

EXPERIMENT:

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Diffraction Grating

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- Aim: To determine the number of lines in a given grating using a laser source of light.
- APPARATUS REQUIRED: He-Ne laser or semiconducting laser, grating, grating stand, scales.
- FORMULA USED:

$$N = \frac{\sin \theta}{n \lambda}$$

Where,

$N \rightarrow$ The density of lines in the grating (lines/meter OR lines/inch)

$\theta \rightarrow$ Angle of diffraction (degree)

$n \rightarrow$ Order of diffraction

$\lambda \rightarrow$ Wavelength of the laser light used in the experiment (nm)

- RESULT:

The density of lines in the given grating was determined to be
 $N = 2449.82 \approx 2450$ lines/inches.

• OBSERVATION TABLE :

$$\lambda = 660 \text{ nm} = 6.6 \times 10^{-7} \text{ m} = [6.6 \times 39.37] \times 10^{-7} \text{ inches} = 259.842 \times 10^{-7} \text{ in} \\ = 2.59842 \times 10^{-5} \text{ in}$$

Diffraction Order	D (cm)	2L (cm)	L (cm)	$\tan \theta = L/D$	$\theta = \tan^{-1}(L/D)$	$\sin \theta$	Mean $\sin \theta$	N (lines/inch)
1	30	4	2	0.001164	3.8141	0.06652	0.0650	2502.56
	35	4.6	2.3	0.001157	3.7597	0.06557		
	40	5.2	2.6	0.001134	3.7140	0.06486		
	45	5.8	2.9	0.001125	3.6873	0.06431		
	50	6.4	3.2	0.001117	3.6619	0.06387		
2	30	7.6	3.8	0.002211	7.2190	0.12566	0.1275	2453.46
	35	9.2	4.6	0.002294	7.4874	0.13031		
	40	10.4	5.2	0.002264	7.4064	0.12892		
	45	11.4	5.7	0.002211	7.2190	0.12566		
	50	12.8	6.4	0.002234	7.2942	0.12696		
3	30	11.6	5.8	0.003374	10.9422	0.18982	0.1905	2444.00
	35	13.8	6.9	0.003441	11.1524	0.19342		
	40	15.6	7.8	0.003403	11.0342	0.19140		
	45	17	8.5	0.003297	10.6965	0.18561		
	50	19.6	9.8	0.003421	11.0894	0.19234		
4	30	15.6	7.8	0.004538	14.5742	0.25163	0.2534	2438.01
	35	18.6	9.3	0.004638	14.8805	0.25680		
	40	21	10.5	0.004582	14.7083	0.25390		
	45	23	11.5	0.004460	14.3354	0.24760		
	50	26.6	13.3	0.004643	14.8957	0.25706		

Diffraction Order	D (cm)	2L (cm)	L (cm)	$\tan \theta = \left(\frac{L}{D}\right)$	$\theta = \tan^{-1}\left(\frac{L}{D}\right)$	$\sin \theta$	Mean $\sin \theta$	N (Lines/inches)
5	30	19.6	9.8	0.005701	18.0905	0.31052	0.3132	2411.07
	35	23.2	11.6	0.005785	18.3367	0.31460		
	40	26.6	13.3	0.005803	18.3920	0.31552		
	45	29.4	14.7	0.005701	18.0905	0.31052		
	50	33.2	16.6	0.005795	18.3662	0.31509		
Mean								2449.82 ≈ 2450

$$\frac{\sin \theta}{\lambda} = N$$

• CALCULATIONS:

$$\lambda = 2.59842 \times 10^{-5} \text{ in}, N = \frac{\sin \theta}{n \lambda}$$

① n=1:

$$N_1 = \frac{0.0650271}{1 \times 2.59842 \times 10^{-5}} = 2502.5620$$

$$\Rightarrow N_1 = 2502.56 \text{ lines/inch}$$

④ n=4:

$$N_4 = \frac{0.25339891}{4 \times 2.59842 \times 10^{-5}} = 2438.0096$$

$$\Rightarrow N_4 = 2438.01 \text{ lines/inch}$$

② n=2:

$$N_2 = \frac{0.12750250}{2 \times 2.59842 \times 10^{-5}} = 2453.4621$$

$$\Rightarrow N_2 = 2453.46 \text{ lines/inch}$$

⑤ n=5:

$$N_5 = \frac{0.31324840}{5 \times 2.59842 \times 10^{-5}} = 2411.0683$$

$$\Rightarrow N_5 = 2411.07 \text{ lines/inch}$$

③ n=3:

$$N_3 = \frac{0.19051611}{3 \times 2.59842 \times 10^{-5}} = 2443.9945$$

$$\Rightarrow N_3 = 2444.00 \text{ lines/inch}$$

$$N = (N_1 + N_2 + N_3 + N_4 + N_5) / 5 = \frac{12249.1}{5}$$

$$\Rightarrow N = 2449.82 \approx 2450 \text{ lines/inch}$$