Experiment - 3

Aim :

a) To determine the number of lines per millimeter of the grating using the green line of the mercury spectrum.

b) To calculate the wavelength of the other prominent lines of mercury by normal incidence method.

Apparatus :

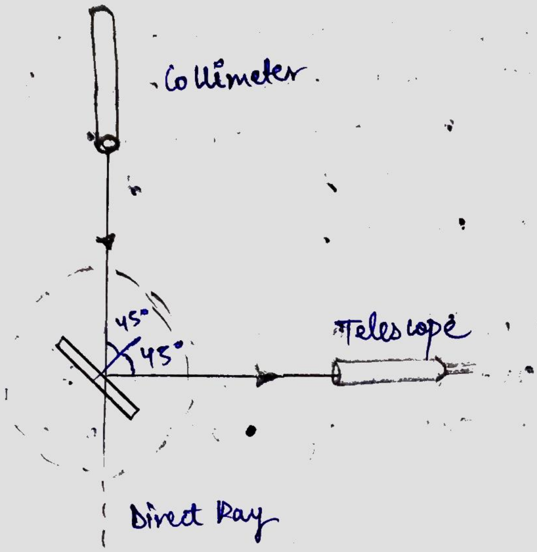
Spectrometer, diffraction grating element, mercury vapor lamp.
Virtual Lab Simulator

Theory :

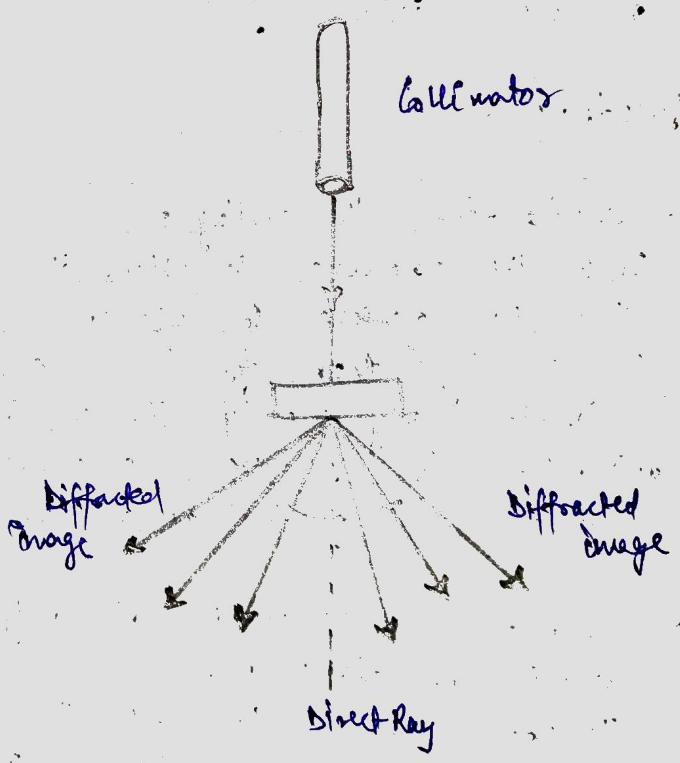
Diffraction Grating - arrangement of large number of equidistant and parallel slits which splits and diffracts light into several beams travelling in different directions. At normal incidence,

$$\sin(\theta) = Nn\lambda$$

where, $N \rightarrow$ no. of lines per unit length of the grating.
$n \rightarrow$ order of spectrum.
$\lambda \rightarrow$ wavelength of light.
$\theta \rightarrow$ diffraction angle.



Collimeter
45°
45°
Telescope
Direct Ray



Collimator
Diffracted image
Diffracted image
Direct Ray

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When waves pass through a gap, which is about as wide as the wavelength they spread out into the region beyond the gap. Huygens considered each point along a wave front to be the source of a secondary disturbance that forms a semi-circular wavelet.

Diffraction is due to the superposition of such secondary wavelets. These spreads and overlap each other interfering with each other to form a pattern of maximum and minimum intensity.

Procedure :

→ To standardize the grating :

1) Turn the telescope to obtain the image of the slit.
2) Turn the telescope to left and right side, note the readings ~~from~~ for green color.
3) Calculate difference in the reading to obtain diffraction angle. Hence calculate no. of lines per unit length of the grating can be calculated.

→ To calculate the wavelength of different lines :

1) obtain the direct image.
2) Telescope is moved to make the cross-wire coincide with each line of the spectrum.
3) Note the readings on the vernier and calculate

Teacher's Signature:

Green colour :

	V_1			V_2		
	MS	VS	Total	MS	VS	Total
Left	340.5	8	340.633	160.5	27	160.95
Right	19	2	19.033	199	10	199.166
Difference (2θ)			321.6			38.216

$V_1 - V_1' = 360 - 321.6 = 38.4$

$V_2 - V_2' = 38.216$

$$\theta_{mean} = \frac{19.2 + 19.108}{2} = 19.154$$

no. of lines per millimeter,

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

$n = 1, \; \lambda_{green} = 546.1 \, nm$,

$$N = \frac{0.328108}{1 \times 546.1} = 600.82.$$

the diffraction angle.

4) Then calculate the wavelength of each colour.

Calculation :

Yellow :

$$V_1 - V_1' = 360 - (339.566 - 20.1) = 20.267$$

$$V_2 - V_2' = 200.066 - 159.533 = 20.2665$$

$$\theta_{mean} = 20.26675$$

$$\lambda = \frac{\sin \theta_{mean}}{nN} = \frac{0.346391}{600.82} = 576.53.$$

Blue :

$$V_1 - V_1' = 360 - (342.6 - 17.033) = 34.433$$

$$V_2 - V_2' = 197.166 - 162.583 = 34.583$$

$$\theta_{mean} = 17.254$$

$$\lambda = \frac{0.296608}{600.82} = 493.67.$$

Violet :

$$V_1 - V_1' = 360 - (345.6 - 14.033) = 28.433$$

$$V_2 - V_2' = 194.166 - 165.566 = 28.6$$

$$\theta_{mean} = 14.258$$

$$\lambda = \frac{0.246293}{600.82} = 409.92$$

Result :

Wavelength of yellow, blue, and violet line comes out to be 576.53 nm, 493.67 nm, and 409.92 nm respectively.

- Determination of wavelength of prominent lines

Color	Left		Right		θ_{mean}	λ
	V_1	V_2	V_1	V_2		
Yellow	339.566	159.53	20.1	20.06	20.26	576.53
Blue	342.6	162.58	17.03	197.16	17.25	493.67
Violet	345.6	165.56	14.03	194.16	14.26	409.92

Least Count of spectrometer $= \left(\frac{N}{V}\right) = \left(\frac{1}{60}\right)^\circ$

Total Reading = MS + VS * Least Count.