Chapter-3

REFRACTION OF LIGHT AT PLANE SURFACES

ACTIVITY-1

Take some water in a glass tumbler.
Keep a pencil in it.
Look at the pencil from one side of the glass and also from the top of the glass.

ACTIVITY-2

Go to a long wall (of length about 30 feet) facing the Sun. Go to one end of a wall and ask your friend to bring a bright metal object near the other end of the wall. When the object is a few inches from the wall it appears distorted and you will see a reflected image in the wall as though the wall were a mirror.

ACTIVITY-3

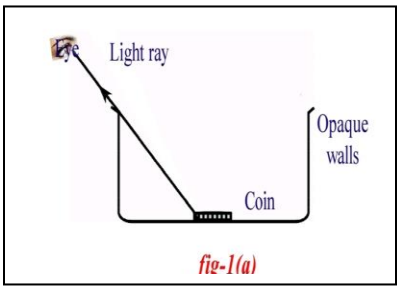


fig-1(a)

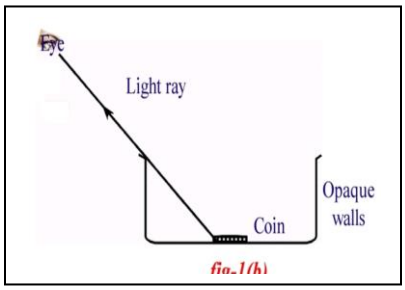


fig-1(b)

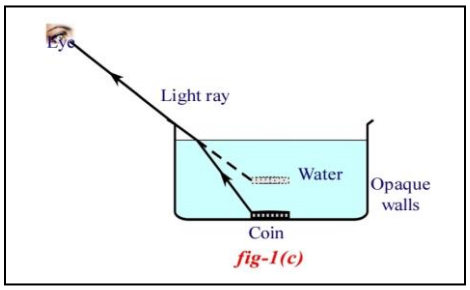


fig-1(c)

Take a shallow vessel with opaque walls such as a mug. (A tin or a pan is suitable). Place a coin at the bottom of the vessel. Move away from the vessel until you cannot see the coin. See figure 1(b). Stand there. Ask your friend to fill the vessel with water. When the vessel is filled with water the coin comes back into view. See figure 1(c) You know that the ray of light originating from the coin, doesn't reach your eye when the vessel is empty (see figure1b). Hence you couldn't see the coin. But the coin becomes visible to you after the vessel is filled with water. Keep in mind that the light ray travelling in a medium takes a straight line path.The light ray changes its direction at the interface separating the two media

Refraction: The process of changing speed at an interface when light travels from one medium to another resulting in a change in direction is refraction of light.

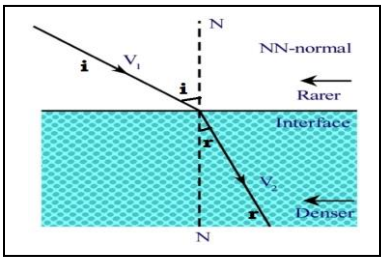
Cause of Refraction: Changing speed of light at an interface

Resulting of Refraction: Change in direction of light

Case-1 : A light ray travel from rarer medium to denser medium

Consider that v_1 is the speed light in rarer medium and v_2 is the speed light in denser medium.(v_1 is greater than v_2)

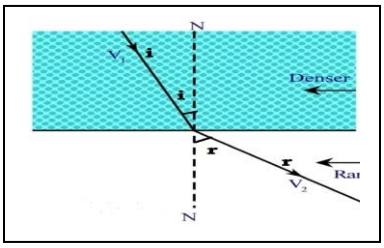
- When light ray enters from rarer medium to denser medium then refracted ray moves towards the normal.
- i > r



Case-2 : A light ray travel from denser medium to rarer medium

Consider that v_1 is the speed light in denser medium and v_2 is the speed light in rarer medium.(v_1 is less than v_2)

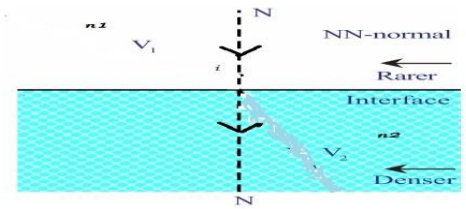
- When light ray enters from denser medium to rarer medium then refracted ray bends away from normal.
- i < r



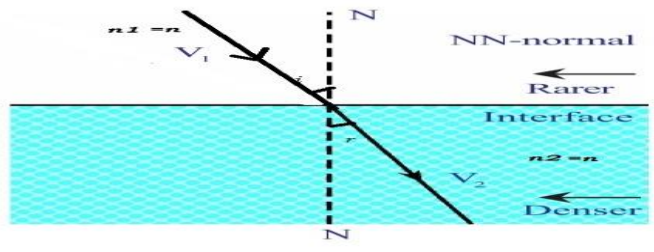
A light ray not deviate at the interface of two media

In two cases, light ray will not deviate at the interface of two media.

