SAP ID - 60004200132
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(Module 1)

Diffraction Grating

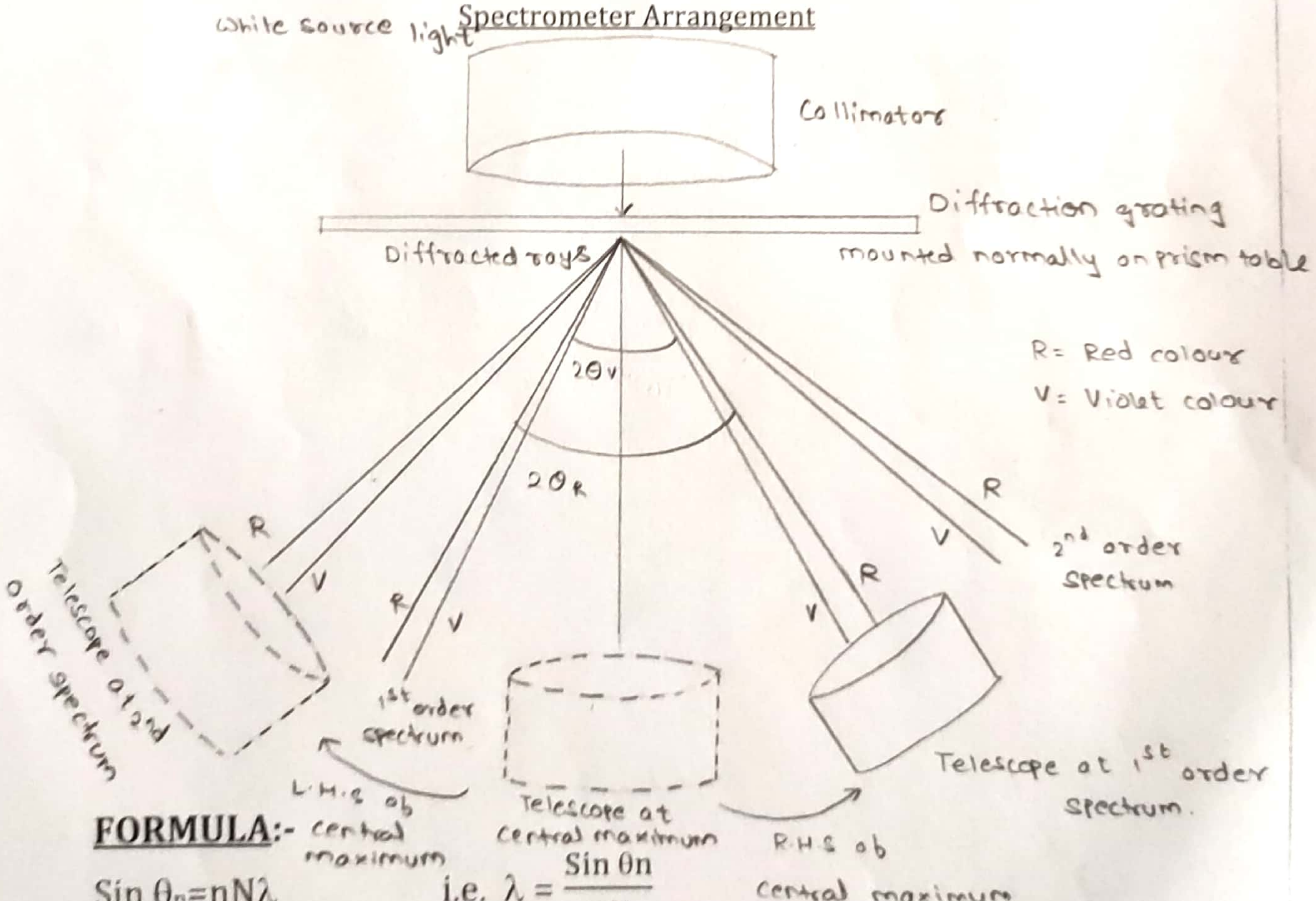
DJ19FEC202.1: Apply the foundations of Optics and Photonics in development of modern communication technology.

AIM: - To find the wavelength of given source using plane diffraction grating.

APPARATUS: - Diffraction grating, Spectrometer, prism, white light source, spirit level.

