MASS PHYSICS

CLASSES FOR XI, XII & NEET-JEE BY PRABHAKAR SIR

INVESTIGATORY PROJECT REPORT

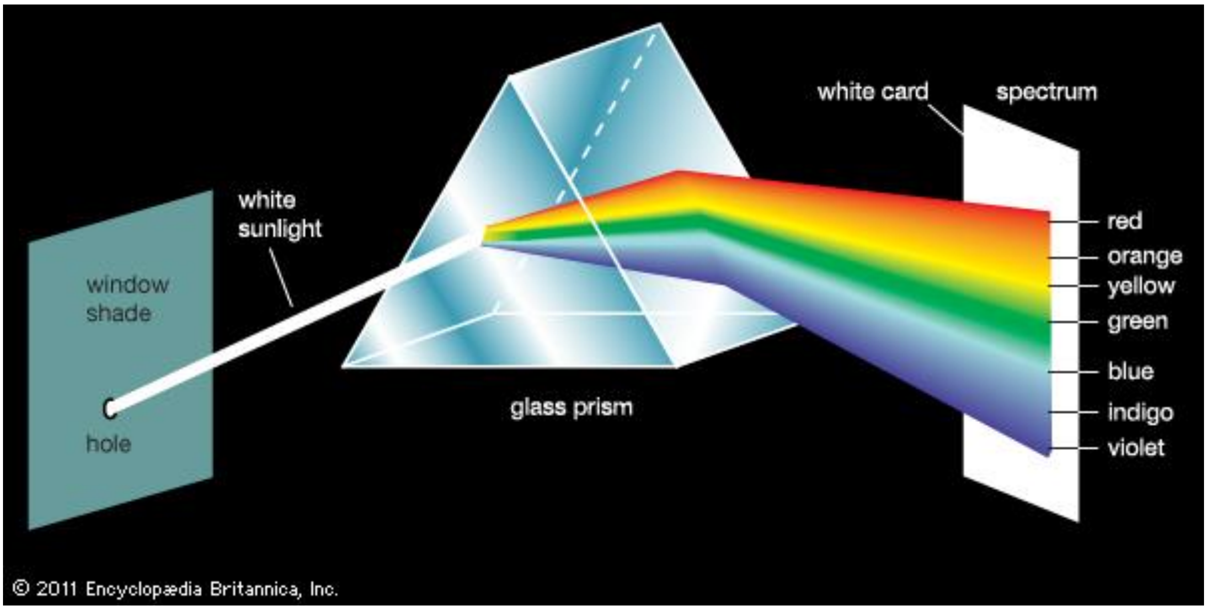
NAME:

CLASS: XII

ROLL NO:

SUBJECT: PHYSICS

TOPIC: REFRACTIVE INDEX OF HOLLOW PRISM FOR DIFFERENT LIQUIDS



ACKNOWLEDGEMENT

I owe a great many thanks to many people who helped and supported me during this Project. My dearest thanks to our physics teacher, for guiding and correcting me when needed. I also express my special thanks of gratitude to our principal for extending his support. This project **REFRACTIVE INDEX OF HOLLOW PRISM FOR DIFFERENT LIQUIDS** helped me in knowing a lot of new things.

Secondly, I would also like to thank my parents and friends who helped me a lot in finalising this project within the limited time frame.

THANK YOU!

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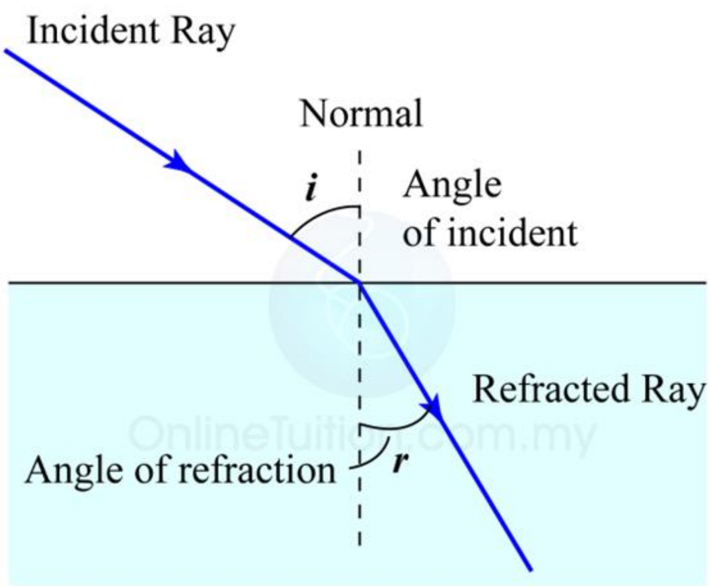
1. REFRACTION

In a homogenous medium light travels along a straight path. But when a ray light travels from one transparent medium to another, it bends while crossing the surface separating the two mediums.