1)When light ray is incident normally



2)When two media having same refractive indices



Refractive index (n) : The ratio of speed of light in vacuum to the speed of light in that medium.
Also called as Absolute refractive index. It is property of the medium.

Units: No unit

Formula: n = C/V

Refractive index depends on the following factors:

1) Nature of the material 2) Wavelength of light used 3) Temperature

Relation between Refractive index(n) and Speed of light in medium(V) :

$$n \propto 1/V$$

It means that 'n' is inversely proportional to 'V'

Table:1 Refractive indices of some material media.

Material medium	Refractive index	Material medium	Refractive index
Air	1.0003	Canada balsam	1.53
Ice	1.31	Rock salt	1.54
Water	1.33	Carbon Diasulphide	1.63
Kerosene	1.44	Dense flint glass	1.65
Fused quartz	1.46	Ruby	1.71
Turpentine oil	1.47	Sapphire	1.77
Crown glass	1.52	Diamond	2.42
Benzene	1.50		

From the above table, you observed that which medium has greater refractive index value,speed of light is low in that medium.

(Kerosene with high refractive index is optically denser than water although its mass density is less than water)

Relative refractive index : The refractive index of a medium with respect to another medium
(OR) The ratio of speed of light in the first medium to the speed of light in the second medium

Refractive index (n_{21}) = *Refractive index of second medium(n2)/Refractive index of first medium(n1)*

$n_{21} = n_2/n_1 = v_1/v_2$

$n_{12} = n_1/n_2 = v_2/v_1$

Snell's law : The ratio of Sine of angle of incidence to Sine of angle of refraction is constant

Snell's law equation: $n_1 \sin i = n_2 \sin r$ (OR) $\sin i/\sin r$= constant

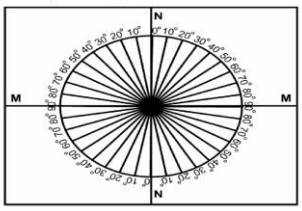
Lab Activity

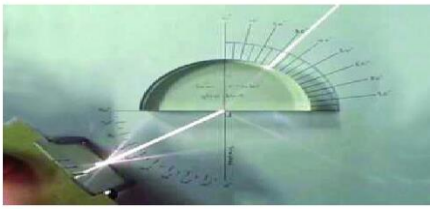
Aim: Obtaining a relation between angle of incidence and angle of refraction (or) experimentally prove that the angle of incidence is more than angle of refraction when light rays travel from rarer medium to denser medium (or) prove that Sin i/Sin r is constant

Materials required: Pro circle, scale, small black printed plank, a semi circular glass disc of thickness nearly 2 cm, pencil and laser light

Preparation of Pro Circle: 1)Take a wooden plank which is covered with white chart

2) Draw two perpendicular lines, passing through the middle of the paper as shown in the figure
3) Let the intersecting point be O.
4) Mark one line as NN which is normal to the another line marked as MM
5) Here MM represents the line drawn along the interface of two media and NN represents the normal drawn to this line at O
6) Take a protractor and place it along NN in such a way that its centre coincides with O as shown in fig.
7) Then mark the angles from 0^0 to 90^0 on both sides of the line NN
8) Repeat the same on the other side of the line NN
9) The angles should be represented on circular line.





Procedure: 10) Now place a semi-circular glass disc so that its diameter coincides with the interface line (MM) and its center coincides with the point O

11)Take the laser light and send it along NN in such a way that the laser propagates from air to glass through the interface at point O and observe the way of laser light coming from other side of disc

12) There is no deviation

13) Send laser light along a line which makes 15 with NN and see that it must pass through point O

14) Measure its corresponding angle of refraction

15) Repeat this experiment with angles of 20^0,30^0 ,40^0,50^0 and 60^0, note the corresponding angles of refraction

i	r	sin i	sin r	sin i/sin r

From the above table we observe that sin i/sin r is constant

From the above table, we observe that i > r

Laws of refraction

1) The incident ray, the refracted ray and normal to interface of two transparent media at the point of incidence all lie in the same plane

2) During refraction , light follows Snell's law

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