DIAGRAM:-

Spectrometer Arrangement



FORMULA:-

$\sin\theta_n = nN\lambda$ i.e. $\lambda = \dfrac{\sin\theta n}{nN}$

Where, n =Order of spectrum
λ = wavelength of light
θ = diffraction angle for n^{th} order maximum/spectrum.
N=Number of lines per cm grating = $\frac{15000}{2.54}$ = 5906 lines /cm

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PROCEDURE:-

1. Do leveling of spectrometer. Follow Schuster's method for parallel light adjustment. Then do the NORMAL MOUNTING of diffraction grating on prism table. NOW LOCK THE PRISM TABLE. DON'T LOOSE IT THROUGOUT THE EXPERIMENT.
2. Observe central maximum by keeping telescope in line with collimator. Then observe 1st or 2nd order maxima/spectra on both sides of central maximum by moving telescope to both sides. The two yellow lines, two red lines, two green lines, etc. will be clearly visible & parallel to vertical crosswire.
3. Set the telescope on 1st order slit images (i.e. 1st order spectrum) on any one side. Coincide vertical crosswire with yellow line (midway between the yellow doublets) & note down spectrometer reading in a considered window. (Take all readings from this window only –W_1 or W_2.Then coincide vertical crosswire with red/green/violet line & note down spectrometer reading.
4. Take similar readings for 1st order spectra on other side of central maximum.
5. From proper tabulation of readings determine diffraction angles θ_1 (1st order diffraction angle) for respective lines.
6. From formula calculate the wavelength of corresponding lines.

OBSERVATIONS:-

Least count of spectrometer = L.C. = $\frac{\textit{smallest division valueon main scale}}{\textit{no.of divisions on vernier scale}} = \frac{10'}{60} = 10''$

L.C. = $10''$

Spectrometer reading = M.S.R. + (C.D. × L.C.)

Where, M.S.R. =main scale reading C.D. =coinciding division number

{Remember ------------------------→**1° = 60' and 1' =60"**}

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OBSERVATION TABLE: -

N=Number of lines per cm grating =15000/2.54 = 5906 lines /cm

n= order of spectrum

Order of spectrum 'n'	Spectral line /colour in n^{th} order spectrum	Use any one window W1 OR W2 — Spectrometer reading in window when... ...Telescope at L.H.S. of central maximum (P)	...Telescope at R.H.S. of central maximum (Q)	Angle between spectral images of same order $2\theta_n = P \sim Q$	Diffraction Angle θ_n
1	Blue	162.00277'	192.0138'	30.0110'	θ_{1B} 15.0055
	Green	159.39444'	197.50277'	38.1083'	θ_{1G} 19.05421
	Yellow	156.673671'	197.34861'	40.675'	θ_{1Y} 20.3375
	Red	155.57055'	198.54166'	43.0311	θ_{1R} 21.5155

CALCULATIONS:-

1. θ_1 for Blue = 15.055, hence $\lambda_{blue} = \frac{\sin\theta_{1B}}{nN}$ = ______ = 4.38×10^{-5} cm

Thus λ_{blue} = 4.38×10^{-5} cm = 4.380×10^{3} A°

2. θ_1 for Green = 19.0542, hence $\lambda_{green} = \frac{\sin\theta_{1G}}{nN}$ = ______ = 5.52×10^{-5} cm

Thus λ_{green} = 5.52×10^{-5} cm = 5520 A°

3. θ_1 for Yellow = 20.337, hence $\lambda_{Yellow} = \frac{\sin\theta_{1Y}}{nN}$ = ______ = 5.884×10^{5} cm

Thus λ_{yellow} = 5.884×10^{-5} cm = 5884 A°

4. θ_1 for Red = 21.515, hence $\lambda_{red} = \frac{\sin\theta_{1R}}{nN}$ = ______ = 6.209×10^{-5} cm

Thus λ_{red} = 6.209×10^{-5} cm = 6.209×10^{3} A°

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RESULT:-

It is found that wavelengths of following colours in white lamp radiation are

λ_{blue} = 4380 A°

λ_{green} = 5520 A°

λ_{yellow} = 5884 A°

λ_{red} = 6209 A°

COMMENTS:-

1. With this grating, what will be maximum order possible?

For maximum order, $\theta = 90°$ $\therefore \sin\theta = 1$ and λ should be smallest for this experiment, i.e. $\lambda_{blue} = 4380\,\mathring{A}$. $\therefore n = \sin\theta / N\lambda$

$\therefore n = \frac{1}{5906 \times 4380 \times 10^{-8}} = 3.866$ $\therefore$ Maximum order possible with this grating is 3

2. If number of lines per inch is increased, what will be the effect on the spectrum?

With the increase in no. of lines the secondary maxima decreases and becomes negligible. The principal maxima becomes more sharp and intense. The grating element (a+b) decreases, hence diffraction angle becomes large.

D.J.S.C.E. (Physics) Journal		
Knowledge	3	
Documentation	3	
Punctuality	3	
Virtual Lab (Performance & Documentation)	6	
Total	15	

Date	Signature of the faculty