1) -**Definitions**

What is diffraction?

What is dispersion and how does it relate to this experiment?

2) **Theory**

On page 5 of PASCO write-up (i.e., **Educational Spectrophotometer Accessory Kit & Systems** used in lab) you will find a diagram of the set-up used in lab.

Duplicate this diagram and include (show) the focal distances (10 cm) of the lenses as well as include (show) the aperture mask on the diagram. What is the purpose of the aperture mask?

The equation used to calculate wavelength of light is given by .

Explain how this equation is derived. Keep explanation short. The most important point after geometry (i.e., rays are parallel) is optical path difference. See figure 1.1 on page 17 of PASCO write-up. Website below is also helpful.

https://www.saburchill.com/physics/chapters2/00151.html

3) **Uncertainty analysis**

Equation of interest - . Eq-1

The uncertainty of this relationship is given by . Eq-2

Since , it can be seen that .

Eq-2 can now be written as or Eq-3

 . Eq-4

Please note that angles should be in radians (here it only matters that is in radians).

We can now quantify the uncertainty of the experiment and compare it to the uncertainty given by the PASCO write-up.

Since the analog scale was used to measure the angle the uncertainty is ½ of readability or 0.5 degrees or 0.00873 radians (**use 0.009 radians).**

**For the (fractional) uncertainty of the diffraction grating (i.e.,),** **use 0.5% or 0.005**). This value was the value given by a PASCO technical representative on 5/25/22).

Since the diffracted wavelength is a function of the measured angle, **use 13.4 degrees as the angle** in these calculations. This is simply the first line noted on the helium spectrum. It gives comparable values used by PASCO in their write-up. **The wavelength is 388 nm for this line.**

Using Eq-4 and the given uncertainties above, calculate .

**I** **obtained an uncertainty in wavelength of 15 nm or 3.8% fractional uncertainty for a final answer of (388 +/- 15) nm or (390 +/- 20) nm. Show how this value was obtained.**

4) **Analysis of PASCO uncertainty values.** See pages 15 & 16 of PASCO write-up

Note that above, a value for uncertainty of ~4% was calculated, while in the PASCO write-up uses much smaller values for uncertainty of wavelength (i.e., ~0.12 nm or ~ 0.03%) for ‘ScienceWorkshop Rotary Motion Sensor’ & ~ 0.04 nm or 0.01 % for PASPORT sensor used in the lab.

Sh**ow how these values (i.e., 0.12 nm and 0.04 nm)** were obtained by using equation 4 and the assumption that is zero (0). Use

= Eq-5

To find see pages15 & 16 of PASCO write-up. For ‘ScienceWorkshop Rotary Motion Sensor’ the calculation is as follows.

From pages 15 & 16, the “maximum’ angular resolution of sensor is 1440 divisions per rotation” and one rotation (or sensor pinion or rod) is 6 degrees. Thus an angular resolution of 6 degrees/1440 division yields 0.00417 degrees/division or  **= 0.0000727 radians**. **Use this value & 390 nm in Eq-5 above**. Repeat calculation for PASPORT sensor using 4000 divisions per rotation.

An analysis of the calculations above yields two areas to consider : 1) The uncertainty of diffraction grating is ignored and more importantly 2) The calibration of rotary sensor requires the use of analog scale of rotary table which has its resolution (Please note that this uncertainty is smaller than the readability of a single measurement since it is obtained from the uncertainty of a reference range of 130 degrees rather than one degree.

**Comment on/analyze your results of PASCO uncertainty in the context noted above.**

5) **Analysis of your Results.**

Using the uncertainty calculated in question 3 above write all of you results with the correct number of significant figures. **Quantitatively compare only Helium to known values** since helium had the most easily obtained and best results. Use (388, 447, 502, 588, 668 & 707) nm as your reference values.

The mercury and hydrogen lines were difficult to measure and your lines will be incomplete compared helium.

Discuss why this was the case. Consider the properties of the PASCO photometer (in particular its resolution) & closeness & intensity of the spectral lines you were trying to observe.