The phenomenon of change in path of light, as it goes from one medium to another, is called refraction.

When a ray of light passes from an optically rarer medium to a denser medium, it bends towards the normal and when it travels from a denser medium to rarer medium, it bends away from the normal.



2.LAWS OF REFRACTION

The phenomenon of refraction takes place according to the following two laws:-

1. **The incident ray, the refracted ray and the normal to the surface at the point of incidence all lie in one plane.**

2. **For any two given pair of media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant.**

This constant is denoted by μ and is called the relative refractive index of one medium with respect to other medium.

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

It is also called Snell's Law of Refraction.
The refractive index of a medium depends on the following factors:

- **the nature of both the medium**
- **the wavelength of the incident light**

If one medium is vacuum (or air), then the constant ratio given is called absolute refractive index of the other medium.

The absolute refractive index of a medium can be defined in other way also.

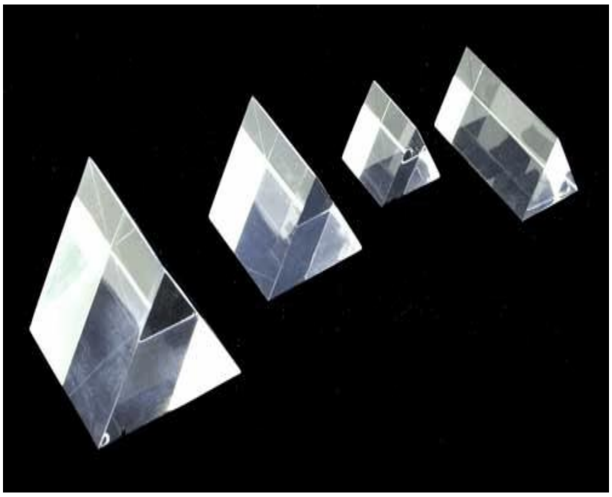
The ratio of the velocity of light in vacuum to the velocity of the light in the medium is called absolute refractive index of the medium.

3.PRISM

A prism is the portion of transparent refracting medium bound by two plane surfaces, which meet each other along a straight edge.

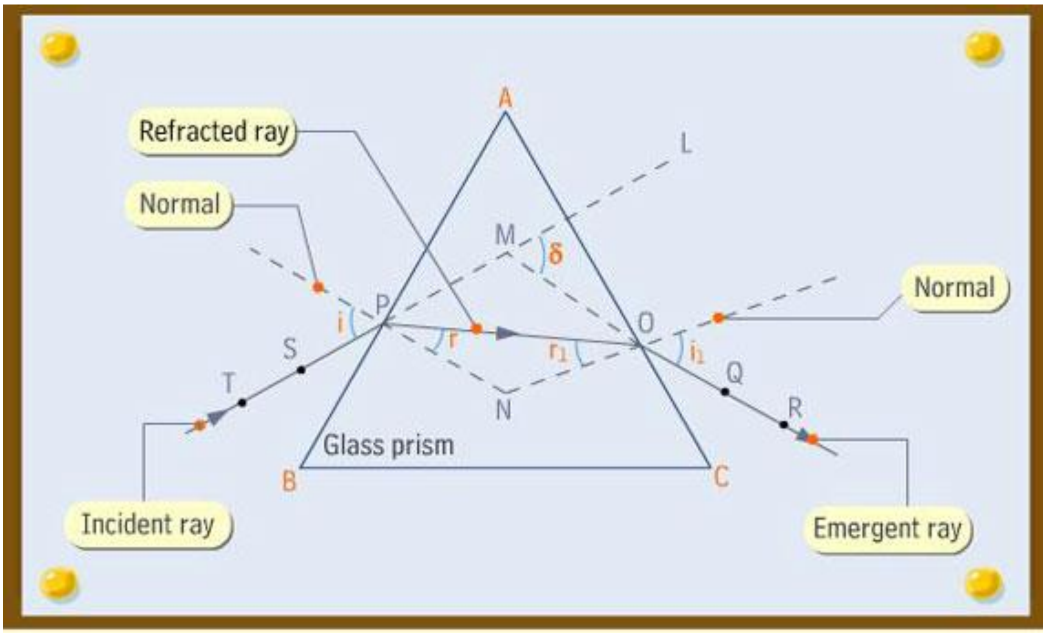
The two plane surfaces are called refracting faces and the line along which the two surfaces meet is called the refracting edge of the prism. The angle between the two refracting surface is called the angle of the prism. Usually, the angle of prism is equal to 60º.

