1. Theory

A prism is a transparent medium separated from the surrounding medium by at least two plane surfaces which are inclined at a certain angle. The spectrometer is an instrument for analyzing the spectra of radiations. The glass prism spectrometer is suitable for measuring ray derivations and refractive indices. When a beam of light strikes on the surface of the prism the portion of the light is transmitted and the other portion is reflected. The transmitted light ray has small derivation of path from the incident angle. This is called refraction. Refraction is due to change in speed of light while passing through the medium. If we consider a prism with a prism angle A.

Let a ray OP is incident on the first face of a prism, and after passing from the principal plane of the prism, finally emerge out through the other face in the direction QR. Let i_1 and r_1 be the respective angles of incidence and refraction at the first face of the prism i_2 and r_2 be the corresponding quantities for the second face.

In the position of minimum deviation, as the ray passes symmetrically through the prism so in this position, $i_1 = i_2$ and, $r_1 = r_2$.

We know the angle of prism, $A = r_1 + r_2$.

In the position of minimum deviation,

$$A = 2r_1$$

$$\therefore r_1 = \frac{A}{2}$$

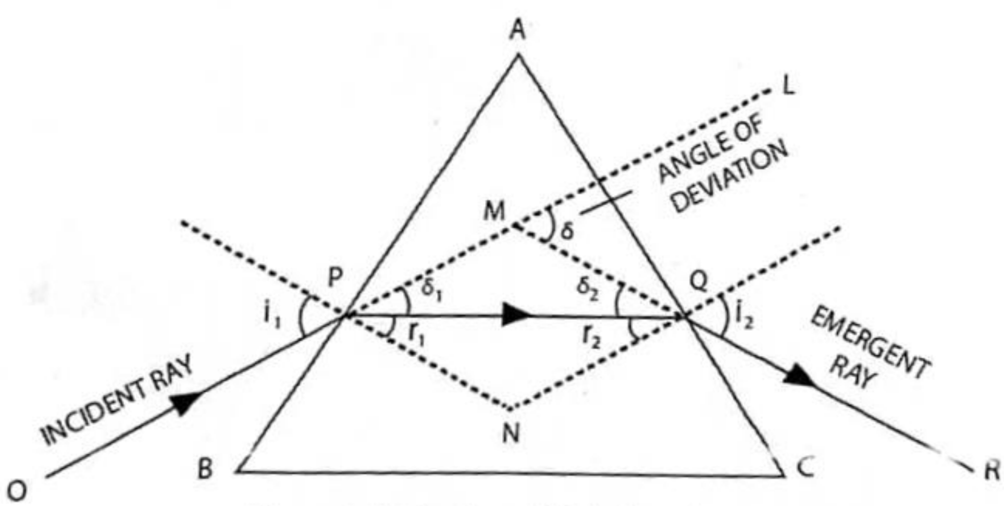

Figure 1: Refraction of light by prism.

Now the deviation of the ray, $\delta = (i_1 - r_1) + (i_2 - r_2)$

$$\Longrightarrow \ \delta = (i_1 + i_2) - (r_1 + r_2)$$

$$\therefore \delta = (i_1 + i_2) - A$$

In the position of minimum deviation, $\delta = \delta_m$. thus,

$$\delta_m = 2i_1 - A$$

$$\therefore i_1 = \frac{\delta_m + A}{2}$$

From Snell's Law, the refractive index, $\mu = \frac{sin i_1}{sin r_1}$

$$\therefore \mu = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{sin \frac{A}{2}} \ldots\ldots\ldots\ldots\ldots (1)$$

2. Apparatus

The components required to carry out this experiment include: -

- Spectrometer
- Sodium Lamp (source of monochromatic light)
- Prism
- Magnifying lens

3. Observations & calculation:

(A) Vernier Constant (VC) = $\frac{1}{60}$ = 0.0167

(B) Wavelength of light used = 589 nm = 589×10^{-9} m

(C) Angle of prism, A = 60°

Table for the angle of minimum deviation:

