DIFFRACTION OF LIGHT

OBJECT:

To determine the wavelength of prominent lines of mercury by plane diffraction grating.

APPARATUS REQUIRED:

A diffraction grating, spectrometer, mercury lamp, prism, reading lens.

FORMULA USED:

The wavelength λ of any spectral lines can be calculated by the formula

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

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

or

where (a + b) = grating element

θ = angle of diffraction

n = order of the spectrum

ADJUSTMENTS:

(A) Before using the spectrometer, the following adjustments are made:

(i) The axis of the telescope and that of the collimator must intersect the principal vertical axis of rotation of telescope.

(ii) Prism table should be levelled.

(iii) Telescope and collimator are adjusted for parallel light by Schuster's method. For the details of these points, see the experiment of refraction and dispersion of light.

(B) Grating should be normal to the axis of collimator:

This adjustment is shown in fig. (1).

(i) Collimator and telescope are arranged in a line and the image of the slit is focused on the vertical cross wire. The reading is noted on both the verniers.

(ii) The telescope is now rotated through 90^o.

(iii) Mount the grating on the prism table and rotate the prism table so that the reflected image is seen on the vertical cross wire. Take the reading on the verniers.

(iv) Turn the prism table from this position through 45^o or 135^o. In this position the grating is normal to the incident beam.

(C) The slit should be adjusted parallel to the lines of the grating:

For this setting, the slit is rotated in its own plane till the spectral lines become very sharp and bright.

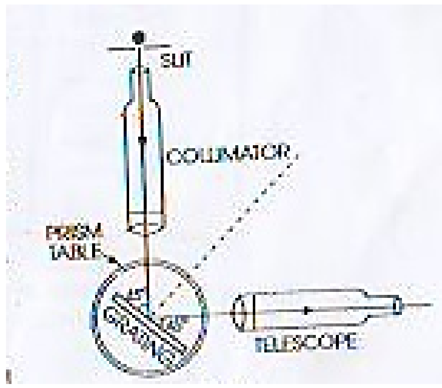


Fig. (1)

PROCEDURE FOR THE DETERMINATION OF ANGLES OF DIFFRACTION:

The spectrum obtained in a grating is shown in fig. (2).

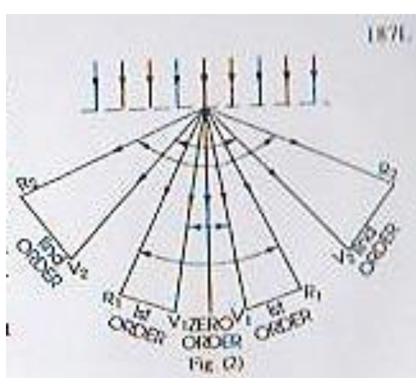
(i) Rotate the telescope to the left side of direct image and adjust the different spectral lines (violet, green and red) turn by turn on the vertical cross wire for 1st order. Note down the reading of both the Vernier in each setting.

(ii) Rotate the telescope further to obtain the second order spectrum and again the spectral lines on the vertical cross wire and note the reading.

(iii) Now rotate the telescope to the right of the direct image and repeat the above procedure for first order as well as for second order.

(iv) Find out the difference of the same kind of Verneirs (V_1 and V_1 and V_2 from V_2) for each spectral line in the first order and then in the second order. The angle is the twice the angle of diffraction for that particular colour. Half of it will be angle of diffraction.

(v) Find out the angles of diffraction for other colours in first and second orders.



