EXPERIMENT NO. 2

AIM:- To determine wavelength of Sodium light using plane-transmission grating.

APPARATUS :- Plane transmission grating with its holder, spectrometer, sodium vapour lamp, prism.

BRIEF THEORY:- An arrangement consisting of a large number of equidistant parallel rectangular slits of equal width separated by equal opaque portions is known as a diffraction grating. It is constructed by ruling equidistant parallel lines with a fine diamond point on an optically plane glass plate. There can be about 12,000 to 30,000 lines drawn per inch. Ruled lines act as opaque regions called **OPACITIES** of width ***b*** each. While equal sized spaces among lines act as transparent regions called **TRANSPARANCIES** each of width ***a.***

The factor $a+b$ is called grating constant and its reciprocal $\frac{1}{a+b}$ is number of lines per unit length on grating. If a total N lines are drawn over a grating of length l then $\frac{N}{l} = \frac{1}{a+b}$

Condition for various order Principal maxima

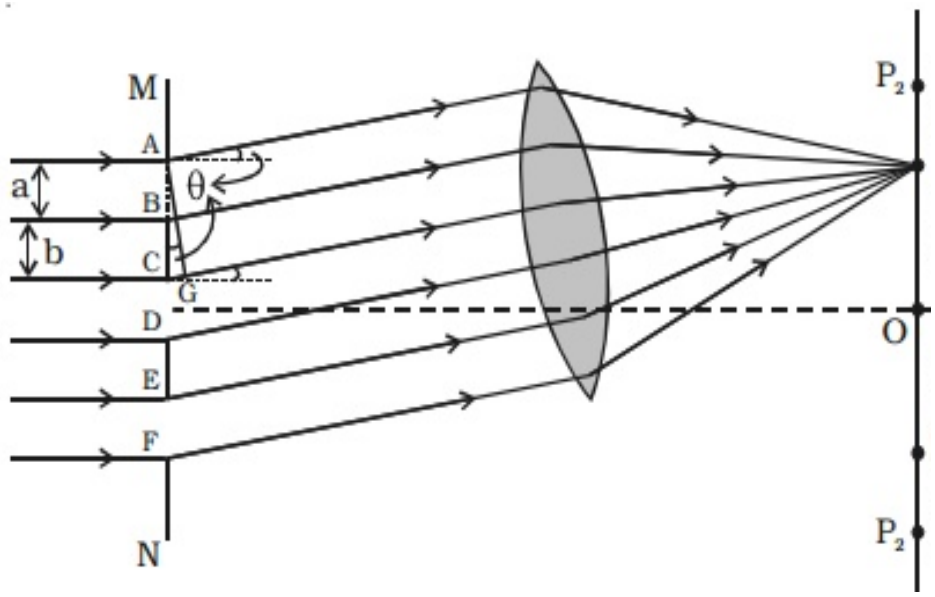
$$(a+b)\sin\theta_n = n\lambda$$

FORMULA USED :-

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

Where, $\boldsymbol{\lambda}$ is wavelength of sodium light, $(\boldsymbol{a+b}) = \frac{\boldsymbol{2.54}}{\boldsymbol{no.of\ lines\ /inch}}$ is grating element and $\boldsymbol{\theta_n}$ is angle of diffraction of n^{th} order, and n is order of spectrum.

