

Chapter 04

Refraction of Light at Plane Surfaces

Refraction through a Glass Slab:

A thin glass slab is formed when a medium is isolated from its surroundings by two plane surfaces parallel to each other. Let us determine position and nature of the image formed when the slab is placed in front of an object.

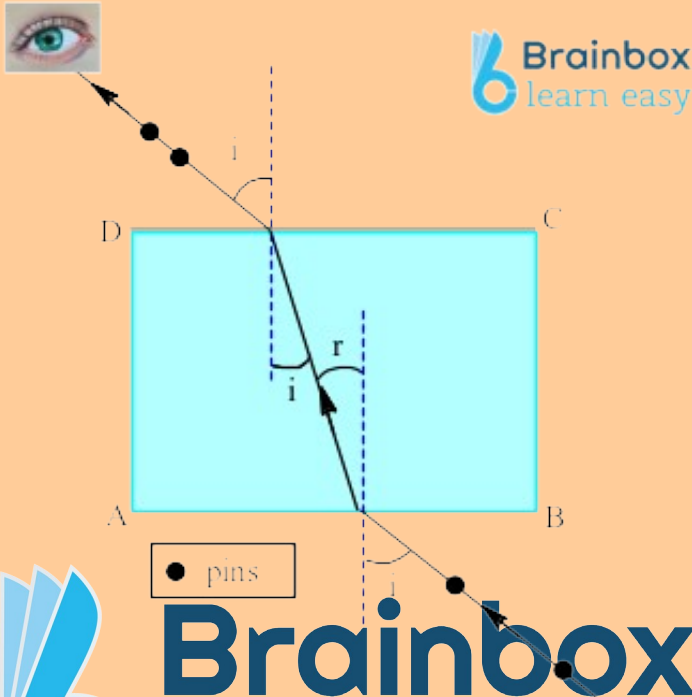
Activity

Place a piece of chart (paper) on a drawing board. Clamp it. Place a glass slab in the middle of the paper. Draw borderline along the edges of the slab by using a pencil. Remove it. You will get a figure of a rectangle. Name the vertices of the rectangle as A, B, C and D.

Draw a perpendicular at a point on the longer side (AB) of the rectangle. Again keep the slab on paper such that it coincides with the sides of the rectangle ABCD. Take two pins. Stick them on the perpendicular line to AB. Take two more pins and stick them on the other side of the slab in such a way that all pins come to view along a straight line. Remove the slab from its place. Take out the pins. Draw a straight line by using the dots formed by the pins such that it reaches first edge (AB) of the rectangle. You will get a long straight line. The light ray that falls perpendicular to one side of the slab surface comes out without any deviation.

Now take another piece of white chart on the plank. Clamp it. Place a glass slab in the middle of the paper. Again draw a borderline along the edges of the slab by using a pencil. Remove the slab and name the vertices of the rectangle formed as A, B, C and D. Draw a perpendicular at a point on the longer side AB. Now draw a line, from the point of intersection where side AB of

rectangle and perpendicular meet, in such a way that it makes 30° angle with normal. This line represents the incident ray falling on the slab and the angle it makes with normal represents the angle of incidence.



Now place the slab on the paper in such way that it fits in the rectangle drawn. Fix two identical pins on the line making 30° angle with normal such that they stand vertically with equal height. By looking at the two pins from the other side of the slab, fix two pins in such a way that all pins appear to be along a straight line. Remove slab and take out pins. Draw a straight line by joining the dots formed by the pins up to the edge CD of the rectangle. This line represents emergent ray of the light.

Draw a perpendicular ON to the line CD where our last line drawn meets the line CD. Measure the angle between emergent ray and normal. This is called angle of emergence.

- Is the line formed a straight line?
- Are the angles of incidence and emergence equal?
- Are the incident and emergent rays parallel?

You will notice an important result that the incident and emergent rays are parallel.

- Can you find the distance between the parallel rays?

The distance between the parallel rays is called lateral shift. Measure this shift. Repeat the experiment for different angles of incidence and tabulate the values of angle of incidence and shift corresponding to each angle of incidence in the table.

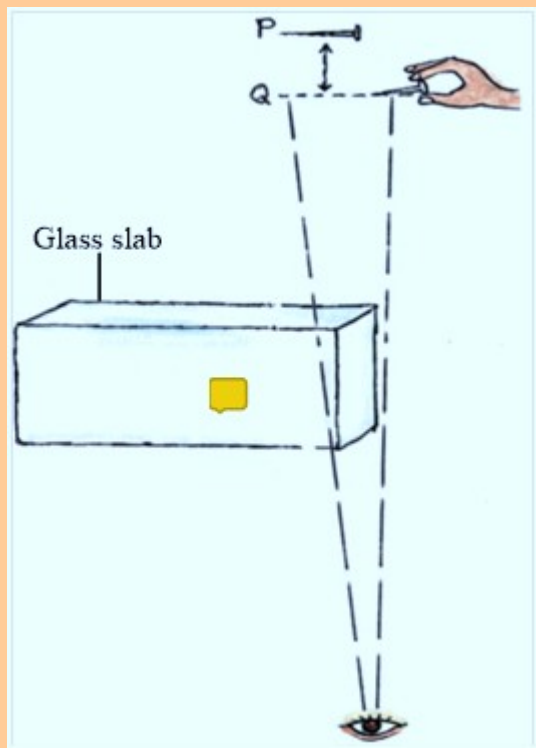
Table	
Agle of Inciddene	Shift

- Can you find any relation between the angle of incidence and shift?
- Can you find the refractive index of the slab?

Let us find the refractive index of the glass slab.

Activity

Let us take a glass slab and measure the thickness of it. Note it in your notebook. Take a white chart and fix it on the table. Take the slab and place it in the middle of the chart. Draw its boundary. Remove the slab from its place. The lines form a rectangle. Name the vertices as A, B, C and D. Draw a perpendicular to the longer line AB of the rectangle at any point on it. Place slab again in the rectangle ABCD. Take a pin. Place at a point P in such a way that its length is parallel to the AB on the perpendicular line at a distance of 15cm from the slab. Now take another pin and by looking at the first pin from the other side of the slab try to place the pin so that it forms a straight line with the first pin.



Note :

While doing this, keep your eye fixed along the edge of the glass slab and first pin is seen through the glass slab, whereas second pin is seen through air i.e. Outside of the glass slab.

Remove the slab and observe the positions of pins.

- Are they in same line?

Draw a perpendicular line from the second pin to the line on which first pin misplaced. Call the intersection point Q. Find the distance between P and Q. We may call it vertical shift.

- Is this shift independent of distance of first pin from slab?

To find this, do the same activity for another distance of the pin from the slab. You will get the same vertical shift. We could use a formula to find out refractive index of the glass.

$$R.I = \frac{\text{Thickness of the slab}}{(\text{Thickness of slab} - \text{Vertical shift})}$$