Vernier number	No. of observations	Reading for the minimum deviation position				Reading for the direct position				Angle of minimum deviation (δ_m)=M~ N	Mean δ_m	Refractive index $\mu = \frac{\sin\frac{\delta_m+A}{2}}{\sin\frac{A}{2}}$
		Main scale Reading (s)	Vernier scale division	Vernier scale reading V=vd× VC	Total M=S+V	Main scale Reading (s)	Vernier scale division	Total reading V=vd× VC	Total N=S+V			
1	1	60	25	0.417	60.417	98.5	10	0.167	98.66	38.243	38.86	1.51922
	2	10.5	6	0.1	10.6	50	28	0.467	50.467	39.867		
2	1	240.5	5	0.084	240.58	278.5	2	0.034	278.53	37.95		
	2	190.5	7	0.117	190.617	229.5	30	0.5	230	39.383		

Here, A = 60°

$\boldsymbol{\delta_m}$ = 38.86°

Refractive index $\boldsymbol{\mu} = \dfrac{sin\frac{\delta_{m+A}}{2}}{sin\frac{A}{2}}$

$= \dfrac{sin\frac{38.86+60}{2}}{sin\frac{60}{2}}$

=1.51922

4. Error Calculation:

Percentage of error = $\dfrac{\boldsymbol{Standard\,Value(g)-Experimental\,Value}}{\boldsymbol{Standard\,Value(g)}}\,\boldsymbol{\times 100\%}$

= $\dfrac{\mathbf{1.5-1.51922}}{\mathbf{1.5}}\,\boldsymbol{\times 100\%}$

= -1.28 %

5. Result

The refractive index of the material of the prism (μ) is 1.51922.

6. Discussion

This experiment was conducted to determine the refractive index of the material of a given prism by using a spectrometer. The main objective of this experiment is to observe the refracted light rays through a prism and to determine the refractive index of the material of that prism by finding out the minimum deviation using a spectrometer. Refractive index is essentially the measure of how much a wave bends when going from one medium to another. Refractive index for a given material is the ratio of the sine of the angle of incidence to the sine of the angle of refraction. Refractive index is also the velocity of light in empty space (vacuum) divided by the velocity of light in the substance/medium (such as water). White light consists of different wavelengths, all of which have differing refractive indices. Refractive index is inversely proportional to wavelength. Hence, in each medium, red light (longest wavelength) will have the smallest refractive index whereas violet (smallest wavelength) will have the largest refractive index, meaning red light will travel the fastest in that medium. The angle of minimum deviation is the smallest angle of deviation that a ray of light undergoes as it passes through a prism. When a ray of light enters a prism, it is refracted or bent, and the amount of bending depends on the angle at which the light hits the surface of the prism. The prism also disperses the different colors of light, causing them to separate and form a spectrum. The angle of deviation of a beam of light passing through a prism depends on several factors such as the angle of incidence, the angle of the prism, the refractive index of the prism material, the wavelength of light, the shape of the prism. The angle of a prism is the angle between its two refracting surfaces. When a beam of light passes through a prism, the angle of the prism determines the amount of bending, or refraction that occurs. The angle of the prism is measured by the angle between the two faces of the prism at their apex or tip. The angle of the prism is an important parameter in optics, as it determines the amount of deviation that a beam of light undergoes when it passes through the prism. A monochromatic light source must be used so that only one-color light ray is passed to the prism. Light adjusted so that a sufficiently bright and clear slit forms. Monochromatic light is light composed of a single wavelength or color. Monochromatic light is usually created by filtering or selecting out all but one wavelength of light from a source that emits a range of wavelengths, such as a white light source. The eyepiece used in the telescope of a spectrometer is known as a graticule eyepiece or crosshair eyepiece. This type of eyepiece has a reticle or grid of lines etched onto the lens, which helps the observer to precisely position the sample being analyzed. The lines on the graticule eyepiece can be calibrated to measure the angle of deviation of the light passing through the sample, allowing for accurate determination of its spectral properties. Human parallax error may present errors while observing the slits. Zero error of Vernier may also contribute to inaccurate measurements. Low-risk experiment so no danger of any injury being inflicted.

7. References

resources for the experiment:

- **Fundamentals of Physics**: The Law of Refraction (Chapter 35, page 1048), Wavelength and Index of Refraction (Chapter 35, page 1050)
- **Video Link:** **https://www.youtube.com/watch?v=oRch7irmLvo**