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EXPERIMENT 6

AIM:- To determine the wavelength of a given laser source by forming diffraction pattern with a plane transmission grating

THEORY :- The laser diode module and laser detector are mounted in place of collimator and telescope of a spectrometer respectively. The grating is mounted on prism base of the spectrometer. The emitted laser beam diffracted by grating. The diffraction pattern can be seen one move by holding it at the place of detector. Here one can notice the decrease in the intensity of light as one move away from the zero order towards the higher orders.

Now wavelength (λ) of the laser light is obtained from the relation -

$$d \sin\theta = m\lambda$$

$$\text{or } \lambda = \frac{d \sin\theta}{m}$$

$$\text{or } \lambda = \frac{\sin\theta}{mn} \quad (\text{where } d = 1/n)$$

where, d = grating element
θ = angle of diffraction
m = order of spectrum
λ = wavelength of light
n = number of rulling per unit length

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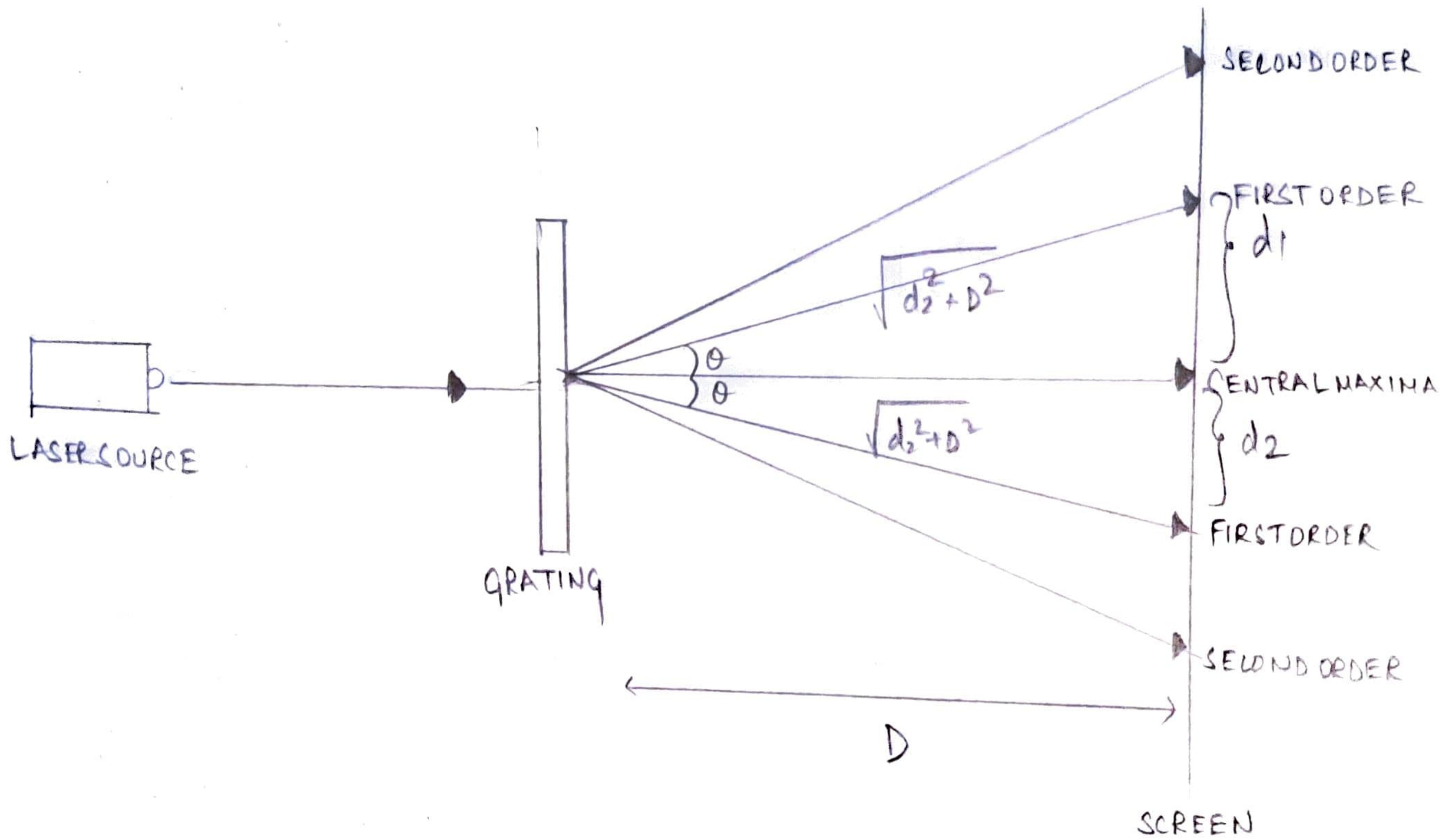
SECOND ORDER
FIRST ORDER
d1
$\sqrt{d_2^2 + D^2}$
θ
θ
CENTRAL MAXIMA
$\sqrt{d_2^2 + D^2}$
d2
FIRST ORDER
SECOND ORDER
LASER SOURCE
GRATING
D
SCREEN

