EXPERIMENT-01
REFRACTION THROUGH GLASS SLAB

AIM: To trace the course of different rays of light through a rectangular glass slab at different angles of incidence, measure the angle of incidence, refraction and verify Snell`s law. Also measure the lateral displacement.

APPARATUS: Drawing board, sheet of paper, board pins, rectangular glass slab.

THEORY:

Consider a rectangular glass slab EFGH as shown in fig. A ray of light AB incident at an angle of incidence ***i*** with the normal NN^1 at the point of incidence B. This ray is refracted along BC and bent towards the normal because it is going from air to glass. The refracted ray again suffers refraction at the surface GH and bents away from the normal MM` and emerges along CD which is thus the emergent ray. The emergent ray is parallel to the incident ray but is displaced. The distance between the incident ray produced forward and the emergent ray i.e. distance CP gives us the lateral displacement.

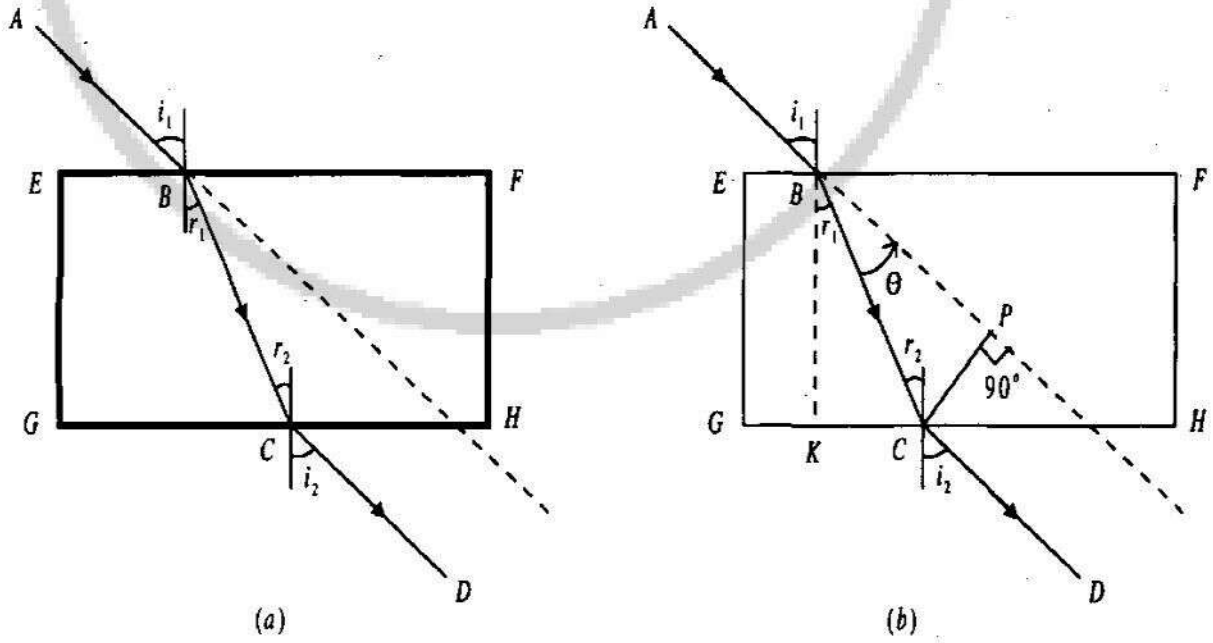

Fig. 23.4

PROCEDURE:

a) Fix a sheet of white paper on the drawing board with the help of drawing pins at the four corners of the sheet.
b) Place a glass slab at the centre of the paper and mark its boundary EFGH with fine pencil.
c) Remove the glass slab. Draw any line AB making an angle of 40^0 with the normal at the point B, the middle point of EF approximately.
d) Put the glass slab back in position on the boundary line. Fix two pins P_1 and P_2 vertically on the line AB at least 5cm apart- and one pin close to the slab.
e) Look for the image of these pins in the slab from the opposite side GH and fix two pins P_3 and P_4 so that they are in the line with the image of P_1 and P_2 as seen through the slab and at least 5cm apart.
f) Join the pricks of P_3 and P_4 to obtain the emergent ray. Draw a normal to GH at the point C. join BC to get the refracted ray.
g) Measure the angle of incidence and angle of refraction. Produce AB forward and draw a perpendicular from C on AB produced to meet it at P. Then the lateral displacement = CP.
h) Repeat the experiment with different angles of incidence 50^0 and 60^0.

OBSERVATION TABLE:

S.N	Angle of incidence, *i*	Angle of refraction, *r*	Sin *i*	Sin *r*	μ = Sin *i* / Sin*r*	Lateral Displacement
1.	40^0					
2.	50^0					
3.	60^0					

GRAPH: Plot graph Sin*i* Vs Sin*r*.

