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Experiment No :-> 04 :

1) Aim :-> To measure the wavelength of yellow line of mercury light using plane diffraction grating

2) Apparatus Required :-> Spectrometer, Diffraction Grating, Mercury Light, Spirit Level, Magnifying Glass.

3) Theory :->

A Diffraction Grating is an optical component with a periodic structure of a large number of parallel & closely spaced slits & diffracts light into several beams travelling in different direction

4) Condition for Principal Maxima

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

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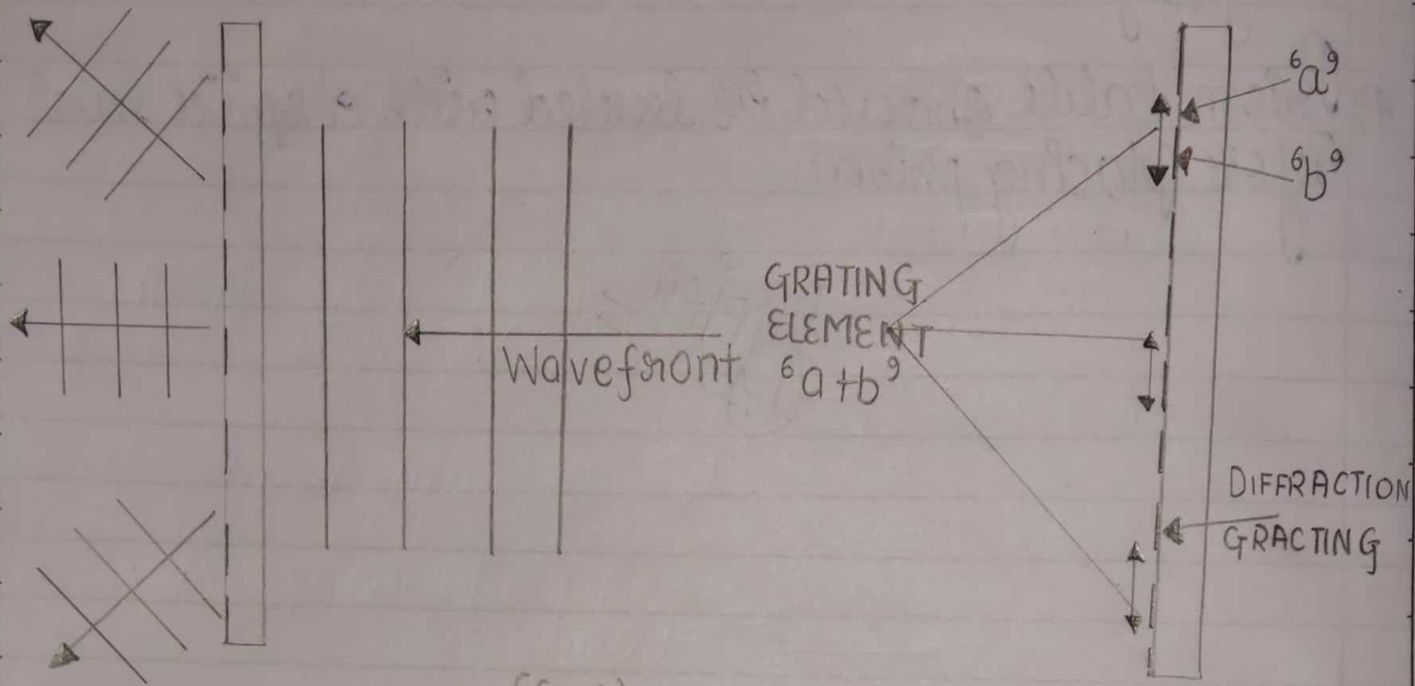
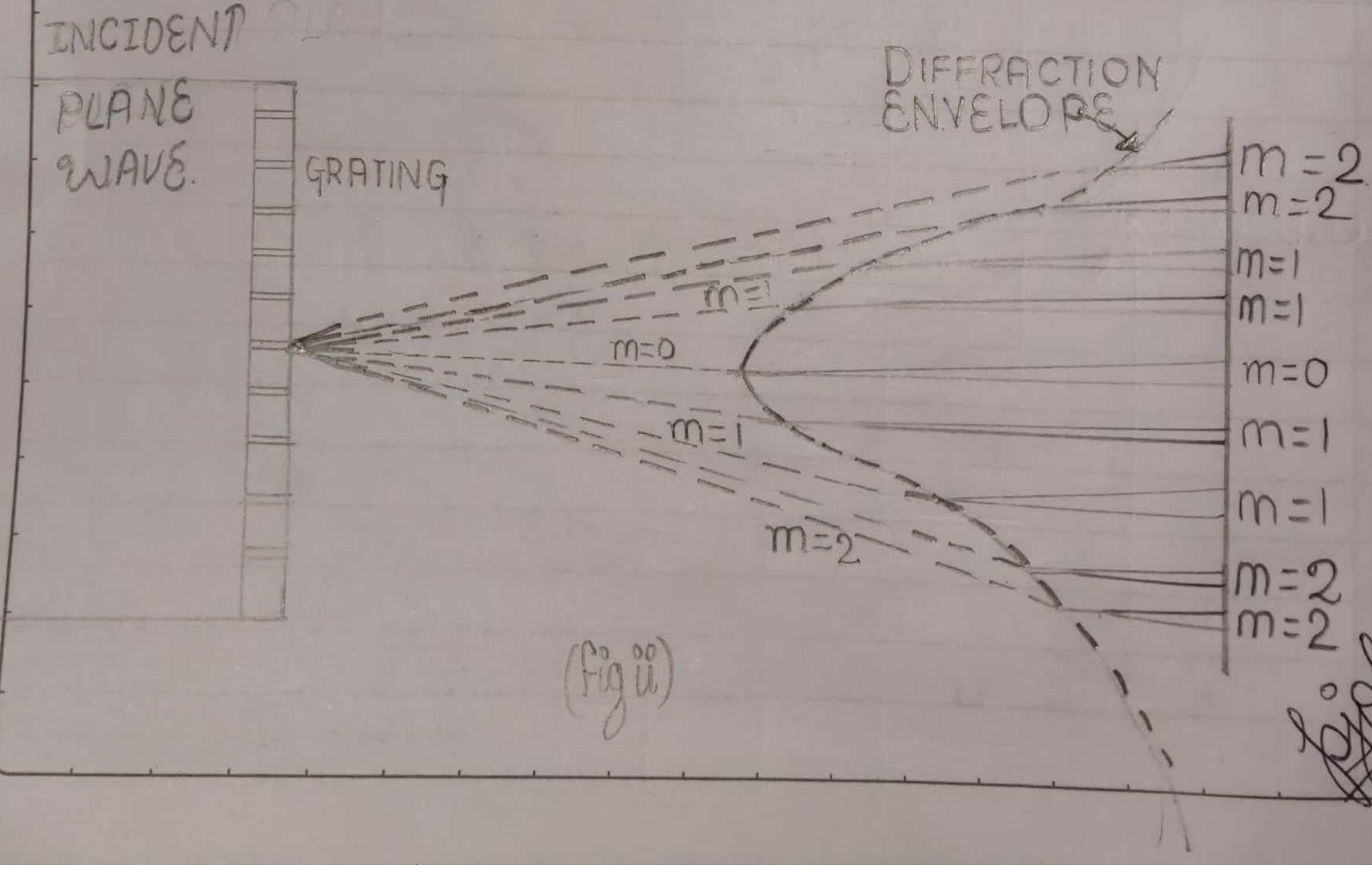


