Practical No.14: Determination of the refractive index of glass slab

I Practical Significance

Optical fibers has numbers of industrial and house hold applications, such as guiding medium for sending communication signals, fiber optic sensor for leveling of bridges, pressure sensor, stress sensor, Endoscopes and decorative purposes. Optical fiber works on the principle of total internal reflection (TIR). Mirage is an optical illusion, is also an illustration of TIR. In this lab experience student will analyze the phenomenon of TIR and determine the refractive index of glass by measuring the critical angle.

II Industry/ Employer Expected Outcome

Apply principles of physics and chemistry to solve broad based relevant engineering Problems.

III Course Level Learning Outcome

Apply basic principles of thermometry and fibre optics to solve engineering problems

IV Laboratory Learning Outcome(s)

Determine the refractive index of glass slab using TIR phenomenon.

V Relevant Affective domain related Outcomes

Practice good housekeeping.

VI Relevant Theoretical Background

Refractive index: It is a measure of bending of light while entering the medium. It is a dimensionless quantity. It is denoted as " μ". ***Snell's law*** is defined as "The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant, for the light of a given colour and for the given pair of media".

$$\mu = \frac{\sin i}{\sin r}$$

Critical angle: The critical angle of incidence is defined as that angle of incidence from denser medium for which the angle of refraction in rarer medium is 90°.

Total internal reflection: When a ray of light passes from a denser to a rarer medium, some part of it gets refracted into the rarer medium such that it bends away from the normal. Some part of it gets reflected back into the denser medium. The light reflected back into the denser medium is said to be internally reflected. In case of refraction from a denser to a rarer medium, the angle of refraction 'r' is greater than the angle of incidence 'i'. If the angle of incidence of the light ray is gradually increased, then at a certain angle of incidence, the angle of refraction in the rarer medium becomes 90°.

The refracted light grazes the interface of the two media. This angle of

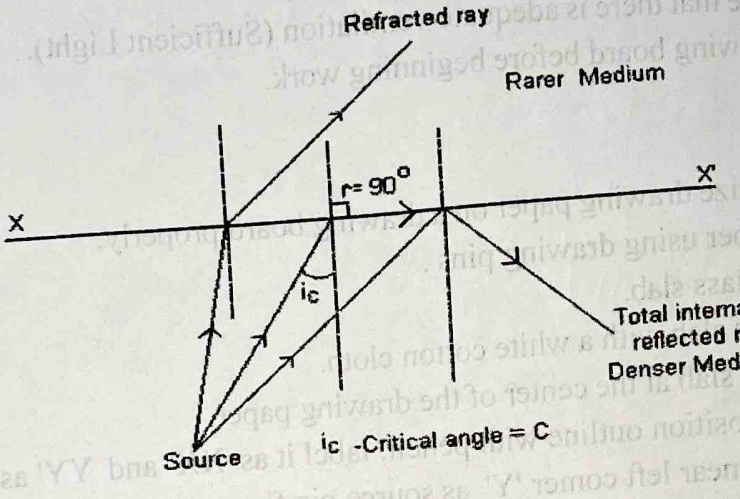
incidence in the denser medium is called the critical angle, C, for the pair of media under consideration. When angle of incidence i = C, angle of refraction r = 90°.The refractive index of the denser medium with respect to the rarer medium is given by,

