2019 Grating Spectrometer.

Purpose To calibrate a grating spectrometer and use it to determine the wavelength of a few emission lines in the mercury spectrum.

Method: Alignment of the slits, lenses, grating will be partially completed. Further adjustment will be required when changing sources and tuning acquired spectra by moving + changing slits for collimation and light sensor aperture/sensitivity.

1) Always ensure the "zero" order light beam strikes the aperture slit (in front of the light sensor) centrally when the table angle is set to exactly zero degrees.

2) Use acquired spectra to tune slit width(s), light source position + the light sensor's range button to achieve thin + bright spectral lines.

3) Although second order + third order lines are visible and could be used, we will focus on the use of the brighter first order $m=1$ spectral lines!

4) After acquiring reasonable spectra - The brightest lines are not or nearly not flat-topped - analysis can begin after importing your Na + Hg spectra into xmgrace.

Analysis

The exact details will vary from group to group, as the orientation of the RMS sensor and the direction of spectrometer arm sweep can be different from group to group. The general steps include:

(1) Use data for RMS angle [rad] and corresponding Table angle in degrees to convert your Light Intensity versus RMS angle graphs for Na so that the central "zero" order peak is at zero degrees Table angle. For sodium, the emission line of 589.3 nm should then appear on the plot at about $+20.5°$ + $-20.5°$.

(2) Average the absolute values of both the actual peaks. The mouse pointer can be used in Xmgrace to get these angles. Call this θ_{Na}.

(3) Calculate the grating spacing d value using this θ_{Na}: and the equation:

$$m\lambda = d \sin\theta_{Na}$$

where m = the order of the used emission line of sodium

λ = 589.3 nm

(4) Plot the Hg spectrum the same as above and apply the same RMS angle to Table angle conversion as above. Check that this plot again has the central zero order light @ zero degrees table angle.

(5) Make a table of the Hg spectrum's brightest emission lines (suggested: 4 to 6 lines as available) and the corresponding Table angle values for their peaks.

(6) Calculate the Hg line wavelengths using the value of d from the sodium spectrum above.

(7) Print your spectra and table of values for Hg. Label the emission lines of Hg in the plot using the Text tool (under the "Drawing objects" menu).

(8) On the Na spectrum add your θ_{Na} values on the left and right peaks.

(9) In your table put a column showing the accepted Hg emission lines you measured.

(10) List any sources of error & descrapency between your measured λ_{Hg} and the accepted values.

Pasco states the value of d ≃ 1666 nm without errors.

The equipment is capable of measuring & recording many, many emission lines in the Hg spectrum. Feel free to include another plot or two of these but measuring their λ is not required.

The key to the calibration of RMS → Table angle is to check that the central "zero" order maximum is centered on 0 degrees table angle, as that is how the optics was set up. Next, your sodium emission peaks should appear at around 20.5° Table angle.

There should be enough information available to catch any possible blunders. :)