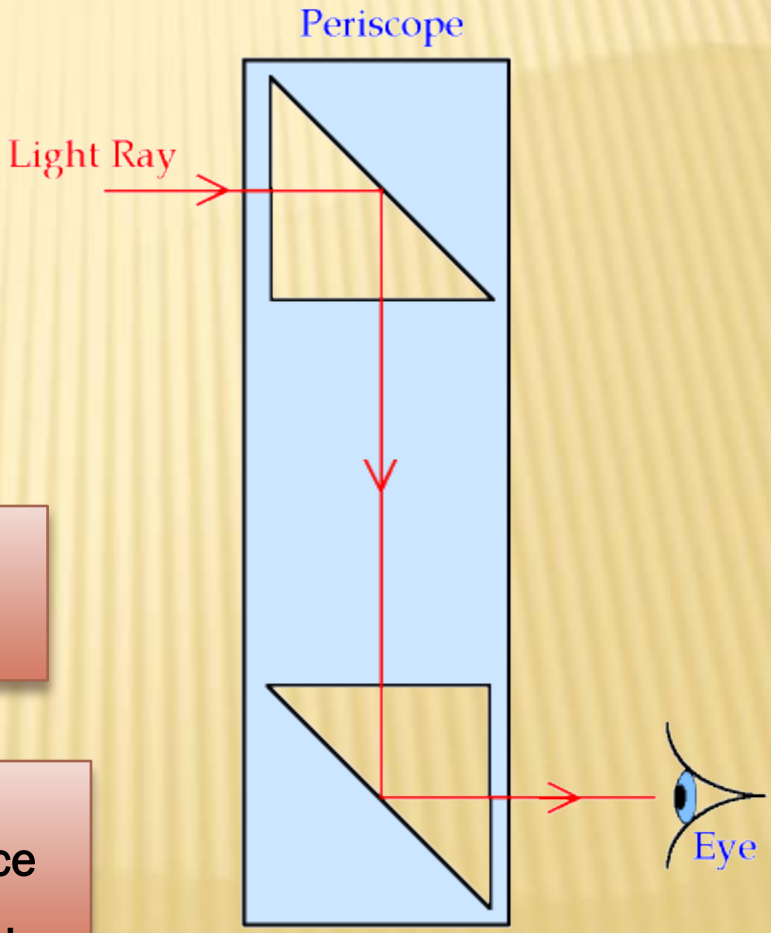
- It takes place when light passes from a denser medium to a rare medium when angle of incidence is greater than the critical angle
- The entire light is reflected
- There is no loss of energy
- The image is much brighter and the brightness is permanent

