

Experiment No. -----

Aim: To determine the wavelength of sodium light with diffraction grating.

Apparatus Required: -

S. No.	Name of Apparatus	Specifications	Quantity
1.	Spectrometer	Standard	1
2.	Diffraction Grating	15,000 LPI	1
3.	Sodium Lamp	Monochromatic	1
4	Magnifying Glass	-	1
5.	Spirit Level	-	1

Theoretical Background: -

A diffraction grating is an optical device consisting of a large number of equally spaced parallel slits (or lines). When monochromatic light passes through these slits, each slit acts as a source of secondary wavelets according to Huygens' principle. These waves interfere with each other, producing a pattern of bright and dark fringes known as a diffraction pattern.

Constructive interference (bright fringes) occurs when the path difference between light waves from adjacent slits is an integral multiple of the wavelength.

Mathematically, the condition for principal maxima is:

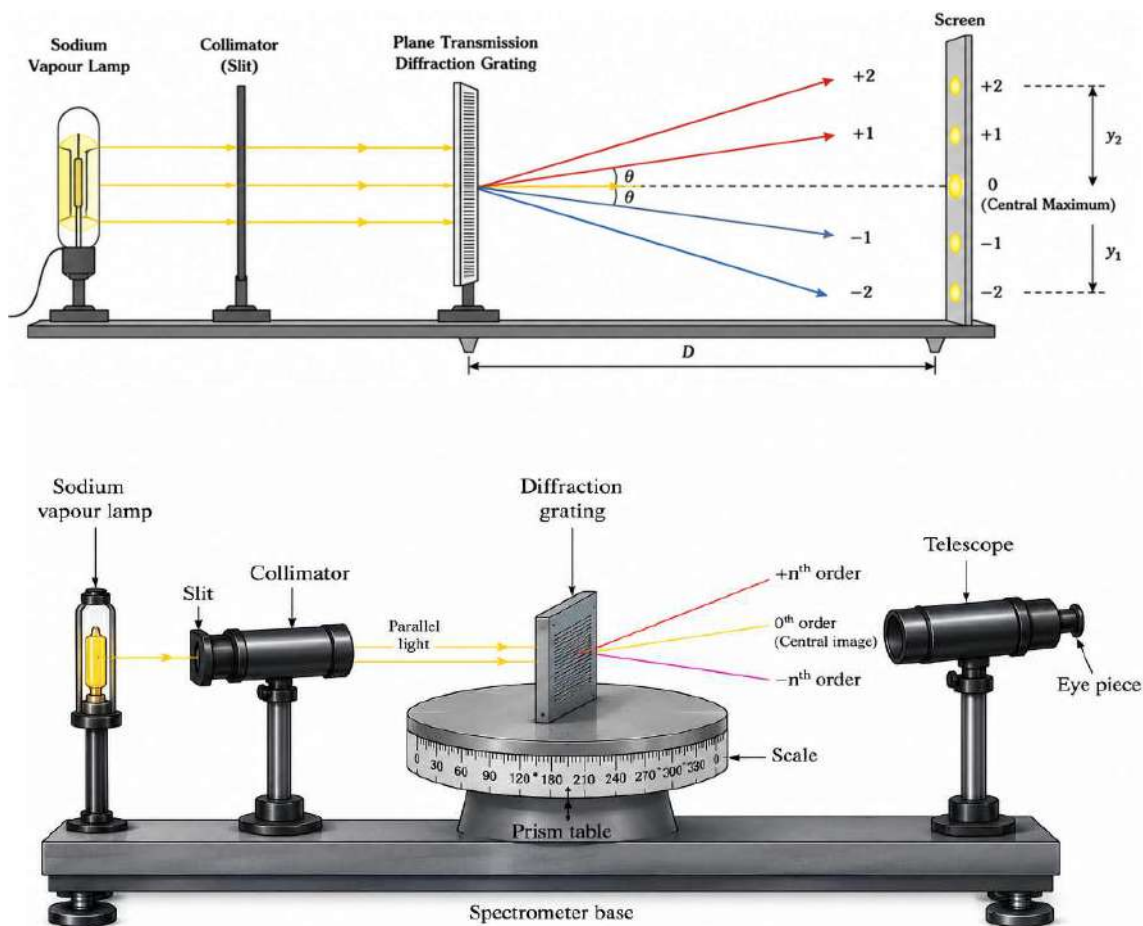
$$d \sin \theta = n \lambda$$

where,

- d = grating element (distance between the centres of two adjacent slits),
- θ = angle of diffraction,
- n = order of diffraction spectrum.
- λ = wavelength of light.

