Theory :

When a parallel beam of monochromatic light is incident on grating surface, the transmitted light gives rise to primary maximum in certain directions. Now if θ be the angular deviation of light, which forms the n^{th} order, primary maximum and $(a+b)$ be the grating element. Then,

$$(a+b)\sin\theta = n\lambda$$

$$\therefore \sin\theta = nN\lambda$$

Here, $a+b = 1/N$, where N is the number of lines on ruling per cm of the grating surface.

$$\Rightarrow \lambda = \frac{\sin\theta}{nN}$$

The resolving power of diffraction grating is defend as the ratio of the wavelength of any spectral line to the difference in wavelength between this line and neighboring line such that the two lines appear to be just resolved. Thus, the resolving power of a diffraction grating is,

$$\frac{\lambda}{d\lambda} = \frac{\lambda}{\lambda_2 - \lambda_1}$$

Where $d\lambda$ is the smallest difference in wavelength of two lines. By measuring the angel of diffraction of the given light with the help of spectrometer and by knowing the number of lines per cm of the grating surface, the wavelength of a given light and resolving power of grating can be determined from the above eqn. (I) and eqn. (II) respectively.

Apparatus :

(I) Spectrometer
(II) Spirit level
(III) magnifying glass
(IV) grating with clamping arrangement
e.t.c.

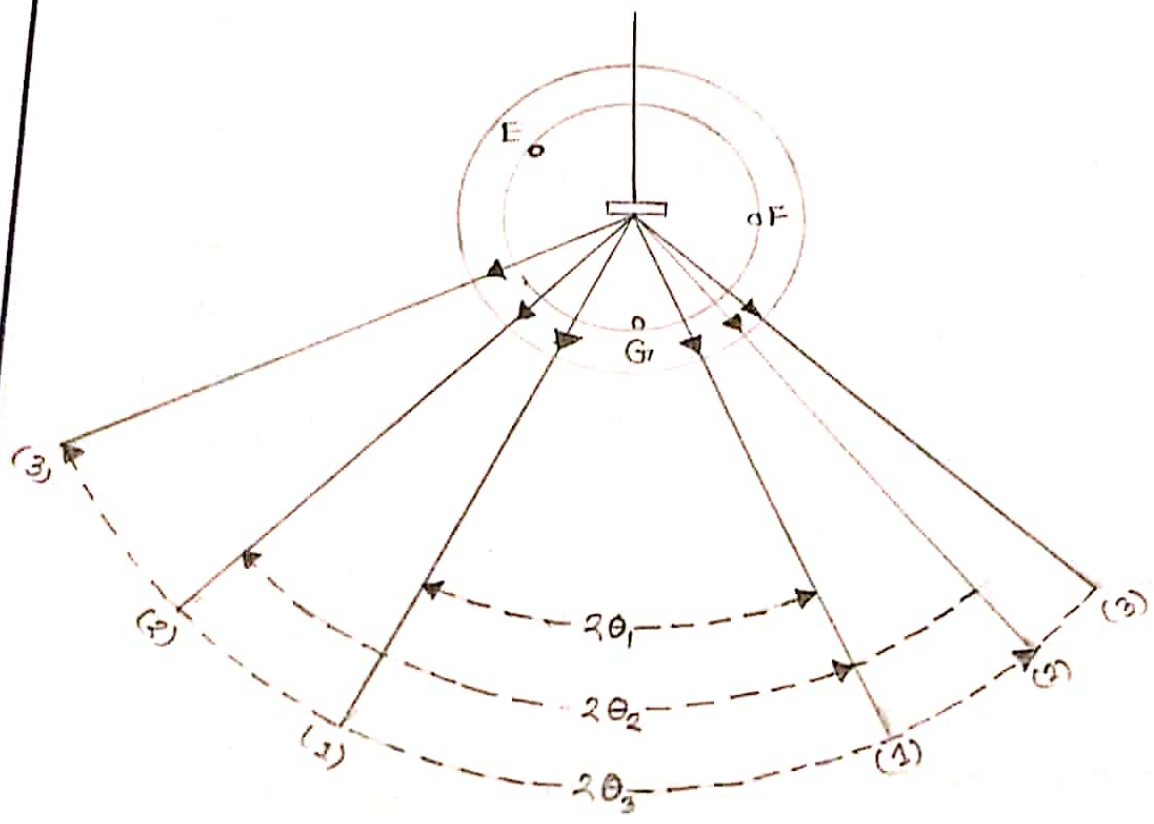

Figure 1 : The angel of diffraction of sodium light due to a plane diffraction grating.

Procedure :

(I) All the adjustments of the spectrometer including focusing for parallel rays were performed Exp. L2.

(II) The grating stand on the circular table with two screws in the holes drilled on one of the lines parallel to the line joining two of the screws was fixed. The face of the stand to which the clamps were attached come at the center of the table. The grating was taken carefully from the box. Holding it from the edge and without touching its surface. ~~fix it reverse~~ fixed very carefully to the frame with its ruled surface towards the telescope.