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

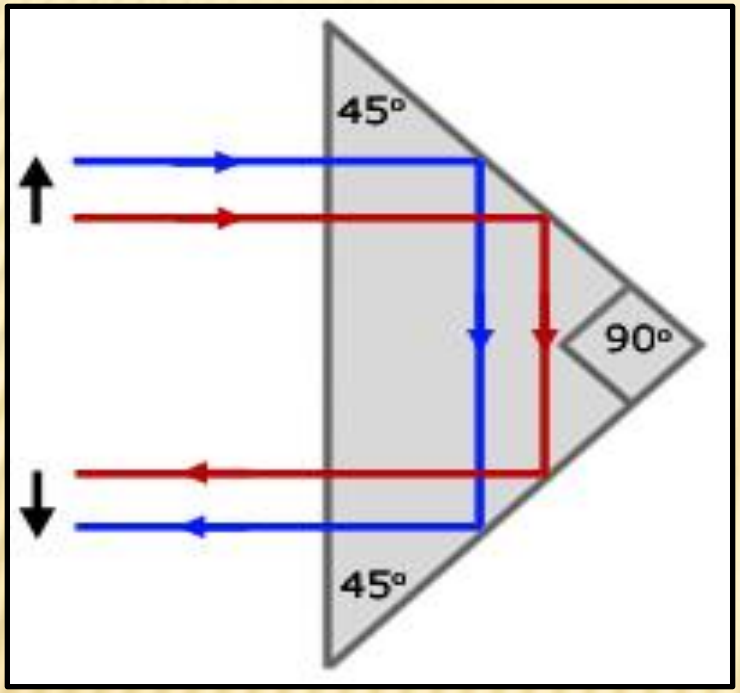


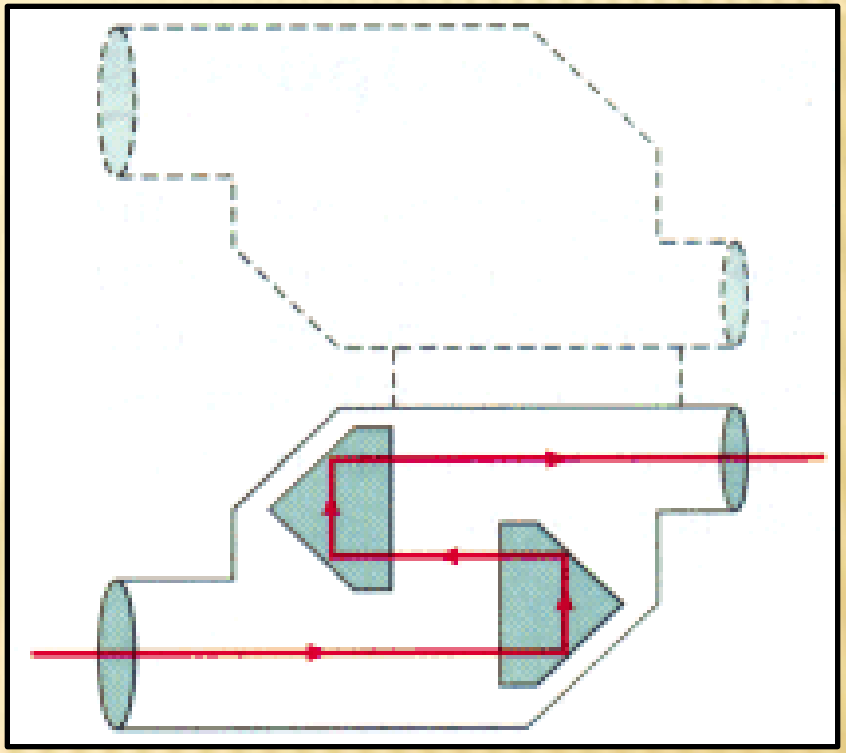


This action of prism is used in a periscope

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.