(fig i)



(fig ii)

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5.) **Formula Used:->** $n\lambda_r = (a+b)\sin\theta_n$

To find $(a+b)$ we take $\lambda_r = \lambda_s$ for Green colour Line, where

λ_r = Experimental Wavelength

λ_s = Standard Wavelength

$a+b$ = Grating Element Length

θ_n = Angle of Diffraction

n = Order of Maxima

Least count of Spectrometer:->

Least count of Spectrometer :=> $\frac{1 MSD}{\text{No of divisions on Vernier Scale}}$

As $20 MSD = 10°$

$1 MSD = \left(\frac{10}{20}\right)° \Rightarrow \left(\frac{1}{2}\right)°$

No of vernier divisions = 30

Least count $= \left(\frac{1}{60}\right)°$ = 1minute.

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Observation Table:-> (for n=1)

Spectral Line		Angular position for spectral line: Left Side (deg) MSD	VSD	Total	Right side (deg) MSD	VSD	Total	2θ	Angle of Diffraction (θ)	Exp (λ) λr (A°)	Standard (λs) (A°)	% deviation
VIOLET	V_1	345	8	345.13	15	4	15.066	29.9327	14.966			
	V_2	165	6	165.10	195	2	195.03	29.933	14.966	4339.2	4387	1.08%
									14.966			
GREEN	V_1	341	8	341.13	19	4	19.066	37.933	18.9665			
	V_2	161	6	161.10	199	1	199.0166	37.9166	18.958325	5460	5460	0%
									18.962425			
YELLOW	V_1	340	4	340.06	20	6	20.1	40.04	20.012			
	V_2	160	2	160.03	200	4	200.06	40.03	20.06	5751.6	5790	0.66%
									20.0175			

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Percentage Deviation = $\left|\frac{\lambda_r - \lambda_s}{\lambda_s}\right| \times 100\%$

where, λ_r = Experimental Wavelength

λ_s = Standard Wavelength

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Calculations :->

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

→ To find (a+b) we take (n=1)

$\lambda = \lambda_s$ of green line $= 5460 A^\circ$

θ_n = Angle of diffraction of Green Line of Order (n)=1

$$a+b = \frac{5460 \times 10^{-10}\ m}{\sin(\theta_n)}$$

$\theta_n = 18.9624125^\circ$

$$a+b = \frac{5460 \times 10^{-10}}{\sin(18.9624125^\circ)}$$

$$a+b = 1.680269877 \times 10^{-06}\ m$$

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for $n=1$

As $(a+b) = 1.680269877 \times 10^{-6} m$

$n(\lambda_r \text{ of Yellow}) = (a+b) \sin(\theta_n)$

$1(\lambda_r \text{ of Yellow}) = 1.680269877 \times \sin(20.0175^\circ)$

$\lambda_r = 5751.68376 \times 10^{-10} m$

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For n=2

Spectral Line		ANGULAR POSITION (in degrees) Left side			Right Side			(in degrees) 2θ	Angle of diffraction (in degrees) θ	λ_r (A°)	λ_s (A°)	% deviation
		MSD	VSD	TOTAL	MSD	VSD	TOTAL					
Violet	V_1	328	2	328.03	31	12	31.2	63.17	31.585 + 31.905 = 31.745	4420.28	4387 Å	0.75860 %
	V_2	148	21	148.35	212	10	212.16	63.8				
Green	V_1	319	1	319.0166	41	10	41.16	82.1434	41.0717 + 40.4835 = 40.7776	5487.12	5460 Å	0.49670 %
	V_2	139	11	139.183	220	9	220.15	80.967				
Yellow	V_1	316	12	316.2	44	8	44.13	87.93	43.965 + 43.95835 = 43.961675	5832.02	5790 Å	0.72573 %
	V_2	136	11	136.1833	224	6	224.10	87.9167				

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Calculations for $n=2$.

Here $a+b = 1.680269877 \times 10^{-6}$ m

So,

$n(\lambda_r \text{ of yellow}) = (a+b)\sin\theta_{ny}$

θ_{ny} = Angle of diffraction of Yellow line

$n = 2$.

$2(\lambda_r \text{ of yellow}) = 1.680269877 \times 10^{-6} \times \sin(43.961675°)$

$\lambda_r \text{ of Yellow} = \dfrac{1.166404787 \times 10^{-06}}{2}$

$\lambda_r = 5832.023937 \times 10^{-10}$ m

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$$\text{Mean} = \left(\frac{\text{Sum of all values}}{2}\right)$$

$$\text{Mean} = \left(\frac{5832.023937 + 5751.6}{2}\right) \times 10^{-10}$$

$$\text{Mean} = 5791.811969\,\text{Å}$$

Result:- The Wavelength of Yellow line of mercury light comes out to be using plane diffraction grating is ⇒ (5791.811969 Å) Ans

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Result:-> The wavelength of yellow line of mercury light comes out to be using plane diffraction grating is $\boxed{5791.811969 \text{Å}}$ ANS

Percentage Error:->

Percentage error = $\left|\frac{\lambda_r - \lambda_s}{\lambda_s}\right| \times 100\%$ where λ_r = experimental wavelength, λ_s = standard wavelength

% error in wavelength of Yellow line

$$\left|\frac{5791.811969 - 5790}{5790}\right| \times 100\%$$

$= \underline{0.0312948011\%}$

Precautions and Sources of error:->

1.) The telescope must be so adjusted as to receive parallel rays and form a well defined image of the slit on the crosswire

2.) The slit should be as narrow as possible and parallel to the ruled surface of the grating

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3) While taking the observations of the spectral lines, the grating ~~~~ table must be clamped

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