CONCLUSION: It is clear from the observation table that the ratio of Sin*i* and Sin*r* is constant. Hence Snell`s is law verified.

VIVA-VOCE:

a) What do you mean by refraction?
b) What is the angle of refraction when the angle of incidence is zero?
c) What is optical density?
d) Does a parallel side glass slab produce any deviation in the incident light?
e) Can angle of refraction be greater than the angle of incidence?
f) Is the refractive index of water w.r.t. glass less or more than 1?
g) What are the factors on which the lateral displacement produced by a glass slab depends?

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THE COPPERBELT UNIVERSITY

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PROGRAMME: BACHELOR OF SCIENCE (NQ)

COURSE: PH 110

TASK: EXPERIMENT 01: REFRACTION THROUGH GLASS SLAB

LECTURER: DR. J. SIMFUKWE

INSTRUCTOR: MR MARTIN

DUE DATE :

LAB PARTNERS:

GROUP: B

EXPERIMENT 01

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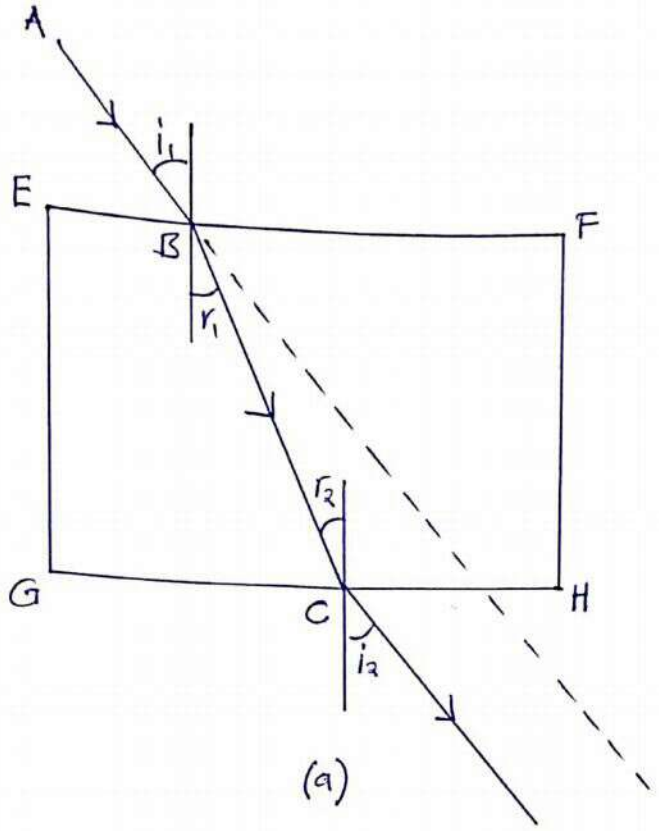
AIM: To trace the course of different rays of light through a rectangular glass slab at different angles of incidence, measure the angle of incidence, refraction and verify Snell's law. Also measure the lateral displacement.

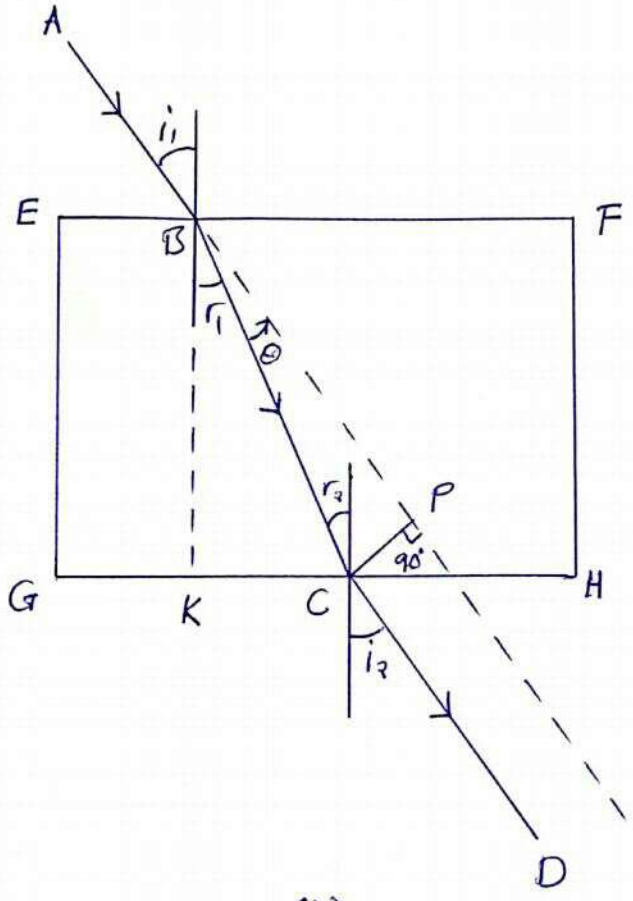
APPARATUS: Drawing board, sheet of paper, board Pins, rectangular glass slab.

