Determine Refractive Index of Material of a prism using Sodium Source

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1 AIM

To Determine Refractive Index of Material of a prism using Sodium Source

2 APPARATUS

Spectrometer, prism, prism clamp, sodium vapour lamp, lens. etc.

3 PROCEDURE

- Focus Telescope on distant object.
- When focus is correct, start button is activated. Then click Start button.
- Switch on the light by clicking Switch On Light button.
- Focus the slit using Slit focus slider.
- Bring Vernier to 0 degree and 180 degree position using Vernier Table Slider.
- Place the prism.
- Bring telescope using Telescope Slider to a position of (180 - 2i) degree by rotating it in anti-clockwise direction, where (i) is the angle of incidence.
- Move Vernier Table in clockwise direction to coincide slit with cross wire.

- Now move telescope in clockwise direction so that refracted ray goes in it and coincide slit with cross wire.
- Note down reading for both Verniers .This will be reading for refracted Ray.
- Remove the Prism.
- Move telescope in anti-clockwise direction to get direct ray in it and coincide slit with cross wire.
- Note down the readings for both Verniers now as well. This will be reading for Direct Ray.

4 PRECAUTIONS

- Slit should be as narrow as possible.
- Vernier numbering should remain fixed throughout the experiment.
- Prism position should be maintained properly.
- Fine adjustment of telescope must be used in each case.

5 OBSERVATIONS

5.1 Least Count of Spectrometer

$27MSD = 30VSD$

$1VSD = \frac{27}{30}$MSD

Least count $= 1MSD - 1VSD$

$1MSD$ - $\frac{27}{30}MSD = \frac{3}{30}$MSD

On main scale 20 divisions $= 10^\circ$

1 division $= (1/2)^\circ = 1$ MSD

$\therefore L.C = (\frac{3}{30}) \times (\frac{1}{2})^\circ = (\frac{1}{20})^\circ$

$= (\frac{1}{20} \times 60)' = 3'$

5.2 Angle of Deviation

$\angle i^\circ$	vs	$\angle r^\circ$	$\angle d^\circ$	$(\angle r^\circ - \angle d^\circ)$	$\angle mean^\circ$
30°	$V1$	$42^\circ\ 30'$	$89^\circ\ 30'$	47°	47°
	$V2$	$222^\circ\ 30'$	$269^\circ\ 30'$	47°	
35°	$V1$	$53^\circ\ 30'$	$94^\circ\ 30'$	41°	41°
	$V2$	$233^\circ\ 30'$	$274^\circ\ 30'$	41°	
40°	$V1$	61°	$99^\circ\ 30'$	$38^\circ\ 30'$	$38^\circ\ 30'$
	$V2$	241°	$279^\circ\ 30'$	$38^\circ\ 30'$	
45°	$V1$	67°	$104^\circ\ 30'$	$37^\circ\ 30'$	$37^\circ\ 30'$
	$V2$	247°	$284^\circ\ 30'$	37°	
50°	$V1$	$72^\circ\ 30'$	$109^\circ\ 30'$	37°	$37^\circ\ 15'$
	$V2$	252°	$289^\circ\ 30'$	$37^\circ\ 30'$	
55°	$V1$	77°	$114^\circ\ 30'$	$37^\circ\ 30'$	$37^\circ\ 30'$
	$V2$	257°	$294^\circ\ 30'$	$37^\circ\ 30'$	
60°	$V1$	$80^\circ\ 30'$	$119^\circ\ 30'$	$39^\circ\ 30'$	39°
	$V2$	$260^\circ\ 30'$	$299^\circ\ 30'$	39°	

5.2.1 Take observation for angle of deviation for various angles of incidence i

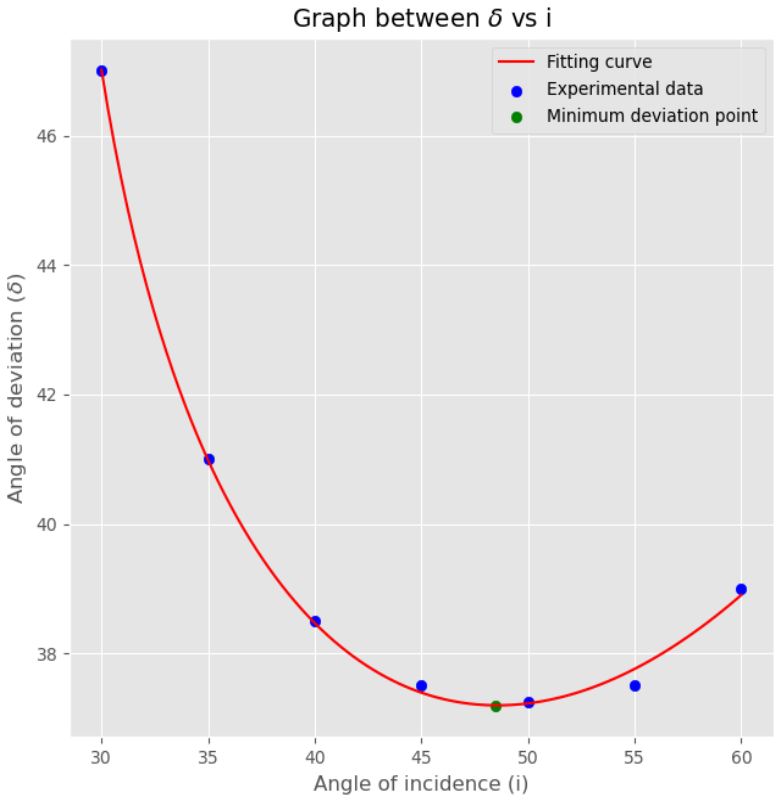
Angle of prism and Refractive index of the prism from fitting: [1.04579575 1.50106945]