Therefore, $\lambda = \frac{d \sin \theta}{n}$

Experimental Setup: -



Experimental setup for determination of wavelength of sodium light using a diffraction grating and spectrometer

Procedure

1. Arrange the sodium vapour lamp, diffraction grating, and optical bench as shown in the experimental setup.
2. Switch on the sodium vapour lamp and allow it to warm up for a few minutes to obtain a stable yellow monochromatic light.
3. Mount the diffraction grating vertically on the optical bench and ensure that light from the sodium lamp falls normally on it.
4. Use the spirit level and the levelling screws to make the grating table horizontal.
5. Observe the central maximum and the diffraction maxima formed on both sides of it.
6. Rotate the telescope from the central (zero-order) maximum towards the left. You will see the first bright yellow image of the slit — this is the **1st order maximum ($n = 1$)** on the left side.

7. Bring the cross-wire exactly on this image and note the angle reading on both verniers (V_1 and V_2).
8. Rotate the telescope to the right and similarly find the 1st order maximum on the right side. Record its angle.
9. Continue rotating further right (and left) to find the **2nd order maximum ($n = 2$)** on both sides. Record all readings.
10. Calculate the diffraction angle (θ) using the measured angular positions.
11. Determine the wavelength of sodium light using the grating equation.

Observation Table:

Least count of vernier scale -

Order of Spectrum	Vernier	Spectrum Left of Direct Image			Spectrum Right of Direct Image			$2\theta = \theta_2 - \theta_1$	θ
		MSR	VSR	Total θ_1	MSR	VSR	Total θ_2		
1	V_1								
	V_2								
2	V_1								
	V_2								

Calculation: -

1. Determination of the grating element (d):

$$N * d = 1 \text{ inch} = 2.54 \text{ cm}$$

$$d = 2.54 / N \text{ cm} \quad (N=15000)$$

$$d = 1.69 \times 10^{-4} \text{ cm}$$

2. Determination of Wavelength (λ)

$$\text{Since, } \lambda = d \sin \theta / n$$

• For First Order ($n = 1$):

$$\lambda_1 = \dots\dots\dots \text{ cm}$$

$$\lambda_1 = \dots\dots\dots \text{ \AA}$$

• **For Second Spectrum (n = 2):**

$\lambda_2 = \dots\dots\dots \text{cm}$

$\lambda_2 = \dots\dots\dots \text{\AA}$

• **Mean wavelength:**

Mean $\lambda = (\lambda_1 + \lambda_2) / 2 = \dots\dots\dots \text{\AA}$

Result: -

The mean wavelength of sodium light = $\dots\dots\dots \text{\AA}$

Interpretation of Result:

$$\begin{aligned} \% \text{ Error} &= \frac{\text{Calculated Value} - \text{Standard Value}}{\text{Standard Value}} \\ &= \dots\dots\dots \end{aligned}$$

Precautions: -

Careful experimentation greatly improves the accuracy of the result. Follow these precautions:

1. Keep the spectrometer properly leveled.
2. Focus the telescope and collimator accurately.
3. Use a narrow slit for a sharp spectrum.
4. Avoid touching the ruled surface of the diffraction grating.
5. Keep the grating perfectly vertical.
6. Remove parallax before taking readings.
7. Record both left and right readings carefully.
8. Read the vernier scale without estimation errors.
9. Repeat observations for better accuracy.
10. Perform the experiment in a dimly lit laboratory.

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