Experiment 2:

To determine the refractive index of the material of given prism using sodium light.

Equipment required:

A spectrometer, a spirit level, a source of monochromatic light (sodium lamp), a glass prism, a wooden screen with a circular aperture, an eye piece and an electric lamp.

Learning Objectives

To learn how to determine the angle of prism and the refractive index.

To acquaint oneself with the setting and alignment of spectrometer.

Theory: When a beam of light strikes on the surface of transparent material(Glass, water, quartz crystal, etc.), the portion of the light is transmitted and other portion is reflected. The transmitted light ray has small deviation of the path from the incident angle. This is called refraction.

Refraction is due to the change in speed of light while passing through the medium. It is given by Snell's Law.

$$\frac{\sin(i)}{\sin(r)} = \frac{n_2}{n_1}$$

Where i is the angle of incident and r is the angle of refraction. And n_1 is the refractive index of the first face and n_2 is the refractive index of the second face.

Procedure:

To have a demonstration on reading a vernier scale, go to the link:

http://labs.physics.dur.ac.uk/level1/ISE/ISEs.php

1. Find the least count of the spectrometer.

2. Find the angle of the prism by rotating the telescope method. Place the prism on the turn table in such a way that the refracting edge A coincides with the centre of the table and one of the refracting and polished face say AB remains perpendicular to the line joining the screws Y and Z.

3. Now rotate the prism table to bring the refracting edge A of the prism towards the collimator so that the light from the collimator falls equally on both faces AB and AC bounding the refracting angle A.

4. Rotate the telescope to the right side to receive the light reflected from the face AB and focus the crosswire on the image of the slit. Now by tangent screw the telescope is moved slowly until its

vertical cross wire coincides with the image. The reading of the two verniers of the spectrometer is taken.

5. Now rotate the telescope to the left side to receive the light reflected from the face AC and again focus the crosswire on the image of the slit by means of tangent screw. The readings of the two verniers of the spectrometer are again noted.

6. The difference of the two vernier readings of the same vernier for two positions of the telescope gives twice the refracting angle A of the prism. Thus half of this angle will give the value of angle of prism.

7. Place the prism on the prism table so that its centre coincides with the centre of the table and one of the reflecting faces say *AB* is perpendicular to the line joining the two screws *P* and *Q*. Rotate the table so that the light from the collimator is incident on the reflecting face *AB* and after refraction passes out of the face *AC* as shown in Fig.2.

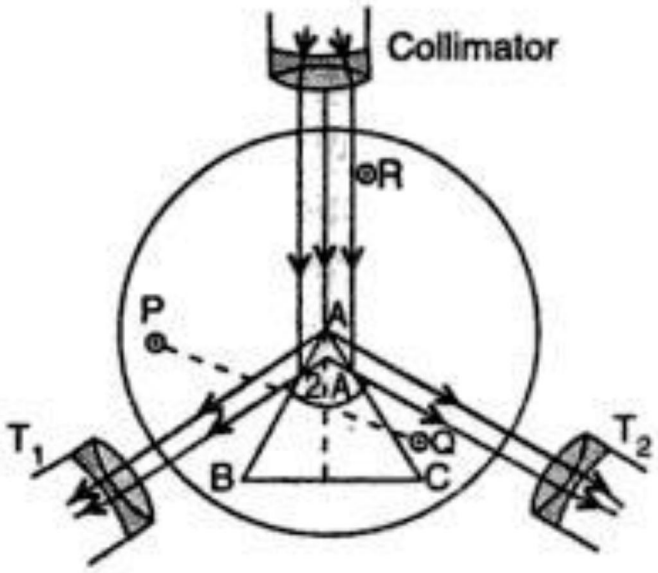


Fig.2 Setup of spectrometer of experiment.

8. Look through the face *AC* and locate the position of the refracted image with the naked eye. Bring the telescope in this position. Adjust the position till the image of the slit falls on the cross-wire. Now turn the prism table in such a direction that the telescope has to be moved towards the line of the collimator axis in order to keep the image in the centre of the field of view. As the prism table is rotated in this way the angle of deviation decreases. When the position of minimum deviation is reached the image becomes stationary and further rotation of the table makes it move in the backward direction. The direction of the telescope is finally adjusted till the image is on the cross-wire in the stationary position from which it turns back in whichever direction the prism is rotated. Clamp the telescope and the table. The minimum deviation position is correct if the image remains

stationary when the tangent screw of the table is given one rotation either way. Note the reading on both the vernier scales *V1* and *V2*.

9. Keep the table fixed and remove the prism gently. Turn the telescope and bring it in line with the collimator and clamp it. Work the tangent screw of the telescope so that the image of the slit falls exactly on the vertical cross-wire. Take the reading on both the vernier scales.