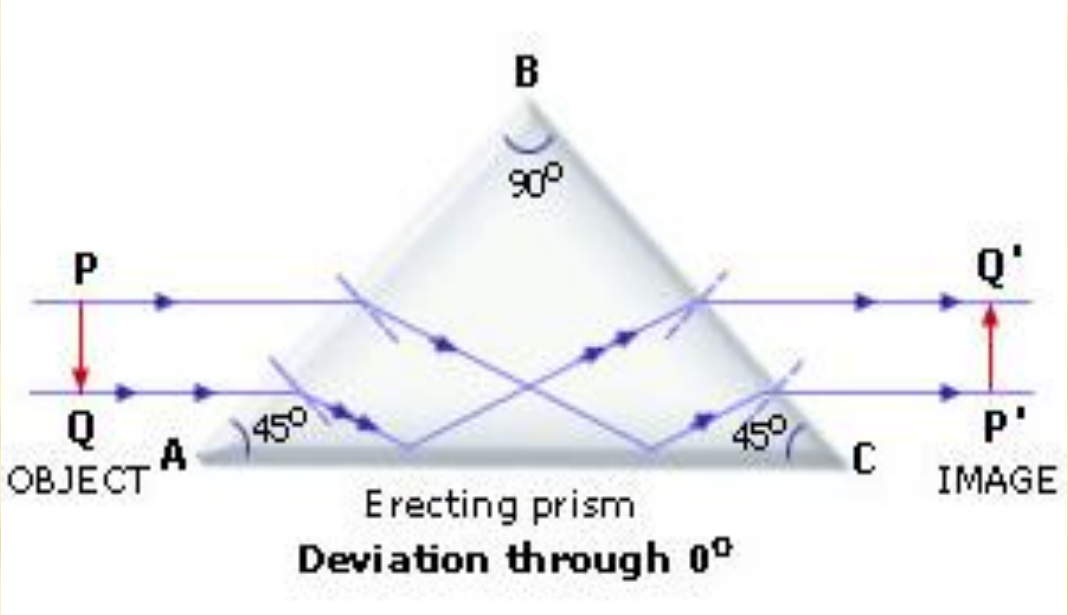
Deviation through 180 degree





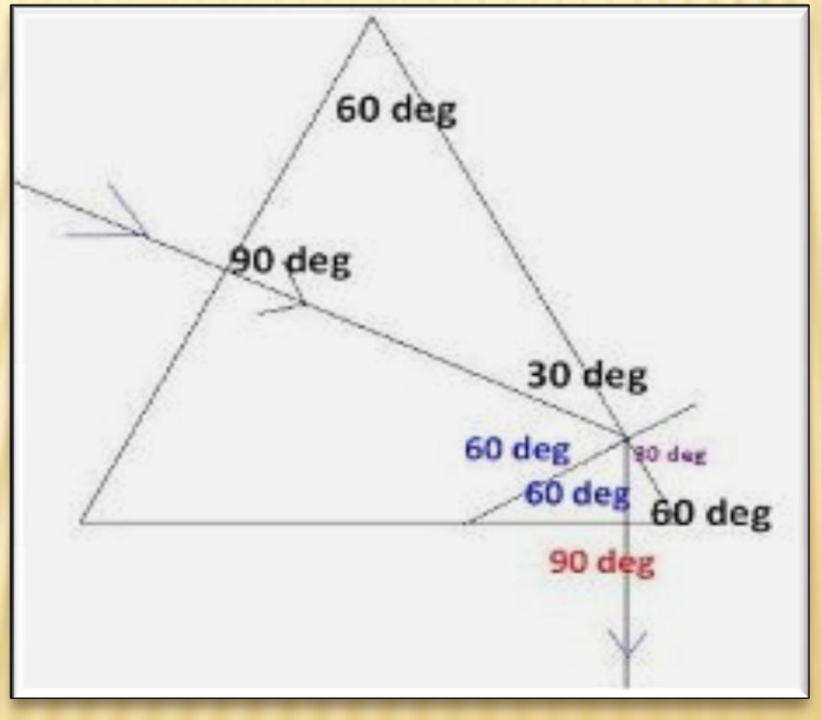
This action of prism is used in binocular