When a ray of light is inclined on one refracting face of the prism, it enters the prism after suffering refraction at the first place. Then, the ray of light emerges out of the prism after suffering refraction at its second refracting face.



4. REFRACTION THROUGH A PRISM

Consider that a ray of light is incident on the refracting face of the prism. According to the laws of refraction, at the point of incidence the ray of light bends towards the normal. The refracted ray again suffers refraction on the second refracting face and emerges out of the prism away from the normal.



$$\delta = (i + e) - (r + r1)$$

$$r + r1 + \angle PNO = 180^{o}$$

$$r + r1 = A$$

$$\delta = (i + e) - A$$

$$A + \delta = i + e$$

Thus, when a ray passes through a prism, the sum of angle of prism and the angle of deviation is equal to the sum of the angle of incidence and the angle of emergence.

Thus, absolute refractive index of the medium,

$$\mu = \frac{velocity\ of\ light\ in\ air}{velocity\ of\ light\ in\ medium}$$

A medium having a greater value of refractive index is called optically denser, while the one having a smaller value is said to be optically rarer.

5.VARIATION IN ANGLE OF DEVIATION WITH ANGLE OF INCIDENCE

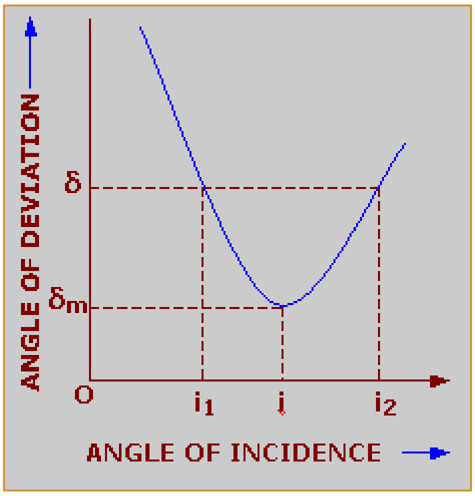
The deviation produced by a prism depends on,

1. **Angle of prism**
2. **Material of prism**
3. **The angle of incidence**

For a given prism, the angle of deviation varies with angle of incidence. To study the variation of the angle of deviation with the angle of incidence, the angle of deviation is measured for different value of the angle of incidence.

On doing so it is found that when the angle of incidence is increased, the angle of deviation first increases and then starts decreasing. For a certain value of the angle of incidence, the angle of deviation becomes minimum. The prism is then said to be placed in minimum deviation position.

Graph between i and δ:- **If a graph is plotted between the angle of incidence i and angle of deviation δ, the graph will be a curve.**



The graph shows that the angle of deviation first decreases as the angle of incidence is increased, till for a particular value of the angle of incidence, it attains a minimum value δ. On increasing the angle of incidence further, the angle of deviation increases.

The angle δ is called the angle of minimum deviation.

6. REFRACTIVE INDEX OF MATERIAL OF THE PRISM

When the angle of deviation is minimum, the prism is said to be placed in minimum deviation position. A prism can deviate the incident ray through the same angle δ for two different values i_1 and i_2 of the angle of incidence corresponding to the angle of minimum deviation. In other words, there is only one angle of incidence, for which the angle of deviation is minimum.

When the prism is placed in minimum deviation position, the prism lies symmetrically to with respect to the incident ray and emergent ray i.e. the angle of incidence is equal to the angle of emergence. Further, in minimum deviation position, the angle of refraction at the first face is equal to angle of deviation at the second face. Also the refracted ray passes parallel to the base of the prism.