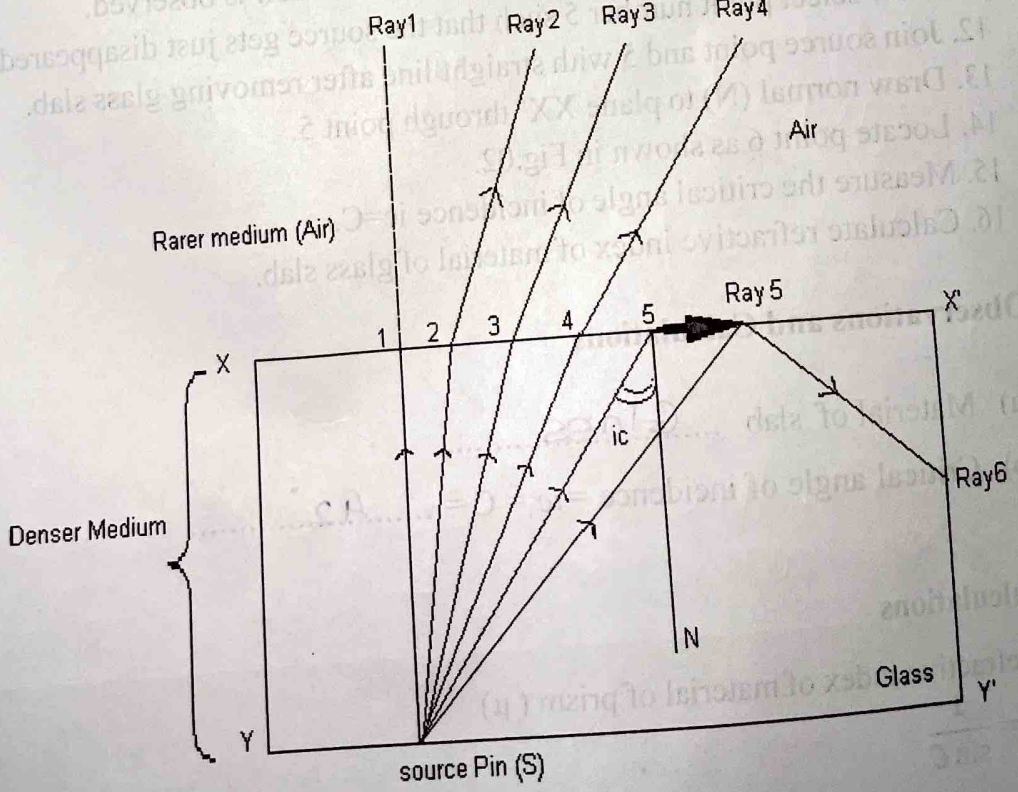
$$\mu = \frac{1}{\sin C}$$

For total internal reflection, the conditions that must be satisfied are:

- Light must pass from a denser medium to a rarer medium.
- The angle of incidence in the denser medium must be greater than the critical angle for that pair of media.

VII Experimental set up / Work Situation.





VIII Resources required

Sr. No.	Name of Instrument	Specifications	Quantity
1	Standard glass slab	Variable size, Different thickness	01
2	Drawing paper	A 4 size	01
3	Drawing pins		01
4	Drawing board	Base wood	01
5	Protractor, scale, HB/B pencil		

IX Precautions

a) Make sure that there is adequate ventilation (Sufficient Light).
b) Clean drawing board before beginning work.

X Procedure

1. Place A4 size drawing paper on a drawing board properly.
2. Fix the paper using drawing pins .
3. Take the glass slab.
4. Clean glass slab with a white cotton cloth.
5. Place glass slab at the center of the drawing paper.
6. Mark the position outline with pencil, label it as XX' and YY' as given in Fig.
7. Place a pin near left comer 'Y' as source pin S.
8. Look at the source pin from other side through glass slab.
9. Locate point 1 on XX', with the help of another pin.
10. Mark point 2, 3 and 4 on plane XX' till refraction is observed.
11. Now select point number 5 such that the source gets just disappeared.
12. Join source point and 5 with straight line after removing glass slab.
13. Draw normal (N) to plane XX' through point 5.
14. Locate point 6 as shown in Fig.02.
15. Measure the critical angle of incidence ic=C.
16. Calculate refractive index of material of glass slab.

XI Observations and Calculations

a) Material of slab .....Glass.....
b) Critical angle of incidence = ic = C = ...42°.....

Calculations

Refractive index of material of prism (μ)

$$\mu = \frac{1}{\sin C}$$

$$\mu = \frac{1}{\sin 42^\circ} = 1.494.$$

XII Results

1. Critical angle of incidence for glass is 42°
2. Refractive index of glass slab is 1.494

XIII Interpretation of results

By adjusting the angle of incidence we found the critical angle at which line passing from glass to air interface.

XIV Conclusions and Recommendations

We conclude that by changing the angle of incidence the light can be either reflected or refracted

XV Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design *more such questions so as to ensure the achievement of identified CO.*

1. State the Snell's law.
2. Define Critical angle.
3. Write the condition of TIR
4. If the angle of incidence is 35 degree & angle of refraction is 40 degree. Find the refractive index.
5. Which among the following is the cause of the twinkling of stars?

   (a) Bursting of light from the stars periodically (b) Variation of refractive index in the atmosphere (c) Incomplete absorption of light in the atmosphere (d) Interference of sunlight with the starlight

[Space to Write Answers]

Q.1) Define Refractive index :

→ Ratio of the speed of light in a vaccum to its speed of light in a vaccum to its speed in a particular medium is known as refractive index.

Q.2) State and Explain Snell's law?

For a given pair of media and for a given wave-length when the sine of the angle of refraction is divided by the sine of the angle of incidence that is the ratio of the sine of the angle of incidence to the sine of the angle of refraction is known as snells law:

$n = \frac{\sin i}{\sin r}$ where i is the angle of incidence where r is the angle of refraction.

CONDITION FOR NO REFRACTION:

1) If the incident light is particular to the surface of the two media.
2) If both the medium have the same refraction index

What will be the refractive index of the medium in which the speed of light is 2.5×10^8 m/s?

→ using formula :- $n = \frac{c}{v}$

- The refractive index of the medium can be calculated

Substituting the value in the formula we get

$n = 3 \times 10^8$ m/s
$= 2.5 \times 10^8$ m/s
$= 1.2$

Therefore, the refractive index of the mediam is 1.2.