Erecting Prism

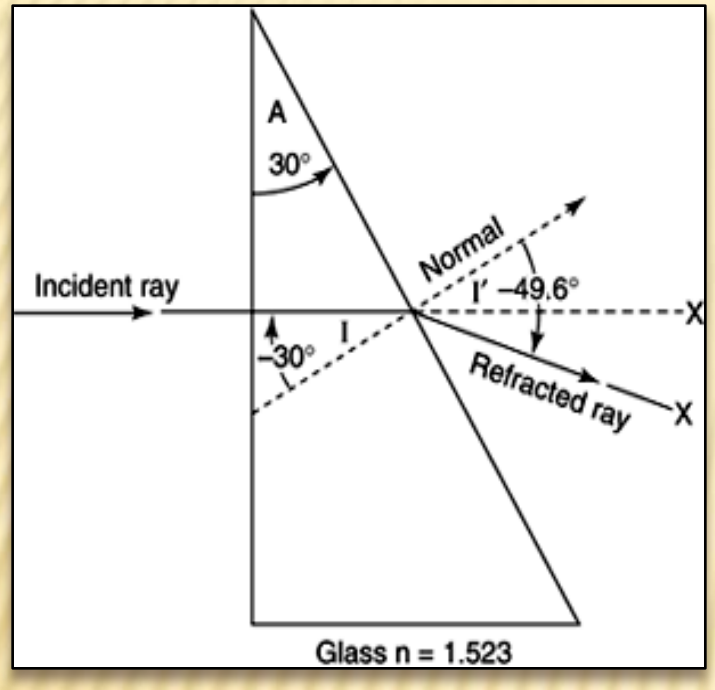


This action of prism is used in a slide projector

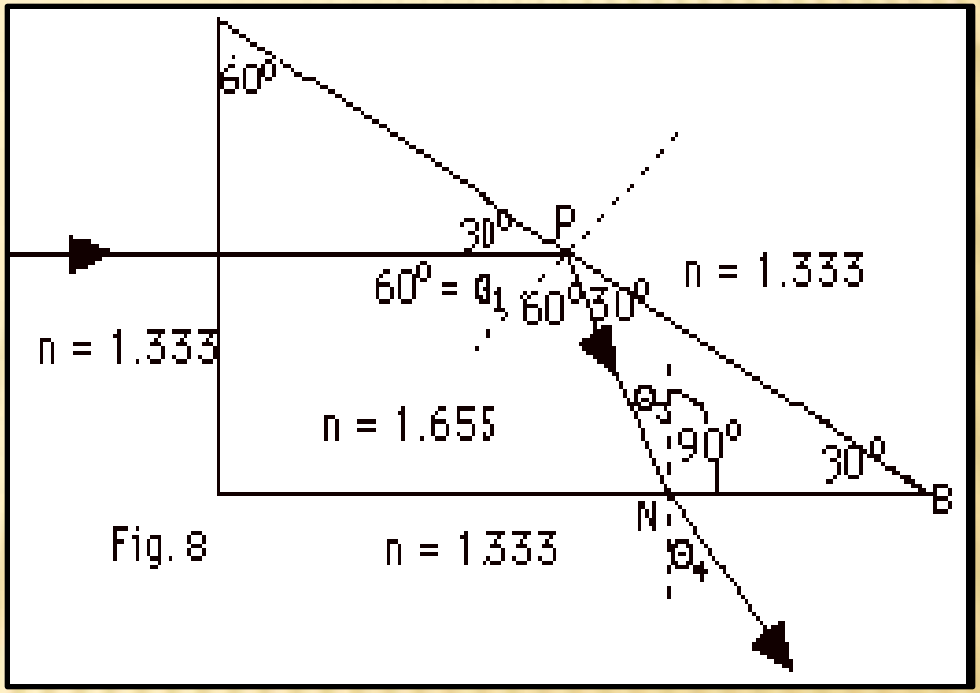
Deviation through 60 degree by an Equilateral Prism