OBSERVATIONS:

No. of rulings per inch on the grating N = …

Least count of spectrometer = …

Reading of telescope for direct image = …

Reading of telescope after rotating it through 90^o = …

Reading of circular scale when reflected image is obtained on the cross wire = …

Reading after rotating the prism table through 45^o or 135^o = …

DETERMINATION OF ANGLES OF DIFFRACTION:

Order of Spectrum	**Colour of light**	**Kinds of vernier**	**Spectrum on left side Reading of Telescope**			**Spectrum on right side Reading of Telescope**			**2θ= a-b**	**Mean 0 Degrees**
			M.S. reading	**V.S. reading**	**Total (a) Degrees**	**M.S. reading**	**V.S. reading**	**Total (b) Degrees**		
First	Violet	V_1 V_2	…	…	…	…	…	…	…	…
	Green	V_1 V_2	…	…	…	…	…	…	…	…
	Red	V_1 V_2	…	…	…	…	…	…	…	…
Second	Violet	V_1 V_2	…	…	…	…	…	…	…	…
	Green	V_1 V_2	…	…	…	…	…	…	…	…
	Red	V_1 V_2	…	…	…	…	…	…	…	…

CALCULATIONS:

Grating element (a + b) = 2.54/N = …per cm.

Where N = number of rulings per inch on the grating.

The wavelength of various spectral lines in the first order (n = 1) can be calculated by

$$\lambda = \frac{(a+b)sin\theta}{1} = (a+b)sin\theta$$

λ violet = …A.U.

Calculate λ for other spectral lines.

Wavelength in second order is given by

$$\lambda = \frac{(a+b)sin\theta}{2}$$

λ violet = …A.U.

PROCEDURE:

For the determination of angles of diffraction, the following procedure is adopted.

(i) Rotate the telescope to the left side of direct image and adjust the spectral lines D_1 and D_2 one by one on the cross wire in first order. Note down the readings of both verniers for D_1 and D_2.

(ii) Rotate the telescope further to obtain the second order spectrum. Adjust the cross wire on the spectral lines D_1 and D_2 one by one in second order. Note down the readings of both verniers for D_1 and D_2.

(iii) Now rotate the telescope to the right of direct image and repeat the above procedure for the first order as well as for second order.

(iv) Find the difference of same kind of verniers for the spectral lines in first order and then in the second order. The angle is twice the angle of diffraction. Half of this angle will be the angle of diffraction. In this way the angles of diffraction for D_1 and D_2 in first order and in second order as known.

OBSERVATION:

No. of rulings per inch on the grating. N = …

Least count of the spectrometer = …

Reading of telescope for direct image = …

Reading of circular scale when reflected image is obtained on the cross wire = …

Reading after rotating the prism table through 45^o = …

Table for determination of angle of diffraction.

Order of Spectrum	**Kinds of vernier**	**Specification of the line**	**Spectrum on left side Reading of Telescope**			**Spectrum on right side Reading of Telescope**			**2θ= a-b**	**Mean 0 Degrees**	**dθ**	**Cos θ**
			M.S. reading	**V.S. reading**	**Total (a) Degrees**	**M.S. reading**	**V.S. reading**	**Total (b) Degrees**				
First	V_1 V_2	D_1	…	…	…	…	…	…	…	…	…	…
	V_1 V_2	D_2	…	…	…	…	…	…	…	…	…	…
Second	V_1 V_2	D_3	…	…	…	…	…	…	…	…	…	…
	V_1 V_2	D_4	…	…	…	…	…	… …	… …	… …	…	…

CALCULATIONS:

Grating element

$$(a+b) = \frac{2.54}{N} = \cdots per\ cm.$$

For I^{st} order,

$$\frac{d\theta}{d\lambda} = \frac{1}{(a+b)\cos\theta} = \cdots$$

Also

$$\frac{d\theta}{d\lambda} = \frac{\theta_2-\theta_1}{\lambda_2-\lambda_1} = \cdots$$

For IInd order

$$\frac{d\theta}{d\lambda} = \frac{2}{(a+b)\cos\theta} = \cdots$$

Also

$$\frac{d\theta}{d\lambda} = \frac{\theta_2-\theta_1}{\lambda_2-\lambda_1} = \cdots$$

RESULT:

The dispersive power of grating in first order = … and the second order = ….

The theoretical and experimental values are approximately equal.