# Observations for experiment no. O1:

Least count of the spectrometer = 20''

## Readings for the measurement of angle of minimum deviation:

Reading of telescope position for direct image of the slit:

Left scale ($\theta_L$): Circular Scale= $332^\circ$ 40', Vernier: 24; Total: **332.8°**

Right scale ($\theta_R$): NOT Required.

| Sr. no. | Colours of light | Reading of telescope position, Left scale ($\theta_1$) | | $\theta_1$ | $D_m = \theta_L \sim \theta_1$ | $C = Sin\left(\frac{D_m + A_0}{2}\right)$ | $\mu = C/E$ |
|---|---|---|---|---|---|---|---|
| | | Circular scale | Vernier scale | | | | |
| 1 | Violet I | $27^\circ$ 40' | 15 | 27.75° | **54.95°** | **0.8438** | **1.6842** |
| 2 | Violet II | $27^\circ$ 20' | 48 | 27.6° | **54.8°** | **0.8431** | **1.6828** |
| 3 | Blue | $26^\circ$ 20' | 57 | 26.65° | **53.85°** | **0.8386** | **1.6738** |
| 4 | Green | $24^\circ$ 20' | 29 | 24.5° | **51.7°** | **0.8283** | **1.6533** |
| 5 | Yellow I | $24^\circ$ | 24 | 24.13° | **51.33°** | **0.8265** | **1.6497** |
| 6 | Yellow II | $24^\circ$ | 21 | 24.12° | **51.32°** | **0.8264** | **1.6495** |
| 7 | Red | $23^\circ$ 40' | 15 | 23.75° | **50.95°** | **0.8246** | **1.6459** |

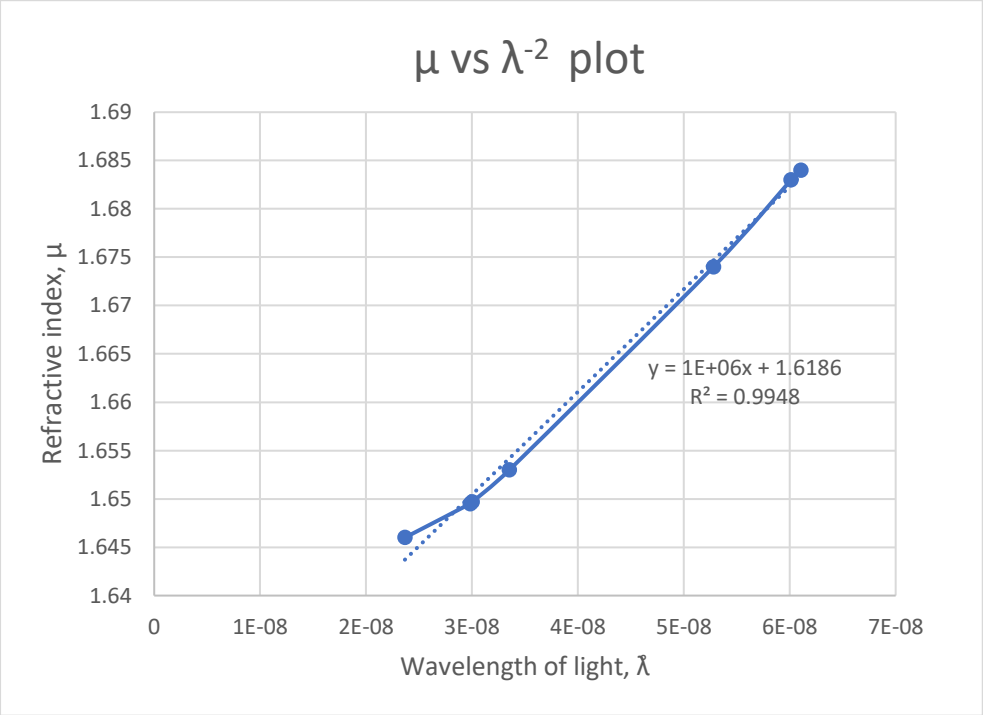
## Readings for measurement of prism angle $A_0$:

| Sr. no. | Position of telescope for reflected slit from | | | | | | $A_0 = \frac{a \sim b}{2}$ | $E = Sin\left(\frac{A_0}{2}\right)$ |
|---|---|---|---|---|---|---|---|---|
| | Left face (a) | | | Right Face (b) | | | | |
| | Circular scale | Vernier scale | a | Circular scale | Vernier scale | b | | |
| 1 | $37^\circ$ | 48 | **37.27°** | $276^\circ$ 40' | 54 | **276.97°** | 60.15° | **0.501** |
| 2 | $37^\circ$ | 46 | **37.25°** | $276^\circ$ 40' | 56 | **276.98°** | 60.14° | |

## Wavelengths for the colours of light:

| Sr. No. | Colour of light | Wavelength in $\mathring{A}$ |
|---|---|---|
| 1 | Violet I | **4047** |
| 2 | Violet II | **4078** |
| 3 | Blue | **4352** |
| 4 | Green | **5461** |
| 5 | Yellow I | **5770** |
| 6 | Yellow II | **5790** |
| 7 | Red | **6500** |

## Plot of the refractive index with respect to $\lambda^{-2}$:




**From this plot, and employing the Cauchy's equation, we get the Cauchy's constants as:**

## Cauchy's linear equation:

**$\mu = A + B/\lambda^2$**

with **A** and **B** are the Cauchy's constants.

