

Experiment No.1

Object: To determine the refractive index of a prism by using a spectrometer.

Apparatus Required: Spectrometer, prism, mercury vapour lamp, spirit level and reading lens.

Formula Used: The refractive index μ of the prism is given by the following formula:

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

Where A = angle of the prism, δ_m = angle of minimum deviation.

Procedure: The following initial adjustments of the spectrometer are made first.

- The spectrometer and the prism table are arranged in horizontal position by using the leveling screws.
- The telescope is turned towards a distant object to receive a clear and sharp image.
- The slit is illuminated by a mercury vapour lamp and the slit and the collimator are suitably adjusted to receive a narrow, vertical image of the slit.
- The telescope is turned to receive the direct ray, so that the vertical slit coincides with the vertical crosswire.

(A) Measurement of the angle of the prism:

- Determine the least count of the spectrometer.
- Place the prism on the prism table with its refracting angle A towards the collimator and with its refracting edge A at the centre. In this case some of the light falling on each face will be reflected and can be received with the help of the telescope.
- The telescope is moved to one side to receive the light reflected from the face AB and the cross wires are focused on the image of the slit. The readings of the two verniers are taken.
- The telescope is moved in other side to receive the light reflected from the face AC and again the cross wires are focused on the image of the slit. The readings of the two verniers are taken.
- The angle through which the telescope is moved; or the difference in the two positions gives twice of the refracting angle A of the prism. Therefore half of this angle gives the refracting angle of the prism.

(B) Measurement of the angle of minimum deviations:

- Place the prism so that its centre coincides with the centre of the prism table and light falls on one of the polished faces and emerges out of the other polished face, after refraction. In this position the spectrum of light is obtained.
- The spectrum is seen through the telescope and the telescope is adjusted for minimum deviation position for a particular colour (wavelength) in the following way: Set up telescope at a particular colour and rotate the prism table in one direction, of course the telescope should be moved in such a way to keep the spectral line in view. By doing so a position will come where a spectral line recede in opposite direction although the rotation of the table is continued in the

same direction. The particular position where the spectral line begins to recede in opposite direction is the minimum deviation position for that colour. Note the readings of two verniers.

- Remove the prism table and bring the telescope in the line of the collimator. See the slit directly through telescope and coincide the image of slit with vertical crosswire. Note the readings of the two verniers.
- The difference in minimum deviation position and direct position gives the angle of minimum deviation for that colour.
- The same procedure is repeated to obtain the angles of minimum deviation for the other colours.

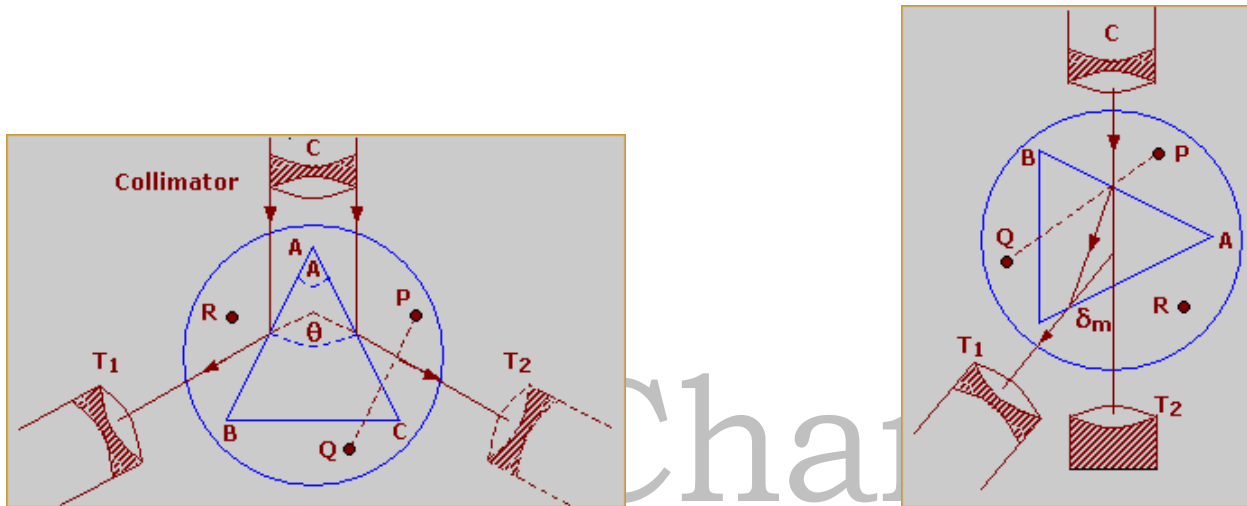


Figure: Left: Arrangement to determine the angle of prim.

Right: Arrangement to determine the angle of minimum deviation.

Observations:

(i) Value of the one division of the main scale = degrees

Total number of vernier divisions =

Least count of the vernier = degrees = second

(ii) Table for the angle (A) of the prism.

| S.No | Vernier | Telescope reading for reflection | | | | | | Difference $\theta = a - b = 2A$ | Mean value of 2A | A | Mean A degrees |
|------|----------------|----------------------------------|-----|--------|------------------|-----|--------|-------------------------------------|------------------|---|----------------|
| | | from first face | | | from second face | | | | | | |
| | | MSR | VSR | TR (a) | MSR | VSR | TR (b) | | | | |
| 1 | V ₁ | | | | | | | } | | | |
| | V ₂ | | | | | | | | | | |
| 2 | V ₁ | | | | | | | } | | | |
| | V ₂ | | | | | | | | | | |
| 3 | V ₁ | | | | | | | } | | | |
| | V ₂ | | | | | | | | | | |

MSR = Main Scale Reading, VSR = Vernier Scale Reading, TR = MSR+VSR = Total Reading.

(iii) Table for the angle of minimum deviation (δ_m).

| S.No | Colour | Vernier | Telescope reading for minimum deviation | | | Telescope reading for direct image | | | Difference $\delta_m = a - b$ | Mean value of δ_m |
|------|--------|----------------|---|-----|--------|------------------------------------|-----|--------|-------------------------------|--------------------------|
| | | | MSR | VSR | TR (a) | MSR | VSR | TR (b) | | |
| 1 | Violet | V ₁ | | | | | | | } | |
| | | V ₂ | | | | | | | | |
| 2 | Yellow | V ₁ | | | | | | | } | |
| | | V ₂ | | | | | | | | |
| 3 | Red | V ₁ | | | | | | | } | |
| | | V ₂ | | | | | | | | |

MSR = Main Scale Reading, VSR = Vernier Scale Reading, TR = MSR+VSR = Total Reading.

Calculations:

Angle of the prism =

Angle of minimum deviation for violet =

Refractive index for violet =

Angle of minimum deviation for blue =

Refractive index for yellow =

Angle of minimum deviation for red =

Refractive index for red =

Result: Refractive index for the material of the prism:

| S.No | Colour | Calculated refractive index | Standard refractive index | % Error |
|------|--------|-----------------------------|---------------------------|---------|
| | | | | |
| | | | | |
| | | | | |

Precautions and sources of error:

- (i) The telescope and collimator should be individually set for parallel rays.
- (ii) Slit should be as narrow as possible.
- (iii) While taking observations, the telescope and prism table should be clamped with the help of clamping screws.
- (iv) Both verniers should be read.
- (v) The prism should be properly placed on the prism table for the measurement of angle of the prism as well as for the angle of minimum deviation.