Diag:-



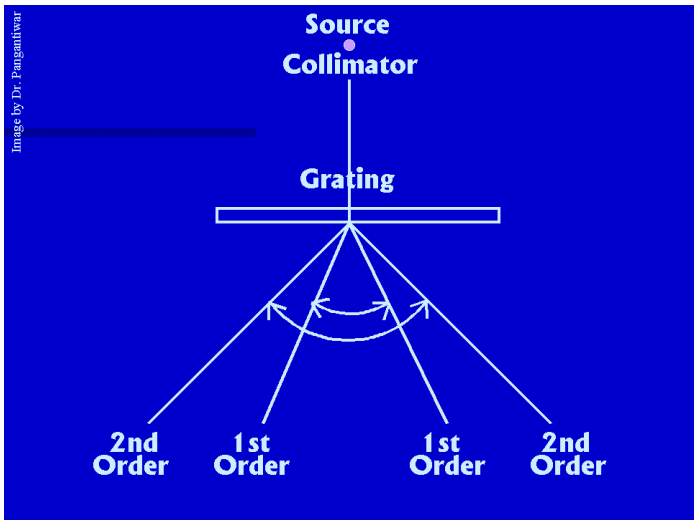
PROCEDURE:-

The spectrometer is set ready for use by doing the following adjustments:-

The spectrometer is set with its collimator towards the source of light. The telescope is brought in line with the collimator. The width of the slit is made sufficiently narrow. The spectrometer is leveled with the help of spirit level such that the image of slit is at the centre of the field of view. The eyepiece of the telescope is adjusted so that cross wires are distinctly visible.

The crosswire tube is rotated such that the vertical crosswire coincides with the image of the slit is obtained. The least count of the instrument is determined. It is taken care that adjustments of the spectrometer are not disturbed subsequently during the experiment.

The telescope is rotated to bring it in line with the collimator to receive the yellow image of the slit on the cross-wires. Now, rotate the telescope up to the first order image of slit on right side and then to the left side. The readings of the positions of the telescope on both sides are noted from both the vernier scales. The difference between the positions on right and the left gives twice the angle of diffraction for the first order ($n = 1$). The telescope is rotated further to get the images belonging to $n = 2$. The difference between the positions of telescopes on the right and the left sides gives twice the angle of diffraction for the second order ($n = 2$). Using the formula, the wavelength of sodium light is calculated.



OBSERVATIONS:-

Diffraction Order (n)	Angular position (Left)	Angular position (Right)	$2\theta_n = \theta_{nL} - \theta_{nR}$	θ_n
1	Vernier-1 $\theta_{1L} =$ ____	Vernier-1 $\theta_{1R} =$ ____		θ_1
	Vernier-2 $\theta_{1L} =$ ____	Vernier-2 $\theta_{1R} =$ ____		θ_1
2	Vernier-1 $\theta_{2L} =$ ____	Vernier-1 $\theta_{2R} =$ ____		θ_2
	Vernier-2 $\theta_{2L} =$ ____	Vernier-2 $\theta_{2R} =$ ____		θ_2

CALCULATIONS:-

$$\theta_1 = average\ of\ \theta_1\ of\ vernier - 1\ and\ vernier - 2$$

$$\theta_2 = average\ of\ \theta_2\ of\ vernier - 1\ and\ vernier - 2$$

Now the wavelength is calculated from both the angles as

$$\boldsymbol{\lambda_1 = \frac{(a+b)sin\theta_1}{1}}$$

$$\boldsymbol{\lambda_2 = \frac{(a+b)sin\theta_2}{2}}$$

$$\boldsymbol{\lambda = \frac{\lambda_1 + \lambda_2}{2}}$$

RESULT:-

The wavelength of yellow line of sodium light is $\boldsymbol{\lambda =}$ _____ A^0.

PRECAUTIONS:-

1. The prism table should be properly leveled.
2. Grating surface is never touched while handling it.
3. Grating should be mounted with its lines parallel to the slit or vertical wire of the cross wires.
4. Prism table should not be disturbed while rotating the telescope to receive images of different orders.
5. Telescope should be rotated slowly; otherwise there is a possibility of missing an order.

Questions for viva-voce:

1. What is diffraction and what is difference between diffraction and interference?
2. What are two types of diffractions?
3. What is a grating and how is it constructed?
4. Find the grating constant for a grating with 1500 lines per inch.
5. What kind of pattern is formed if grating is exposed to white light?
6. Why the central maximum of any diffraction pattern is of double width than the width of others?
7. What is the difference between spectrum of a grating and spectrum of a prism?
8. In double slit fraunhofer diffraction, some of the interference fringes are absent. Why?
9. Which nature of light is depicted with the diffraction of light?
10. Give the examples of the phenomena which are based on wave nature, phenomena which are based on particle nature and phenomena which can be explained by either of the two nature of light?