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$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$R = 1.097 \times 10^7 \,/\mathrm{m}$ $\quad n_f = 2$ $\quad$ Balmer $n_f = 2$

Experimental

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

$\frac{600 \text{ lines}}{1\text{ mm}}$

Lab 12 – Hydrogen Spectrum

Complete this lab worksheet and turn it in for credit. Show all your work including the calculations you performed (attach additional sheets if necessary).

~~Which Data Set are you working with?~~ ________________

12.4.1

Read section 12.4.1 of the demo procedures and watch video 1_1, and 1_3. Summarize how the spectroscope was setup.

Position the spectroscope so that one can comfortably can look into the eyepiece to read one of the divided circle windows. Then have the collimator and telescope aligned with each other.

After inserting the grating holder into the spectroscope align the spectroscope with the collimator so that the light coming from the collimator intersects the grating at 90° angle. Once set at the 90° angle screw down the clamps.

Place the spectral lamps so that the spectral tube is about 2cm from the slit at the end of the collimator. Open the slit to its widest position and assure that the slit is oriented vertically.

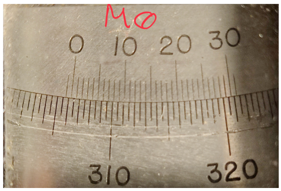
Focus the light

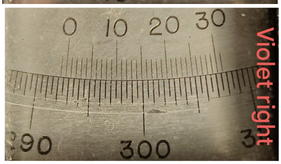
Then adjust the slit with so that it wide enough to allow both light and able to see the crosshairs easy

12.4.2

1. Measure in degrees and arc minutes. θ_0

$306 + 15'$





1. Compute as an angle in degrees. θ_0

306.25

12.4.3

$0 = 306 + 15' = 306.25$

Left

$V_2 = 319.5 + 25' = 319.91^\circ$

$V_1 = 320.5 + 11' = 320.68^\circ$

$t = 322.5 + 3' = 322.55^\circ$

$r = 328 + 23' = 328.38^\circ$

Right

$V_2 = 292.5 + 10' = 292.66$

$V_1 = 291.5 + 11' = 291.68$

$t = 290 + 9' = 290.15$

$r = 284 + 10' = 284.16$

1. Measure the first order angles on both the left and right of the zero-order line and record them in the table below *(make sure you match the color to the correct value of n)*.

	Left, *m = 1*				Right, *m = 1*			
angle label	θ_{3L}	θ_{4L}	θ_{5L}	θ_{6L}	θ_{6R}	θ_{5R}	θ_{4R}	θ_{3L}
color	red	teal	violet 1	violet 2	violet 2	violet 1	teal	red
Raw data (deg, min)	328 +23'	322.5 +3'	320.5 +11'	319.5 +25'	292.5 + 10'	291.5 + 11'	290+ 9'	284 +10'
Convert data (deg)	328.38	322.55	320.68	319.91	292.66	291.68	290.15	284.16
From θ_0 $\theta_0 - xx.xx^\circ$	22.13	16.30	14.43	13.66	13.59	14.57	16.10	22.09

1. Average the left and right angles for each line and report the answer to 4 significant figures.

$Violet_2 = (13.66 + 13.59)/2 = 13.625$

$Violet_1 = (14.57 + 14.43)/2 = 14.5$

$teal = (16.30 + 16.10)/2 = 16.2$

$red = (22.13 + 22.09)/2 = 22.11$

1. Compute *d*, the distance between slits in your grating to 4 significant figures

$\frac{600 \text{ lines}}{1 \text{ mm}} \approx 0.0016\bar{6}$ mm ≈ 1.667 nm

0.0016

1. Use equation 12.1 in the lab manual to compute the measured wavelength of each line to four significant figures. Record these results in the summary table below.

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

Left

V_2: $1.66_{nm} \sin(13.66) = 0.39202$

V_1: $1.66_{nm} \sin(14.43) = 0.41367$

T: $1.66_{nm} \sin(16.3) = 0.46591$

R: $1.66_{nm} \sin(22.13) = 0.62533$

Right

V_2: $1.66_{nm} \sin(13.59) = 0.39005$

V_1: $1.66_{nm} \sin(14.57) = 0.4175$

T: $1.66_{nm} \sin(16.1) = 0.4603$

R: $1.66_{nm} \sin(22.09) = 0.6242$

2. Compute the theoretical values of the wavelength for each line to four significant figures using either equation 12.3 or 12.4 in the lab manual. Record these results in the summary table.

$\left|\frac{M_2 - M_1}{\left(\frac{M_2+M_1}{2}\right)}\right| \times 100\%$

Summary table

Line	λtheory (nm)	λexp (nm)	% Difference
Red	656	627	4.5%
Teal	486	465	4.4%
Violet 1	410	417	1.7%
Violet 2	432	402	7.2%

$\left|\frac{656-627}{\frac{656+627}{2}}\right| \times 100\% \approx 4.5\%$

$\left|\frac{486-465}{\frac{486+465}{2}}\right| \times 100\% \approx 4.4\%$

$\left|\frac{417-410}{\left(\frac{417+410}{2}\right)}\right| \times 100\% = 1.7\%$

$\left|\frac{402-432}{\left(\frac{402+432}{2}\right)}\right| \times 100\% = 7.2\%$

1. Comment on the agreement between your observed wavelength and the theoretical wavelength for each line. Does there seem to be any systematic error? If so, what are

some plausible explanations (be specific).

No there doesn't seem to be any systematic error; however, there is experimenter error where the crosshairs may not be as centered to the color line consistently