Therefore, when δ = δ; (minimum deviation position)

$e = i$ and $r = r_2$

$r + r = A$ or $r = A/2$

So, $A + \delta = i + i$

Or $i = (A + \delta)/2$

The refractive index of the material of prism is given by:-

$$\mu = \frac{sin(A+\delta)/2}{sin\ A/2}$$

WATER

OBSERVATIONS:-

To measure angle of deviation:

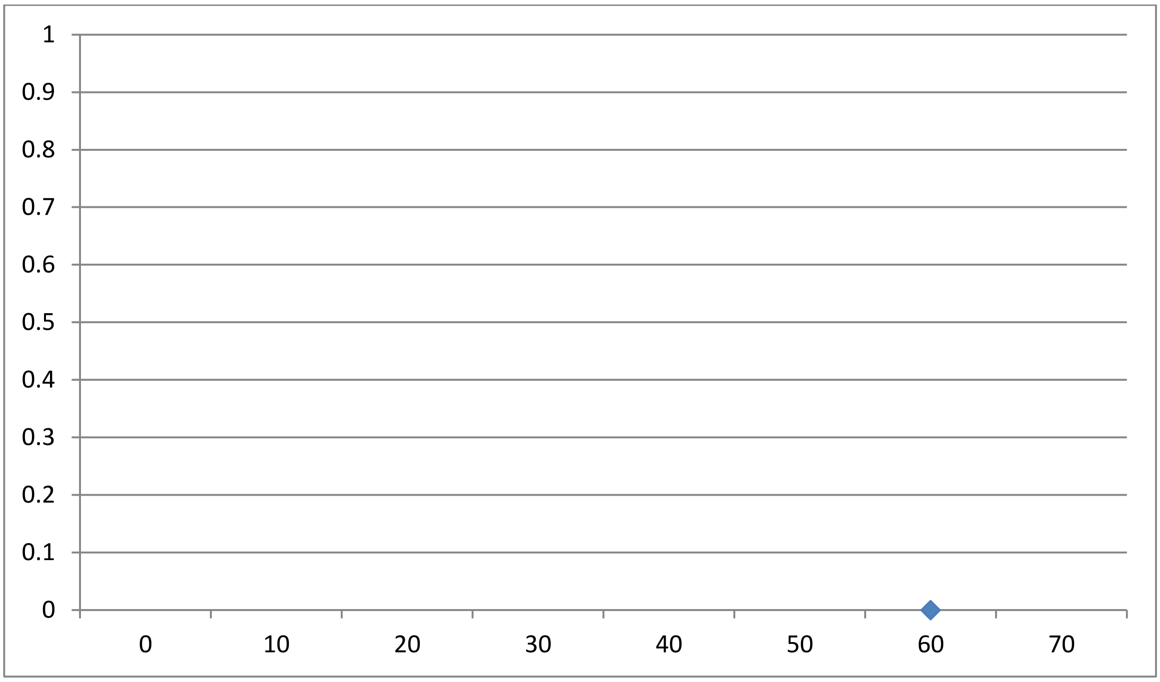
S.No.	Angle of Prism (A)	Angle of Incidence (i)	Angle of Deviation (δ)
1.			
2.			
3.			
4.			
5.			
6.			

CALCULATIONS:-

Mean value of the angle of prism, A =

From the graph between i and δ =

Now, refractive index of material of the prism, μ =



ANGLE OF INCIDENCE

TURPENTINE OIL

OBSERVATIONS:-

To measure angle of deviation:

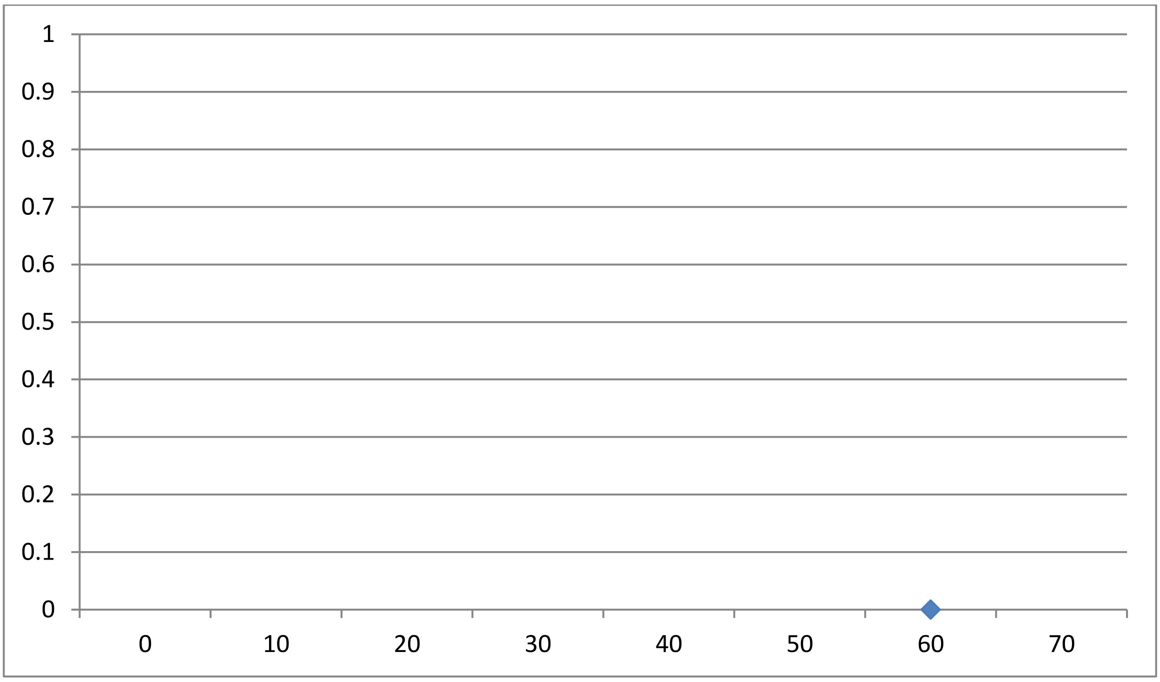
S.No.	Angle of Prism (A)	Angle of Incidence (i)	Angle of Deviation (δ)
1.			
2.			
3.			
4.			
5.			
6.			

CALCULATIONS:-

Mean value of the angle of prism, A =

From the graph between i and δ =

Now, refractive index of material of the prism, μ =



ANGLE OF INCIDENCE

GLYCERINE

OBSERVATIONS:-

To measure angle of deviation:

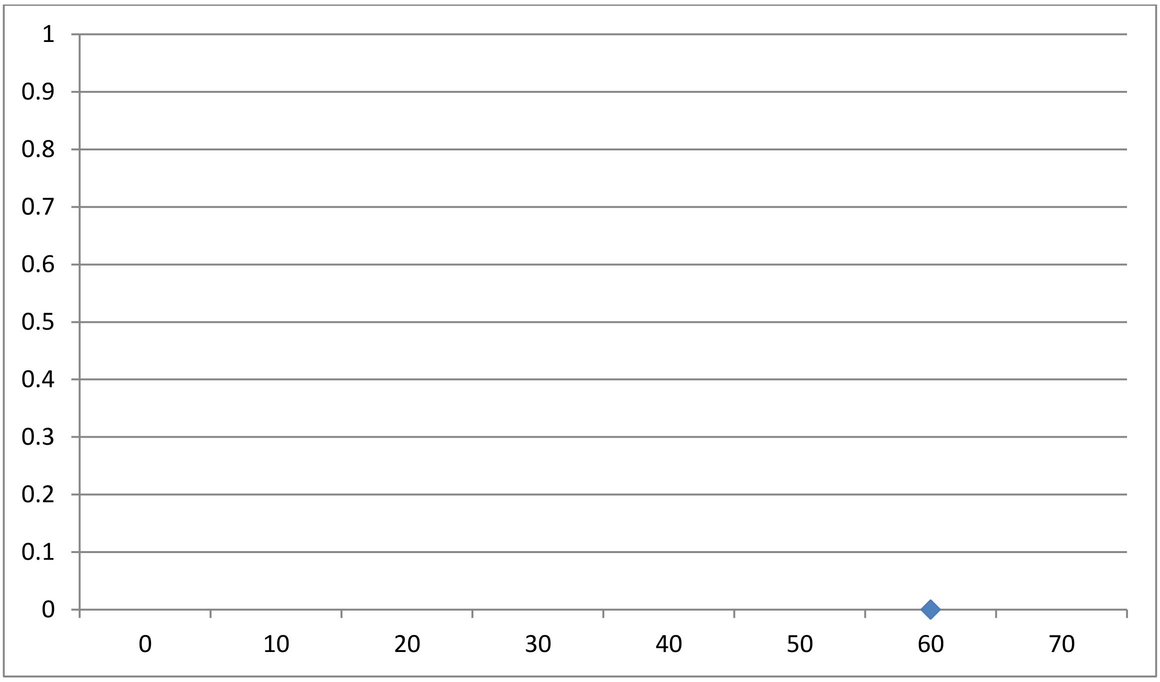
S.No.	Angle of Prism (A)	Angle of Incidence (i)	Angle of Deviation (δ)
1.			
2.			
3.			
4.			
5.			
6.			