Total internal reflection and refraction of light through 30◦ ,90◦,60◦Prism

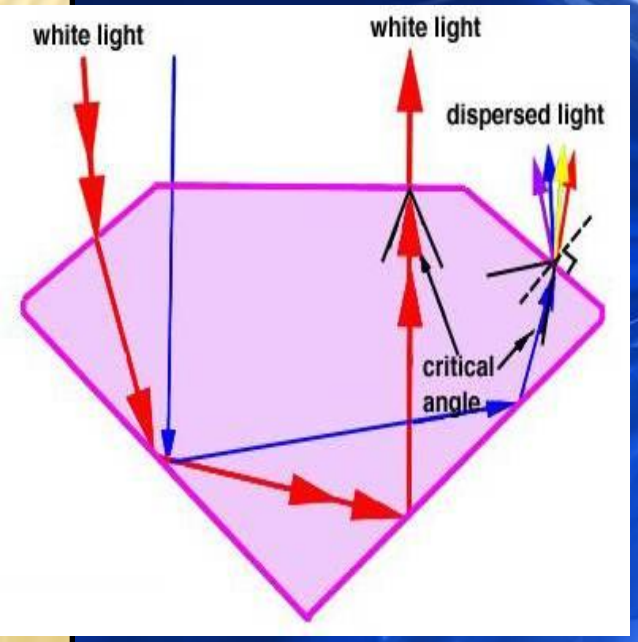


No total internal reflection



Total internal reflection takes place

CONSEQUENCES OF TOTAL INTERNAL REFLECTION

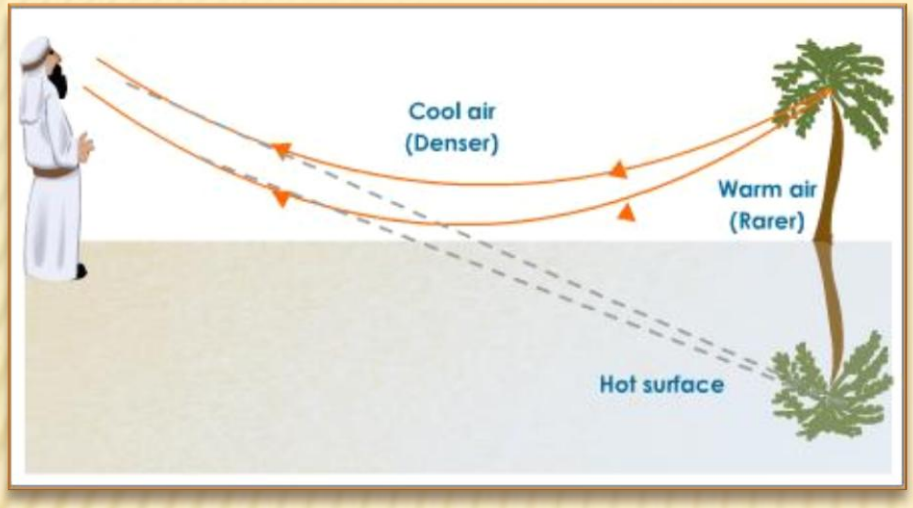


TIR in Diamonds

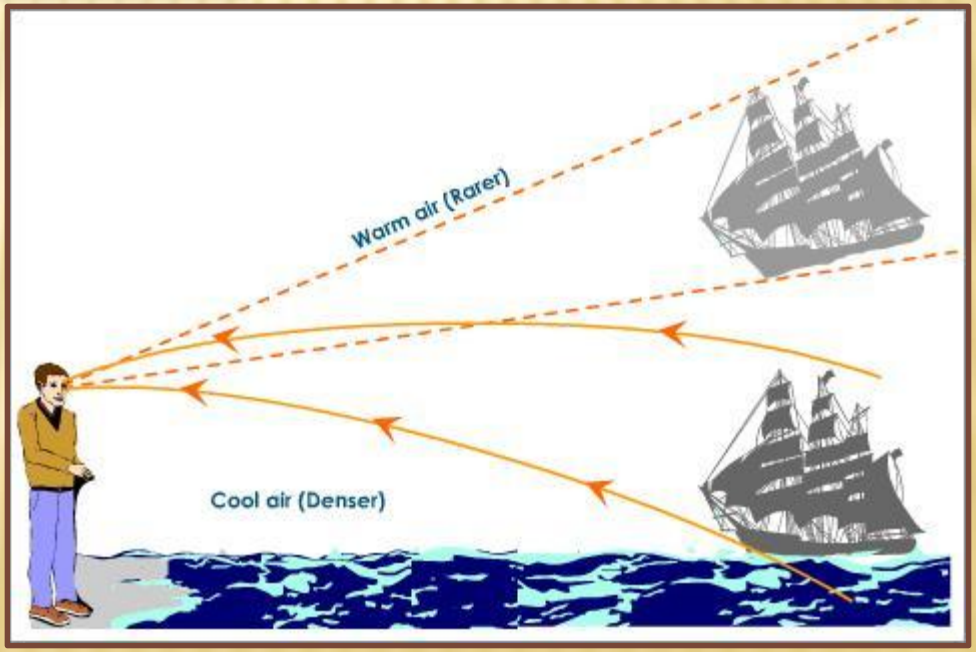
Sparkling is due to:

1. Cut of diamond faces
2. High index of refraction which means a very small critical angle (n = 2.42, C = 24.4°)
   Incident rays can undergo multiple TIR inside a diamond before exiting the top of the diamond.

