Concept of Critical Angle and TIR

(P) What is the concept of the critical angle?

(A)→ Both these conditions will only arise when a ray of light travels from a dense material medium e.g. glass or diamond and moves towards a less dense medium e.g. air.

→ While travelling from a dense medium into a less dense medium, refraction occurs and the ray bends away from the normal (fig. 1).

→ It can be seen that as the angle of incidence increases, the angle of refraction also increases.

→ When the angle of refraction becomes 90°, the refracted ray travels along the boundary between the two mediums. The angle of incidence at this moment is given a special name known as the critical angle. (fig. 2)

⇒ The value of the critical angle can be obtained using the equation: R

$$R.I = \frac{1}{\sin C}$$

⇒ From this equation it can be seen that the higher the value of the refractive index, the smaller will be the value of the critical angle. (fig. 3)

Q) what is the critical angle?

Ans) The

Q) What is the concept of Total Internal Reflection?

⇒ If the angle of incidence is increased even further so that it now becomes greater than the critical angle eg. 45°, 50°, then the ray of light will return back into the same medium from where it originally started. This condition is known as T.I.R. (Fig 1)

Q) what are the differences b/w T.I.R and reflection?

Ans) ① For reflection to take place, only one medium is required. However, for T.I.R, the ray must travel from a dense medium into a less dense medium.

② Reflection occurs at all angles, whereas, for T.I.R to take place, the angle of incidence must be greater than the critical angle.

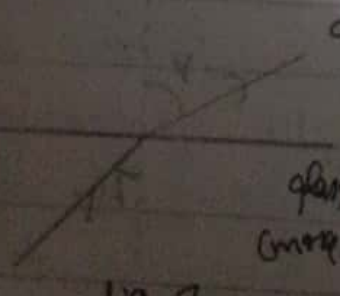


fig. 1

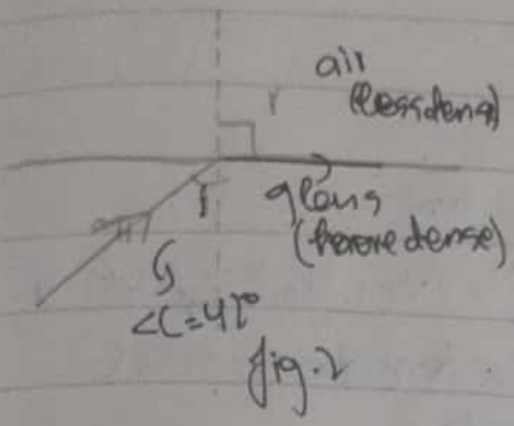


fig.2

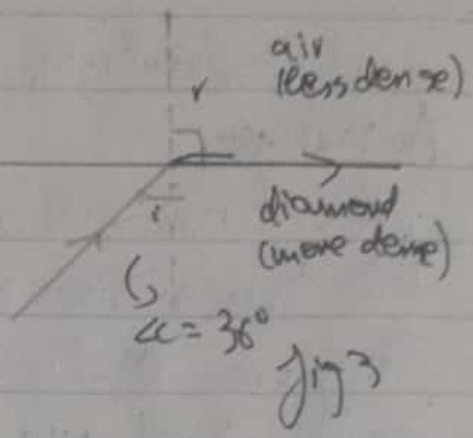
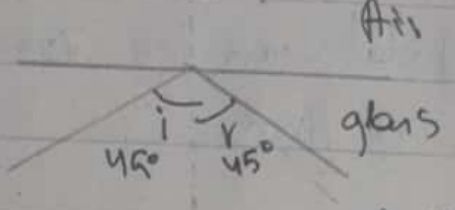


fig3

T.I.R



greater than critical angle

fig.4

Application of T.I.R

Q) How can T.I.R be applied)

Ans T.I.R is used in telecommunication to transfer internet data through a ~~fiber~~ fibre optic cable. The diagram for a fibre optic cable is shown in fig.5. This cable comprises of glass and light can be sent through this cable at any angle greater than the critical angle. eg. 45°. This ray undergoes T.I.R multiple times and finally exits from the opposite side of the cable. Transmission using fibre optic cables has the following advantages

and disadvantages:

Advantages:

1. Data transmission is very secure
2. Data transmission occurs at a very fast speed.
3. They are light weight, therefore they can be easily stored and transported.
4. They have a very high bandwidth, i.e., a large amount of data can be communicated in a short span of time.

Disadvantages:

1. The cable is brittle, therefore it can break easily under high pressure.
2. It is difficult to bend the cable
3. Expensive installation.
4. Costly maintenance.

Experiment to calculate the value of Critical Angle for a semi-circular plastic block given that the critical angle is close to 40°.

→ Trace the outline of the plastic block on a sheet of paper as shown in fig. 6

→ Remove the block, construct a normal at the midpoint M and draw incident rays ranging

from 37° - 43°.

