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# REFRACTION IN A PRISM - A COMPUTER SIMULATED EXPERIMENT TO CALCULATE THE ANGLES OF DEVIATION AND TO PLOT THE I-D CURVE

By

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## INTRODUCTION

The refraction in a prism is one of the most commonly done experiments in the general physics laboratory sessions. However, it is a time consuming experiment, especially, if sufficient data have to be collected to plot a curve of the angle of incidence against the angle of deviation. The purpose of this note is to describe a computer program that has been developed by the author. It is in Basic language and employs the time sharing computing facilities available at SSC campus, for its execution. Savannah State College has remote terminals connected to the CDC 6400 computer at the University of Georgia in Athens.

A table of data is extracted from the program and the data is used to plot the graph between angles of incidence and angles of deviation. The program is versatile enough so that, for one familiar with programming, with slight modifications wide variety of experiments by altering refractive indices, Prism angle etc. could be simulated.

## FORMULAS

In Figure I is given the path of the light ray through the prism. The various symbols for angles used in Figure I, and in the computer program are explained in Table I. It is well known that the following relations hold good for refraction in a Prism.

$$U = \text{refractive index} = \frac{\sin I}{\sin(R1)} = \frac{\sin(I3)}{\sin Q} \dots(1)$$

$$A = (R1) + Q \dots\dots\dots(2)$$

$$\text{and } I + (I3) = A + D \dots\dots\dots(3)$$

## COMPUTER ANALYSIS

In Appendix I is given a partial computer program. The sub-routine that plots I3 vs D is not included due to space limitation. In appendix II is given a trial run of the program. In appendix III is given a computer plot of I3 vs D. In the author's general physics 202 classes, this program was used to (i) simulate the refraction in a prism experiment and/or use the program to check the experimental results and (ii) to provide individual numerical problems for students to be solved in written tests. Both these approaches were very well received and appreciated by the students. Also (iii) the student's perception of the idea of

minimum deviation is greatly aided both by the tabular data and by the I-D curve.

### SUMMARY

A computer simulated experiment dealing with refraction in a Prism has been developed and class tested successfully at Savannah State College in my physics classes.

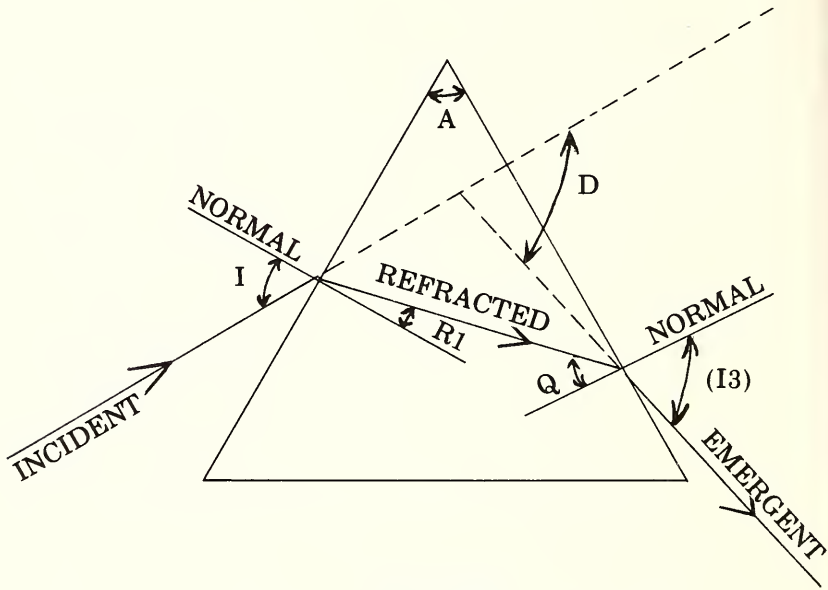


FIGURE I  
REFRACTION IN A PRISM

## TABLE I

A = Prism angle in degree  
A1 = Prism angle in radians  
I = Angle of incidence on Face 1 in degrees  
I1 = Angle of incidence on Face 1 in radians  
R1 = Angle of refraction on Face 1 in degrees  
R = Angle of refraction on Face 1 in radians  
Q = Angle of refraction on Face 2 in degrees  
R2 = Angle of refraction on Face 2 in radians  
I3 = Angle of incidence on Face 2 in degrees  
I2 = Angle of incidence on Face 2 in radians  
D = Angle of deviation in degrees  
D1 = Angle of deviation in radians

