The intensity I_1 of the polarised light transmitted through the analyser is given by the Malus Law

$$I_1 = I \cos^2 \theta$$

where I is the original intensity and θ is the angle between the planes of the polariser and the analyser.

13.8 OBJECT

To determine the polarizing angle for the glass prism surface and to determine the refractive index of the material using Brewster's Law.

Apparatus: Spectrometer, sodium lamp, glass prism, a Polaroid with attachment etc.

Formula used: According to Brewster's law

$$\mu = \tan \phi$$

Where μ = refractive index of the material of prism.
ϕ = angle of polarization

Theory: Whenever light falls on a smooth surface a portion is reflected and the other is refracted. The fraction reflected and refracted depend upon the surface material of the medium and the angle of incidence. However, if the incident light is unpolarised both reflected and refracted rays are partially polarized. Brewster in 1811 carried out a series of experiments and concluded that for a particular angle of incidence, reflected light is completely polarized in the plane of incidence and the refracted light is partial polarized with predominant vibration of electric vectors in the plane of incidence. This angle of incidence is known angle of polarization or Brewster's angle.

Further, when the angle of incidence is equal to the angle of polarization, the reflected and refractive rays are mutually perpendicular to each other and therefore:

$${}_a\mu_g = \sin i/\sin r = \sin \phi/\sin (90° - \phi) = \sin \phi/\cos \phi = \tan \phi$$

Where ϕ is the angle of polarization. The relation $\mu = \tan \phi$ is known as Brewster's Law.

Procedure:

1. Make the mechanical and optical adjustment of the spectrometer as mentioned in the experiment of dispersive power. Attach the Polaroid attachment to the telescope objective.
2. Place the prism on the prism table such that one of the reflecting surface of prism passes through the prism table's center.
3. The prism table is rotated so that the light coming from the collimator is incident on the face of the prism passing through the center. The telescope is adjusted to get the reflected light on the cross wire. Polaroid attached with the telescope is then slowly rotated and the variation of the intensity of the field of view is observed.
4. The angle of incidence is increased by slightly rotating the prism table. The position of the telescope and Polaroid both are adjusted each time to get minimum intensity. The process is repeated till the reflected light completely disappears for one particular adjustment.
5. The position of the telescope is noted on both the verniers of the circular scale.
6. Now remove the prism and set the telescope for the direct image of the slit and again note the readings of the verniers.

The full procedure 3rd, 4th and 5th is repeated in order to determine the position of the telescope more accurately.

7. Calculate the angle.

Observations:

1. Vernier Constant of the spectrometer =
2. Readings for the determination of the angle of polarization:

Sl.No.	*Vernier*	*Position of telescope for extinction of image (a)*	*Position of telescope for direct image (b)*	*Difference (a – b)*	*Mean*	*Mean θ*
1	A					
	B					
2	A					
	B					
3	A					
	B					

Mean θ =

Calculation: Angle of polarization $\phi = (90° - \theta/2)$ =

$\mu = \tan \phi$ =

Result:

1. The angle of polarization for air-glass interface is found to be =
2. Refractive index of the material is found to be =

Precautions:

1. The width of the slit should be narrow.
2. If it is not possible to obtain zero intensity position, then it should be adjusted for minimum possible intensity.

13.9 DOUBLE REFRACTION

Certain crystalline materials have the property that a beam of light incident on them: (*i*) breaks into two plane polarised beams with their planes of polarisation mutually perpendicuar, and (*ii*) these two beams in general have different velocities in medium. The phenomenon is called double refraction.

In Fig. 13.9 the incident ray *AB* of light breaks up into two refracted rays *BO* and *BE*. BO is plane polarised in one plane, *BE* is also plane polarised but in a perpendicular plane. There are obviously two refractive indices,

$$\mu_1 = \frac{\sin i}{\sin r_1}, \quad \mu_2 = \frac{\sin i}{\sin r_2}$$

If the angle of incidence i is varies, snell's law $\frac{\sin i}{\sin r}$ = constant holds for one of the rays e.g., *BO* only. For the other ray this law does not generally hold. The ray *BO* which follows the laws