→ Position the block and place a ray box along the path of the incident ray.

→ Keep adjusting the position of the ray box until the observer seen a ray which travels along the boundary to meet his eye. The angle of incidence at this moment provides a value for the critical angle.

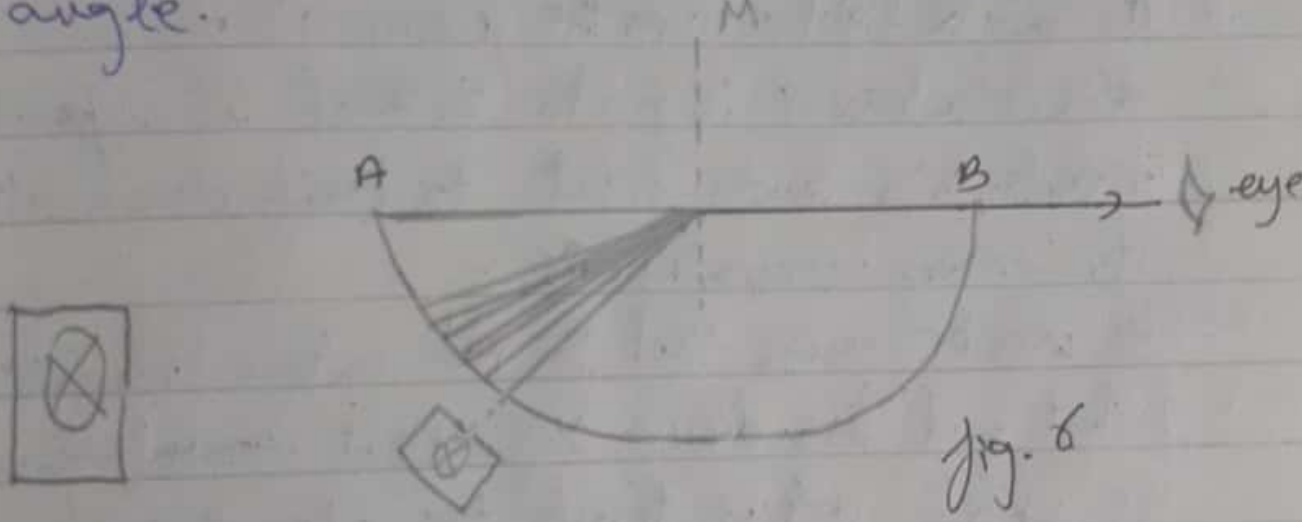


fig. 6

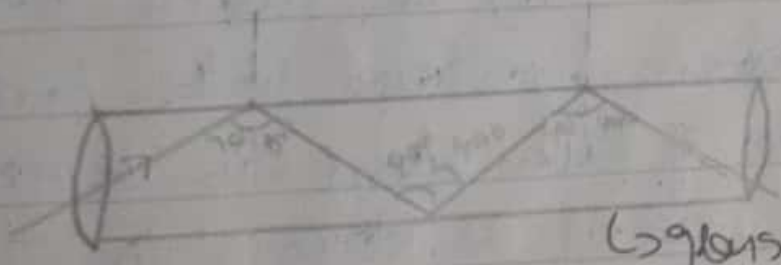


fig. 5

Glass

Dispersion of Light

Q) What is dispersion of light?

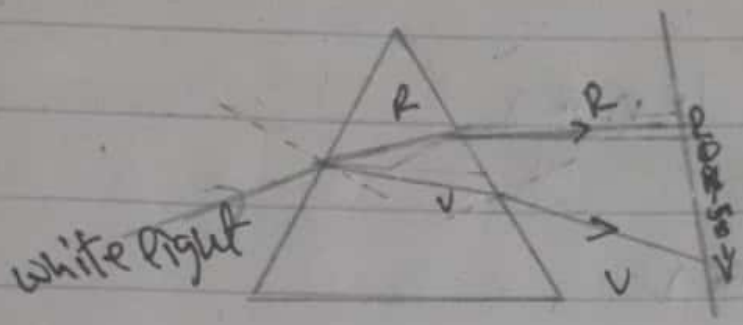
→ The term dispersion refers to the splitting of white light into its 7 colours.

→ This dispersion can be observed by allowing white light to enter a glass prism.

→ As white light enters the prism, all of its seven colours begin to travel at different speeds. This causes light to break down into its seven components.

→ It can be seen that the red colour travels the fastest and bends by the least amount, whereas the violet colour travels the slowest and bends ~~the most~~ by the greatest amount.

→ If a screen is positioned in the background, a spectrum of seven colours can be observed on the screen as shown in fig. 7.8.



① all colours should be diverging
② all colours should look like they go towards bone
③ red bends least, violet bends most
④ first ~~away~~ towards normal then away.