10. Repeat the experiment and take three such observations.

Scope of the result to be reported Plots & Parameters:

1. Plot a graph by taking angle of incidence 'i'along the X-axis and angle of deviation δ along the Y-axis. This graph will give the angle of minimum deviation.
2. Angle of Prism 'A' and Angle of minimum deviation Dm. Refractive Index μ can be found using the formula

μ = *sin [(A + Dm)/2]/sin A/2*

The angle of deviation decreases with angle of incidence. For a particular angle of incidence, the angle of deviation is minimum which is known as angle of minimum deviation and which can be noted from the graph. After this point the angle of deviation again increases with angle of incidence. By measuring the angle of deviation and angle of prism, the refractive index of he material of prism can be determined.

Observations: Vernier constant=

Wavelength of light used=

Angle of Prism:

S.No.	Vernier	Position of telescope for reflection from						Difference (a~b =2A)	Mean of value 2A	A
		Position of Ist face (a)			Position of IInd face (b)					
		M.S.	V.S.	Total	M.S.	V.S.	Total			
1.	V_1 V_2									
2.	V_1 V_2									
3.	V_1 V_2									

Mean value of angle of prism "A" =

Table for Angle of minimum deviation

S.No.	Vernier	Telescope reading						Difference (a'–b' =δm)	Mean value of δm
		Position of minimum deviation (a')			Direct image (b')				
		M.S.	V.S.	T	M.S.	V.S.	T		
1.	V_1 V_2								
2.	V_1 V_2								
3.	V_1 V_2								

Mean value of δm =

(i) Refractive index for sodium light μ = Sin [(A+δm)/2]/SinA/2

(ii) Exact value of μ for extra dense flint glass (material of prism) =
Calculated value = …….
Percentage error = [(calculated value - exact value)/exact value] x 100 = ……..%

Calculations:

1. Angle of Prism 'A' and Angle of minimum deviation Dm

2. Refractive Index μ can be found using the formula

$$\mu = \sin[(A + Dm)/2]/\sin A/2$$

Cautions

1. The axis of telescope, the collimator and the plane of the prism table should be horizontal.
2. The position of the eye piece should be adjusted so that the cross-wires are clearly visible without any strain.
3. The telescope should be focused for infinity and the collimator should be adjusted to give a parallel beam of light.
4. The slit should be narrow.
5. The prism should be placed with its refracting edge at the centre of the prism table when finding the angle by rotating the telescopes.
6. The prism table should be leveled so that reflected image from both the reflecting faces lies systematically with respect to the horizontal cross-wires.

References:

1. B.Sc. Practical Physics by C. L. Arora S.Chand Publication, 20 th edition(2015).

Weblinks: http://vlab.amrita.edu/?sub=1&brch=281

Worksheet of the student:

Date of Performance: **Registration number:**

Experiment: To determine the refractive index of the material of given prism using sodium light.

Observations: Vernier constant=

Wavelength of light used=

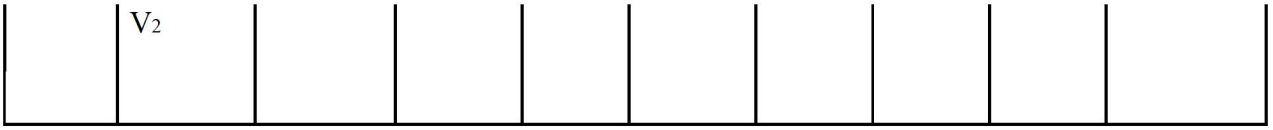
Angle of prism

S.No.	Vernier	Position of telescope for reflection from						Difference (a~b =2A)	Mean of value 2A	A
		Position of Ist face (a)			Position of IInd face (b)					
		M.S.	V.S.	Total	M.S.	V.S.	Total			
1.	V_1 V_2									
2.	V_1 V_2									
3.	V_1 V_2									

Mean value of angle of prism "A" =

Table for Angle of minimum deviation

S.No.	Vernier	Telescope reading						Difference (a'–b' =δm)	Mean value of δm
		Position of minimum deviation (a')			Direct image (b')				
		M.S.	V.S.	T	M.S.	V.S.	T		
1.	V_1 V_2								
2.	V_1 V_2								
3.	V_1								



Calculations:

Mean value of δm =

(i) Refractive index for sodium light μ =

(ii) Exact value of μ for extra dense flint glass (material of prism) =
Calculated value = ……..

Percentage error = [(calculated value = exact value)/exact value] x 100

= ……..%

Learning Outcomes (what I have learnt):

To be filled in by faculty:

S.No.	Parameter	Marks obtained	Max marks
1	Understanding of the student about the procedure/apparatus		20
2	Observations and analysis including learning Outcomes		20
3	Completion of experiment , discipline and Cleanliness		10
	Signature of faculty	Total marks obtained	