### APPENDIX I

A partial listing of the Computer Program (The I-D plot subroutine is excluded due to space limitation)

```
10 Print "Optics: Program 8000"  
20 Print "Ang of Dev for Var Ang of Inc and a Plot of"  
30 Print "I VS D"  
40 Print "Author: Dr. V. Anantha Narayanan"  
50 Print  
60 Print  
80 Print "For further details contact: Dr. V. Anantha Narayanan"  
90 Print "P. O. Box No. 20473, Savannah State College, Savannah"  
100 Print "Ga, 31404. Tel. No. 912-354-5717 Ext. 318"  
110 Print "Office Room No. 212 New Sci. Bldg., Savannah State Coll."  
120 Print "Home Phone No. 912-234-6389"  
150 Print "After? Give a value for U = (The Refractive Index of"  
160 Print "The Material of the Prism)"  
400 Print "This Program Calculates the Angle of Deviation"  
410 Print "In a Prism as a Function of Angle of Incidence"  
478 Print  
479 Print  
480 Print "This Program Was Written by Dr. V. Anantha Narayanan"  
500 Print "On April 10, 1972"  
520 Print  
560 Print  
600 Rem for Simplicity an Equilateral Prism Is Used  
700 Input U  
750 Print "Ref Ind of the Prism =": U  
801 Print "Inc 1 Deg"; Tab(12); "Ref 1 Deg"; Tab(32); "Inc 2 Deg"; Tab(48);  
802 Print "Ref 2 Deg"; Tab(60); "Dev Ang Deg"  
810 Rem I is the Angle of incidence on Face 1 in Degrees  
811 For I = 25 to 89 Step 4  
850 Let I1 = .01745329251994*I  
880 Rem I1 is I converted to radians  
900 Let P=Sin(I1)  
950 Let Q=P/U  
990 Rem Q is Sin(P) Where R is refraction angle on face one  
1000 Rem in radians  
1020 Let R = Atn(Q/SQR(1-Q**2))  
1050 Let R1 = 57.295779513082*R  
1090 Rem R1 is R converted in degrees  
1100 Let A = 60  
1200 Rem A is the prism angle in degrees  
1240 Let AI = A*.01745329251994  
1300 Rem A1 is prism angle converted in radians  
1400 Let R2 = A1-R
```

```

1500 Rem R2 is the angle of refraction on face two in radians
1600 Let Q = 57.295779513082*R2
1700 Rem Q is the angle of refraction on face two in degrees
1800 Let S2 = U*Sin(R2)
1900 Let I2 = Atn(S2/Sqr(1-S2**2))
2000 Rem R2 is the angle of refraction on face two in radians
2100 Let S2 = U*Sin (R2)
2200 Let S2= Sin (I2)
2300 Let I2 = Atn(S2/Sqr(1-S2**2))
2400 Rem S2 is Sin(I2)
2500 Rem S2 is Sin(I2)
2600 Let I2 = Atn(S2/Sqr(1-S2**2))
2800 Let I3 = I2*57.295779513082
2801 Let D1 = I1 + I2-A1
2802 Let D = D1*57.295779513082.
3100 Rem D is ang of deviation in degs and D1 is in radians
3200 Print I; Tab(12); R1; Tab(32); I3; Tab(48); Q; Tab(60); D
3400 Print
3600 Next I
3700 Stop
3800 Return
5000 Rem*****Plot Subroutine

```

## APPENDIX II

Sample run of the Tabular Data

Optics: Program 8000

Ang of dev for var ang of inc and a plot of

I vs D

Author: Dr. V. Anantha Narayanan

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After? Give a Value for U = (The refractive index of the material of the Prism)  
This program calculates the angle of deviation in a prism as a function of angle of incidence

This program was written by Dr. V. Anantha Narayanan on April 10, 1972  
? 1.4563

Ref Ind of the Prism = 1.4563

Inc 1 Deg	Ref 1 Deg	Inc 2 Deg	Ref 2 Deg	Dev ang Deg
25	16.8699	84.629	43.1301	49.629
29	19.4452	71.2357	40.5548	40.2357
33	21.9618	63.8123	38.0382	36.8123
37	24.4091	57.947	35.5909	34.947
41	26.7756	52.9334	33.2244	33.9334
45	29.0485	48.5032	30.9515	33.5032
49	31.2141	44.5285	28.7859	33.5285
53	33.2573	40.9433	26.7427	33.9433
57	35.1621	37.7142	24.8379	34.7142
61	36.9112	34.8269	23.0888	35.8269
65	38.4869	32.2792	21.5131	37.2792
69	39.8711	30.0768	20.1289	39.0768
73	41.0462	28.2301	18.9538	41.2301
77	41.9955	26.752	18.0045	43.752
81	42.7045	25.6554	17.2955	46.6554
85	43.1616	24.9515	16.8384	49.9515
89	43.359	24.6483	16.641	53.6483

### APPENDIX III

#### COMPUTER PLOT OF I VS D

Horizontal Range 33.5032 (.402902) 53.6483

Vertical Range 89 (1.28) 25