THEORY:

Consider a rectangular glass slab EFGH as shown in fig 23.4. A ray of light AB incident at an angle of incidence i with the normal NM' at the point of incidence B. This ray is refracted along BC and bent towards the normal because it is going from air to glass. The refracted ray again suffers refraction at the surface GH and bends away from the normal MM' and emerges along CD which is thus the emergent ray. The emergent ray is parallel to the incident ray but is displaced. The distance between the incident ray produced forward and the emergent ray i.e distance CP gives us the lateral displacement.



(a)



(b)

Fig. 23.4

PROCEDURE

Data Collection Procedure

(a) Fixed a sheet of white paper on the drawing board with the help of drawing pins at the four corners of the sheet.

(b) Placed a glass slab at the centre of the paper and marked its boundary EFGH with fine pencil.

(c) Removed the glass slab. Drew any line AB making an angle of 40° with the normal at the point B, the middle point of EF approximately.

(d) Put the glass slab back into position on the boundary line. Fixed two pins P_1 and P_2 vertically on the line AB at least 5cm apart and one pin close to the slab.

(e) Looked for the image of these pins in the slab from the opposite side GH and fixed two pins P_3 and P_4 so that they are in line with the image of P_1 and P_2 as seen through the slab and at least 5cm apart.

(f) Joined the pricks of P_3 and P_4 to obtain the emergent ray. Drew a normal to GH at the point C. Joined BC to get the refracted ray.

(g) Measured the angle of incidence and angle of refraction. Produced AB forward and drew a perpendicular from C on AB produced to meet it at P.

(h) Then the lateral displacemen = CP
Repeated the experiment with different angles of incidence 50° and 60°.

DATA COLLECTION

S.N	Angle of incidence i	Angle of refraction r
1.	40°	26°
2	50°	30°
3.	60°	34°

DATA ANALYSIS

OBSERVATION TABLE

S.N	Angle of incidence i	Angle of refraction r	$\sin i$	$\sin r$	$\mu = \frac{\sin i}{\sin r}$	Lateral Displacement
1.	40°	26°	0.643	0.438	1.466	
2.	50°	30°	0.776	0.500	1.532	
3.	60°	34°	0.866	0.559	1.549	

① Angle of incidence $i = 40°$
Angle of refraction $r = 26°$

$$\mu_1 = \frac{\sin i}{\sin r}$$

$$= \frac{\sin 40°}{\sin 26°}$$

$$= \frac{0.643}{0.438}$$

$$\mu_1 = 1.466$$

② Angle of incidence $i = 50°$
Angle of refraction $r = 30°$

$$\mu_2 = \frac{\sin i}{\sin r}$$

$$= \frac{0.766}{0.500}$$

$\mu_2 = 1.532$

(3) Angle of incidence $i = 60°$

Angle of refraction $r = 34°$

$$\mu_3 = \frac{\sin i}{\sin r}$$

$$= \frac{\sin 60°}{\sin 34}$$

$$= \frac{0.866}{0.559}$$

$$\mu_3 = 1.549$$

VIVA - VOCE

(a) Refraction is the change in direction of propagation of any wave as a result of its travelling at different speed at different points along the wave front.

(b) When angle of incidence is zero, Angle of refraction is also zero.

(c) Optical density is the degree to which a refractive medium retards transmitted rays of light.

(d) It does not deviate nor does it disperse the light rays passing through it.

(e) Yes, the angle of refraction can be greater than the angle of incidence.

(f) The refractive index of water wrt glass is less than 1.

(g) Lateral displacement depends on the thickness of glass slab and the angle of incidence.

DISCUSSION

Using three distinct angles of incidence, we were able to obtain experimentally the angles of refraction using a rectangular glass slab. The refractive index was calculated for all angles of incidence with their respective angles of refraction which gave an almost constant value of 1.5. Then the lateral displacements were measured. Experimental errors could have occured when arranging the pins in line with each other when you view them through the glass slab. Carefully placing the pins can resolve such errors.

CONCLUSION

The experiment was carried out successfully and all the objectives of the experiment which was mainly verifying Snell's law were archieved with respect to our predictions.

REFERENCES

① PH 110 Laboratory Manual (2021/2022), school of mathematic and Natural sciences, Department of physical sciences, Copperbelt University, Kitwe, Zambia.