(III) Optical leveling of the grating table:-

The table carrying the grating was rotated so that the plane of the grating was approximately perpendicular to the collimator. This first order spectrum on one side of the direct image of the slit was looked for. The telescope was turned so that vertical cross-wire coincides with the 1st order diffracted image. If If that image was not symmetrical with respect to the horizontal cross-wire, it was adjusted with the help of one of the screw. In that position the grating lines were parallel to the axis of the spectrometer. The Telescope was turned to the other side that the vertical cross-wire again coincides with the 1st order diffracted image. If the adjustments were carefully done then the diffracted images of the slit would be symmetrical with respect to the horizontal cross-wire in all position.

(III) Setting the grating normal to the incident light :-
This completes the adjustments required for mounting of the grating. The telescope was set on the 1st order of the diffracted image on left side of the direct image. The telescope was focused and the reading was taken. Then the focus telescope on the right diffracted image of the same order was focused and the reading was taken. The difference between those two readings was twice the angle of diffraction for 1st order of image.

(IV) The angle of diffraction's for the 2nd order was similarly measured. During these measurements the width of the slit was as narrow as possible. In the 2nd order 2 slits was observed due to the small difference of two wavelength of sodium light. Inner image was called D_1 and the outer image was called D_2 line. The readings for each diffracted image of sodium D_1 & D_2 line was taken at least three times for three independent settings of the telescope. The cross wires was always focused on the same edge of the image of the slit.

(V) The reading of the scale on both the Venniens was noted. The number of lines per inch as marked on the grating was noted also it was replaced carefully in the box with ruled surface upwards.

Experimental Data :

For example,

Vernier constant of the spectrometer (V.C) :

Value of the smallest circular scale division = 1'

$\therefore$ 1 VSD $= \frac{59}{60}$ MSD

VC = (1 MSD - 1 VSD)

$= 1\,\text{MSD} - \frac{59}{60}\,\text{MSD}$

$= (0.0167)\,\text{MSD} \times 1' = (0.0167 \times \frac{1}{60}) = 2.783 \times 10^{-4}$

Number of lines per inch on the grating surface,

N = 15,000 lines/inch

= 5905.51 lines/cm

Table-1: Data for the angle of diffraction (θ)

Order of Spectrum	Vernier Scale no.	No of Obs.	Reading for left image				Reading for right image				2θ = θ	
			MSR M degree	VD	VSR V = VD×Vc degree	Total reading L = M+V degree	MSR M degree	VD	VSR V = VD×Vc degree	Total reading R = M+V degree	L-R degree	degree
1st Order	V_1	1	152	29	0·4843	116·4843	111	5	0·0835	111·0835	41·64 93	20·83
		2	153	5	0·0835	115·0835	111	20	0·334	111·334	42·746	
		3	152	30	0·501	117·501	111	10	0·167	111·167	41·334	
	V_2	1	332	50	0·835	332·835	291	2	0·0334	291·0334	41·82	
		2	332·5	15	0·2505	332·751	291	10	0·167	291·167	41·58	
		3	33~~7~~	20	0·334	33~~7~~·334	291	30	0·501	291·501	40·833	
2nd Order	D_1 Line V_1	1	178	5	0·0835	178·0835	87·5	19	0·3173	87·8713	90·212	44·87
		2	177	20	0·334	177·334	88	35	0·5845	88·585	88·749	
		3	178	10	0·167	178·0167	87·5	30	0·501	88·001	90·0167	
	V_2	1	358	50	0·835	358·835	2~~6~~8·5	6	0·1002	2~~6~~8·6002	90·25 28	
		2	357	10	0·167	357·167	267·5	40	0·668	268·168	88·99	
		3	358	4	0·0668	358·0668	267·5	21	0·3507	267·8507	90·2161	
	D_2 Line V_1	1	178	10	0·167	178·167	87	16	0·2672	87·2672	90·899 8	45·06
		2	178	20	0·334	178·334	87·5	21	0·3572	87·8572	90·14 28	
		3	178	10	0·167	178·167	87·5	30	0·501	88·001	90·30~~8~~	
	V_2	1	358	10	0·167	358·167	2~~6~~8	35	0·5845	2~~6~~8·5845	89·58	
		2	358	10	0·167	358·167	268	25	0·4175	268·4175	89·74 95	
		3	358	10	0·167	358·167	267·5	35	0·5~~8~~75	268·0875	90·07 95	

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Calculation :

For 1st order image,

Here, Order, $n = 1$

Number of lines per cm on the grating surface,

$N =$

Angel of diffraction, $\theta =$

So, we know from the theory, the wavelength of sodium light is, $\lambda = \frac{\sin\theta}{nN} =$

For 2nd order image,

Here, order, $n = 2$

Angle of diffraction, $\theta_1 =$

$\theta_2 =$

So, $\lambda_1 = \frac{\sin\theta_1}{nN} =$

$\lambda_2 = \frac{\sin\theta_2}{nN} =$

Thus, we know the resolving power of a diffraction grating is, $\frac{\lambda}{d\lambda} = \frac{\lambda}{\lambda_2 - \lambda_1}$

Error Calculation :

Error for the wavelength of sodium light

The theoretical value of the wavelength of sodium light =

The experimental value of the wavelength of sodium light

So, Percentage of error, % = $\left(\frac{\text{Theoretical value} - \text{Experimental value}}{\text{Theoretical value}}\right)$

Error for the resolving power of diffraction grating

Similar as before

Results :

The wavelength of Sodium light λ =

The resolving power of a diffraction grating, $\frac{\lambda}{d\lambda}$ =