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APPARATUS : (a) Diffraction grating
(b) Laser source
(c) Screen

OBSERVATION TABLES :

FOR GREEN LIGHT :

SL NO	ORDER	LHS d_1 (in cm)	RHS d_2 (in cm)	MEAN $d = \frac{d_1+d_2}{2}$ (cm)	$\sin\theta = \frac{d}{\sqrt{d^2+D^2}}$	$\lambda = \frac{\sin\theta}{mn}$ (in cm)	λ in mm
1	1	80	80	80	0.1576	0.1576/3000 = 0.0000525	525
2	2	170	170	170	0.3219	0.3219/3000 ×2 = 0.0000536	536
3	3	270	270	270	0.4751	0.4751/3000 ×3 = 0.0000527	527
4	4	410	410	410	0.6340	0.6340/3000 ×4 = 0.0000528	528

Mean of all wavelength for green light is 529 nm

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Percentage error for green light

$$\frac{\text{Difference b/w observed } \lambda \text{ and taken } \lambda}{\lambda \text{ taken}} \times 100$$

$$= \frac{532 - 529}{532} \times 100 = 0.56\%$$

FOR RED LIGHT

SL NO	ORDER	LHS d_1 (in cm)	RHS d_2 (in cm)	MEAN $d = \frac{d_1+d_2}{2}$ (cm)	$\sin\theta = \frac{d}{\sqrt{d^2+D^2}}$	$\lambda = \frac{\sin\theta}{Nn}$ (in cm)	λ in nm.
1	1	110	110	110	0.214	0.214/3000 =0.0000713	713
2	2	230	230	230	0.417	0.417/3000×2 = 0.0000695	695
3	3	410	410	410	~~00~~ 0.634	0.634/3000×3 =0.0000704	704

The mean wavelength of red light = 704 nm

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Percentage error $= \frac{704 - 700}{700} \times 100 = 0.57\%$

FOR LIGHT BLUE LIGHT

SL.NO.	ORDER	LHS d_1 (in cm)	RHS d_2 (in cm)	MEAN $d = \frac{d_1+d_2}{2}$ (cm)	$\sin\theta = \frac{d}{\sqrt{d^2+D^2}}$	$\lambda = \frac{\sin\theta}{mn}$ (in cm)	λ in nm
1	1	70	70	70	0.138	0.318/3000 =	472
2	2	160	160	160	0.304	0.304/3000×2 =0.0000506	506
3	3	250	250	250	0.447	0.447/3000×3 =0.0000496	496
4	4	370	370	370	0.594	0.594/3000×4 =0.0000495	495

The mean wavelength of light blue light is 492.25 nm

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Percentage error $= \frac{497.5 - 492.25}{497.5} \times 100 = 1.05\%$

FOR DARK BLUE LIGHT

SL NO	ORDER	LHS d_1 (in cm)	RHS d_2 (in cm)	MEAN $d = \frac{d_1+d_2}{2}$ (cm)	$\sin\theta = \frac{d}{\sqrt{d^2+D^2}}$	$\lambda = \frac{\sin\theta}{Nn}$ (cm)	λ in nm
1	1	60	60	60	0.119	0.119/3000 0.0000396	396
2	2	120	120	120	0.233	0.233/3000×2 0.0000388	388
3	3	190	190	190	0.355	0.355/3000×3 =0.0000394	394
4	4	270	270	270	0.475	0.475/3000×4 0.0000395	395
5	5	370	370	370	0.594	0.594/3000×5 0.0000396	396

The mean wavelength of dark blue light is 393.8 nm

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Percentage error $= \frac{400 - 393.8}{400} \times 100$

$= 1.5\ \%$