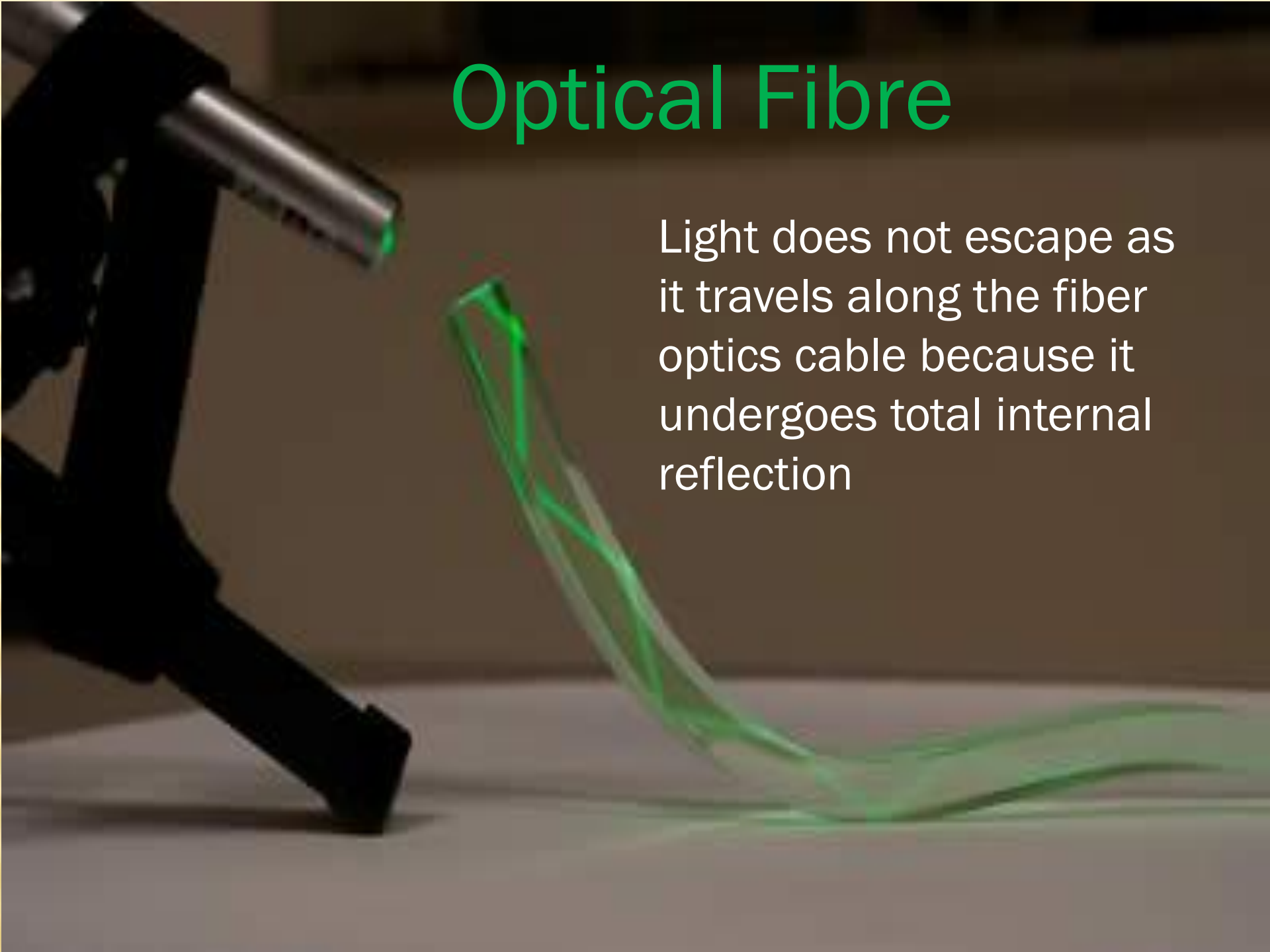
MIRAGE



LOOMING



Optical Fibre



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