PHYS222-Diffraction and Interference
Data and uncertainty calculations (Spring 2015)

Data Table

Type of Slit	**Slit Label**	**Slit Width (mm)**	**Slit spacing (mm)**	**Width of Central max (mm)**	y_{aver} **(mm)**	**Calculated Wavelength [uncorrected] (nm)**	**Corrected Wavelength** $\lambda \pm \delta\lambda$ **(nm)**	**Corrected Wavelength** $\lambda \pm \delta_{\%}\lambda$ **(You supply correct units here)**
single	A		xxxxxxx		xxxxxxx			
single	B		xxxxxxx		xxxxxxx			
single	C		xxxxxxx		xxxxxxx			
single	D		xxxxxxx		xxxxxxx			
double	A	xxxxxx		xxxxxxx				
double	B	xxxxxxx		xxxxxxxx				
double	C	xxxxxxx		xxxxxxx				
double	D	xxxxxxx		xxxxxxxx				

Wavelength and Uncertainty Calculations

Single slit- Wavelength λ is given by $\boxed{\lambda = \frac{W}{2D_{screen}} d_{slitwidth}}$, Eq-1

The **fractional uncertainty** given by

$$\frac{\delta\lambda}{\lambda} = \sqrt{\left(\frac{\delta d_{slitwidth}}{d_{slitwidth}}\right)^2 + \left(\frac{\delta W}{W}\right)^2 + \left(\frac{\delta D_{screen}}{D_{screen}}\right)^2} \qquad \text{Eq-2}$$

If we assume: 1) the uncertainty in the distance δD_{screen} to the screen is small compared to the distance to the screen D_{screen}, and 2) the uncertainty in width of central pattern δW is small compared to the width of the pattern W, we can ignore both $\frac{\delta W}{W}$ and $\frac{\delta D_{screen}}{D_{screen}}$ **the *approximate uncertainty*** in the single slit method is given by

$$\boxed{\delta\lambda \approx \lambda \frac{\delta d_{slitwidth}}{d_{slitwidth}}} \qquad \text{Eq-3}$$

The uncertainty in slit width $\delta d_{slitwidth}$ (as given by the slit manufacturer) is **0.005mm.**

Double Slit- Wavelength λ is given by $\lambda = \frac{d_{slit\_spacing}}{D_{screen}}\left(\frac{2y}{2m}\right)_{measured} \Rightarrow \boxed{\lambda = \frac{d_{slit\_spacing}}{D_{screen}} y_{av}.}$ Eq-4

The fractional uncertainty is given by $\frac{\delta\lambda}{\lambda} = \sqrt{\left(\frac{\delta d_{slit\_spacing}}{d_{slit\_spacing}}\right)^2 + \left(\frac{\delta D_{screen}}{D_{screen}}\right)^2 + \left(\frac{\delta y_{av}}{y_{av}}\right)^2}$ Eq-5

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Note: $\delta y_{av} = \delta y / (\#even\_tick\_marks) = \dfrac{0.5mm}{number\_of\_tickmarks}$

If we assume: 1) the uncertainty in the distance δD_{screen} to the screen is small compared to the distance to the screen D_{screen}, and 2) the uncertainty in the average bright fringe spacing δy_{av} is small compared to the total fringe spacing measured y_{av} we can ignore both $\dfrac{\delta y_{av}}{y_{av}}$ and $\dfrac{\delta D_{screen}}{D_{screen}}$ we can write the ***approximate uncertainty*** in the double slit method as

$$\boxed{\delta\lambda \approx \lambda \frac{\delta d_{slit\_spacing}}{d_{slit\_spacing}}} \qquad \text{Eq-6}$$

[*In **question 4** below you will examine if the simplifications above are 'good' assumptions for the both slits*]
The uncertainty in slit width **and** $\delta d_{slit\_spacing}$ (as given by the slit manufacturer) is **0.005mm.**

50 point format

Data Sheet (5 pts)
Calculations [copy of lab notebook] (10 pts)

Questions (1 &2 from procedure and the following ones) (35 pts)

3) In column 7 of the table, you should have a total of 8 different wavelengths with absolute uncertainties. In column 8 you *should rewrite all eight wavelengths and their uncertainties with the correct number of significant figures based upon the uncertainty value.*

Considering uncertainty, did all of your wavelengths fall within the accepted range of **632.8 nm**?

Using column 9 in data table above rewrite all **(corrected)** wavelengths with their **percent uncertainties** instead of absolute uncertainty. (Column labeled $\lambda \pm \delta\lambda_{\%}$)

4) Calculate the fractional uncertainties $\dfrac{\delta W}{W}$ and $\dfrac{\delta D_{screen}}{D_{screen}}$ for **single slit A** (**only**) measurement and $\dfrac{\delta y_{av}}{y_{av}}$ and $\dfrac{\delta D_{screen}}{D_{screen}}$ for **one double slit A (only)** measurement and determine whether or not the assumption that these errors are small is an appropriate assumption (i.e., compare the magnitude of these values of your percent uncertainty to the new column you generated in question 3 above).