**Slope (B):** 1062599.001 Å^2
**Intercept (A):** 1.6186

----------end of data analysis----------

# Error Analysis

Least count of spectrometer $= 20'' = 9.696 \times 10^{-5}\ radian$ $\left\{As\ 1'' = \frac{\pi}{180}\frac{1}{3600}\ radian\right\}$

Error in measuring the angle of prism

For one side circular scale of spectrometer = least count of spectrometer

Hence, for angle of prism, the error in measuring the angle of prism $(\delta A) = 2 \times Least\ Count$

Similarly, Error in measuring the minimum deviation $(\delta D_m) = 2 \times Least\ Count.$

Now, Error in refractive index measurement:

Form the formula, refractive index $(\mu)$ is

$$\mu = \frac{sin\left(\frac{A + D_m}{2}\right)}{sin\left(\frac{A}{2}\right)} = f(A, D_m)$$

Differentiating (complete) above formula, we have

$$d\mu = \frac{\partial f}{\partial A}\delta A + \frac{\partial f}{\partial D_m}\delta D_m$$

For error calculation

$$|d\mu| = \left|\frac{\partial f}{\partial A}\right||\delta A| + \left|\frac{\partial f}{\partial D_m}\right||\delta D_m|$$

$$d\mu = \frac{1}{2}\left[\left\{\frac{sin(A/2)\cos\left(\frac{A + D_m}{2}\right) - cos(A/2)\sin\left(\frac{A + D_m}{2}\right)}{sin^2(A/2)}\right\}\delta A + \left\{\frac{\cos\left(\frac{A + D_m}{2}\right)}{sin(A/2)}\right\}\delta D_m\right]$$

| S. No. | Color of Light | Deviation ($D_m$) | Error in $\mu$ or $\|d\mu\|$ | $\mu_f = \mu \pm \|d\mu\|$ |
|---|---|---|---|---|
| 1. | Violet I | 54.95˚ | 0.0003 | $1.6842 \pm 0.0003$ |
| 2. | Violet II | 54.8˚ | 0.0003 | $1.6828 \pm 0.0003$ |
| 3. | Blue | 53.85˚ | 0.0003 | $1.6738 \pm 0.0003$ |
| 4. | Green | 51.7˚ | 0.0003 | $1.6533 \pm 0.0003$ |
| 5. | Yellow I | 51.33˚ | 0.0003 | $1.6497 \pm 0.0003$ |
| 6. | Yellow II | 51.32˚ | 0.0003 | $1.6495 \pm 0.0003$ |
| 7. | Red | 50.95˚ | 0.0003 | $1.6459 \pm 0.0003$ |

***----------

For example, for Violet I (lambda=4047 A),

A=60.144, $D_m = 54.95°,\ i\ (say) = \left(\frac{A+D_m}{2}\right) = \left(\frac{60.144+54.95}{2}\right) = 57.547,$

$\sin\left(\frac{A}{2}\right) = 0.5011,\ \sin^2\left(\frac{A}{2}\right) = 0.2511,\ \cos\left(\frac{A}{2}\right) = 0.8654,$

$\sin(i) = sin\left(\frac{A+\boldsymbol{D_m}}{2}\right) = \sin(57.547) = 0.8438,\ \ cos\left(\frac{A+\boldsymbol{D_m}}{2}\right) = \cos(57.547) = 0.5366,$ and

$\delta A = \delta D_m = 2 \times LC = 1.9392 \times 10^{-4}\ radian$, then

$$|d\mu| = \frac{1}{2}\left[\left|\left\{\frac{sin(A/2)\cos\left(\frac{A+D_m}{2}\right) - cos(A/2)\sin\left(\frac{A+D_m}{2}\right)}{sin^2(A/2)}\right\}\right||\delta A| + \left|\left\{\frac{\cos\left(\frac{A+D_m}{2}\right)}{sin(A/2)}\right\}\right||\delta D_m|\right]$$

$$|d\mu| = \frac{1}{2}\left[\left|\left\{\frac{sin(A/2)\cos\left(\frac{A+D_m}{2}\right) - cos(A/2)\sin\left(\frac{A+D_m}{2}\right)}{sin^2(A/2)}\right\}\right| + \left|\left\{\frac{\cos\left(\frac{A+D_m}{2}\right)}{sin(A/2)}\right\}\right|\right]|\delta D_m| \qquad \{As\ |\delta A| = |\delta D_m|\}$$

$$|d\mu| = \frac{1}{2}\left[\left|\left\{\frac{0.5011\times0.5366 - 0.8654\times0.8438}{0.2511}\right\}\right| + \left|\left\{\frac{0.5366}{0.5011}\right\}\right|\right]1.939 \times 10^{-4}$$

$$|d\mu| = \frac{1}{2}\left[\left|\left\{\frac{0.2689 - 0.7302}{0.2511}\right\}\right| + \left|\left\{\frac{0.5366}{0.5011}\right\}\right|\right]1.939 \times 10^{-4}$$

$$|d\mu| = \frac{1}{2}[|-1.8377| + |1.0709|]1.939 \times 10^{-4}$$

$$|d\mu| = 0.000282 \sim 0.0003$$

---***