CALCULATIONS:-

Mean value of the angle of prism, A =

From the graph between i and δ =

Now, refractive index of material of the prism, μ =



ANGLE OF INCIDENCE

EXPERIMENT

AIM:-

To determine angle of minimum deviation for a given glass prism by plotting a graph between the angle of incidence and angle of deviation and hence to find the refractive index of the material of the prism.

APPARATUS:-

A glass prism, drawing board, a sheet of paper, drawing pins (or gum), paper pins, a protractor and a half meter scale.

FORMULA USED:-

The refractive index of the material of prism is given by -

$$\mu = \frac{\sin(A+\delta_m)/2}{sinA/2}$$

Where A, is the angle of prism and δ_m is the angle of minimum deviation.

Procedure:-

1. Fix a sheet of paper on the drawing board with the help of pins.
2. Draw line XY in the middle of the paper and parallel to its length.
3. Place the prism such that its face AB is parallel to the line XY and draw its boundary with a sharp pencil.

Remove the prism and draw normal EN roughly at the centre of the refracting surface AB. Then, draw a line DE making an angle of 30° with the normal EN. Fix two pins P and Q on the line DE vertically, so that the distance between them is at least 10cm.

4. Put the prism back in its position and look for the images of the pins P and Q through the refracting faces AC of the prism. By bringing the images of the two pins in line, fix a third pin R so that it is in the line with the images of pins P and Q.
5. Now by bringing the pins P and Q in the line with the pin R, fix the fourth pin S, so that it is in the line with the pin R and the images of pins P and Q, the distance between the pins R and S must again be at least 10cm. See that the feet of all the four pins are in line with each other.
6. Remove the pins one by one and encircle their positions. Also, remove the prism.
7. Draw a line joining the positions of the pins R and S, so as to meet face AC at the point F. join the points E and F. then, DE,EF anf FG are respectively the incident, refracted and emergent rays.
8. Produce the incident ray DE forward and the emergent ray FG backward, so as to meet at the point T. Then, angle KTS=δ is the angle of deviation. It gives the angle of deviation, when the angle of incidence is 30°. Measure the value of the angle of deviation with the help of protractor.
9. Measure the angle.

10. By proceeding as in step 3-8, determine the value of the angle of deviation when the angle of deviation is 35°, 40°….55°.
11. Record the observations in tabular form.
12. Plot a graph between the angle of incidence i(along X axis) and angle of deviation δ(along Y axis). The graph obtained will be as shown in figure.
13. Note the value of angle of minimum deviation (δ_m) from the graph corresponding to the lowest point i-δ curve as shown in figure.

RESULT:-

The graph between i and δ shows that as the angle of incidence increases, the angle of deviation first decreases, attains a minimum value and then on increasing the angle of incidence further, the angle of deviation increases.

- The angle of minimum deviation, $\boldsymbol{\delta_m}$**=**____ (water)
- The refractive index of the material of the prism, **μ** = ____

PRECAUTIONS:-

- The boundary of the prism, incident ray and emergent ray should be drawn with a sharp pencil.

- The angle of incident during various observations should lie between 30^0 and 60^o.
- The distance between the pins should be at least 1o cm.
- The pins should be vertical.
- While fixing the pins, their feet should be brought in one line.
- During fixing the pins, if the prism gets distributed by chance, it should be brought back to its marked boundary.
- The arrowheads should be drawn so as to indicate the directions of the incident, refracted and emergent rays.
- The angle of deviation should be measured with the protractor carefully and so accurately as possible.
- The i-graph should be obtained by joining the various points on the graph with a smooth free hand curve.

SOURCES OF ERROR:-

- The distance between the pins may be small.
- The pins may not have been fixed vertically.
- The feet of the pins may not be in the line.
- The angle of deviation may not have been measured correctly.
- The curve joining the various points of the graph may not be a smooth free hand curve.