[47.01860351 46.41513369 45.86531544 45.3603979 44.89377642 44.46032214 44.05595883 43.677384 43.32187829 42.98717135 42.67134485 42.37276088 42.09000809 41.82186035 41.56724471 41.32521609 41.09493709 40.87566181 40.66672255 40.46751898 40.27750911 40.09620181 39.92315046 39.75794763 39.60022054 39.44962716 39.30585287 39.16860753 39.03762307 38.91265117 38.79346144 38.67983972 38.57158654 38.46851586 38.37045389 38.27723803 38.18871596 38.10474482 38.02519042 37.94992661 37.87883465 37.81180268 37.74872518 37.68950259 37.63404082

37.58225094 37.53404878 37.48935468 37.44809315 37.41019262
37.37558521 37.34420649 37.31599529 37.29089351 37.26884591
37.24979999 37.23370581 37.22051587 37.21018497 37.20267007
37.19793021 37.19592639 37.19662145 37.19998001 37.20596837
37.21455443 37.22570761 37.23939877 37.25560019 37.27428542
37.29542933 37.31900794 37.34499846 37.3733792 37.40412951
37.43722976 37.47266131 37.51040641 37.55044824 37.59277082
37.63735899 37.68419839 37.73327541 37.78457718 37.83809152
37.89380694 37.95171259 38.01179826 38.07405433 38.13847176
38.20504209 38.27375738 38.34461022 38.4175937 38.4927014
38.56992735 38.64926607 38.73071246 38.81426189 38.89991012]

Coordinates of minima of the graph (x,y): [48.48484848
37.19592639]

Angle of minimum deviation from Graph is: 37.195926387124224



6 RESULT AND DISCUSSION

Minimum angle of deviation is 37°11'45"

- We just went through the theory of experiment by sharing links with info of concerned points and definitions.
- We just worked together on simulator by sharing screen via Gmeet.
- We evaluated the readings taken.

- We discussed the error part.

7 Contribution of Team Mates

Anjali : She did most of the theoretical part including working on simulator.

Preetpal Singh : He did Python programming and Latex part.

8 Programming Code

```
import matplotlib.pyplot as plt
from scipy.optimize import curve_fit
import numpy as np

def rad(x):
    return (x * np.pi/180)

def func(i,A,n):
    return i - A + np.arcsin(n * np.sin(A - np.arcsin(np.sin(i)/n))
    )

def min_dev(y_cal,xlim):
    list = []
    for j in range(len(y_cal)):
        xlim[j]
        if y_cal[j] == np.min(y_cal):
            list.append(xlim[j])
            list.append(np.min(y_cal))
    mini = np.array(list)
    print("\nCoordinates of minima of the graph (x,y):\n",mini)
    print("\n Angle of minimum deviation from Graph is: ",min(y_cal
    ))
    return mini


if __name__ == "__main__":
    datax = np.array([30,35,40,45,50,55,60])
    mean_dev_deg = np.array([47,41,38,37,37,37,39])
    mean_dev_min = np.array([0,0,30,30,15,30,0])
    datay= np.array((mean_dev_deg) + (mean_dev_min/60))
    xlim = np.linspace(30,60,100)

    popt, pcov = curve_fit(func,rad(datax),rad(datay))
    print("\nAngle of prism and Refractive index of the prism from
    fitting:\n",popt,"\n")
    y_cal = np.array(func(rad(xlim),*popt)) * 180/np.pi
```

```
    print(y_cal)
    mini = min_dev(y_cal,xlim)

    plt.style.use("ggplot")
    plt.title("Graph between $\delta$ vs i")
    plt.xlabel('Angle of incidence (i)')
    plt.ylabel('Angle of deviation ($\delta$)')
    plt.scatter(datax,datay,color = "b",label = "Experimental data"
    )
    plt.scatter(mini[0],mini[1],c = "g",label = "Minimum deviation
    point")
    plt.plot(xlim,np.array(func(rad(xlim),*popt) * 180/np.pi),
    color = "r",label = "Fitting curve")
    plt.legend()
    plt.show()
```

9 References

https://vlab.amrita.edu/