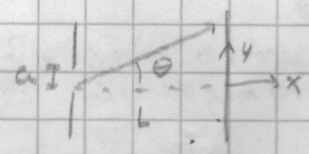
Homework 3: Diffraction

1) 

$\lambda = 650\,nm$ $L = 2\,m$ $a = 50$ microns

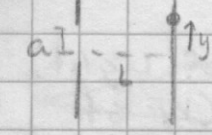
1. $y_{max} = ?$ $y_{max} = 0$ cm

2. $\theta_{min} = ?$ $I = 0$ $\lambda = a \sin\theta_{min}$ $650\,nm = 50\,microns \cdot \sin\theta_{min}$ $0.013 = \sin\theta_{min}$ $\theta_{min} \approx \boxed{0.746^\circ}$

3. $y_{min} = ?$ $y = \frac{w}{2} = L\tan\theta_{min}$ $y_{min} = 2m \tan(0.745^\circ)$ $= \boxed{2.6\,cm}$

4. $\Delta y = spot\,size = ?$ $\Delta y = 2y = \boxed{5.2\,cm}$

5. Want $\Delta y_{new} = \frac{\Delta y}{2} = y$ $a_{new} = ?$ $a\sin\theta_0 = \lambda$ $y = L\tan\theta_{min} \rightarrow \frac{0.013\,m}{2\,m} = \tan\theta_{min}$ $a\sin(0.37245) = 650\,nm$ $\theta_{min} \approx 0.37245^\circ$ $a \approx 9.999 \times 10^{-6}\,m$ $\approx \boxed{100\,nm}$

2) 

$\lambda = 550\,nm$ $L = 2m$ $y_1 = 34\,cm$ ← first zero

1. $a = ?$ $y = L\tan\theta_{min}$ $\tan\theta_{min} = \frac{34\,cm}{200\,cm}$ $\theta_{min} = 9.648^\circ$ $\lambda = a\sin\theta_{min}$ $550\,nm = a\sin(9.648^\circ)$ $a \approx 3.28 \times 10^{-6}$ $= \boxed{3.28\,microns}$

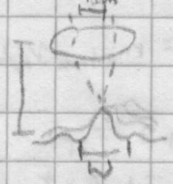
2. 2nd diff min $y_2 = 2y_1 = 68\,cm$ $\lambda_2 = ?$ $a\sin\theta_0 = n\lambda$ $y = L\tan\theta_0$ $3.28\times10^{-6}\sin(18.778) = 2\lambda$ $\frac{0.68}{2} = \tan\theta_0$ $\lambda = \frac{1.0558\times10^{-6}}{2} \approx \boxed{527.9\,nm}$ $\theta_0 \approx 18.778^\circ$

3) 

$D\sin\theta_0 = 1.22\lambda$ $\theta \approx \theta_{min}$ $1.5\times10^{11} = 4.2\times10^6 \tan\theta$ $\lambda = 570\,nm$ a) $y = L\tan\theta_{min}$ $\theta \approx 2.046\times10^{-4}{}^\circ$ $= \boxed{3.57\times10^{-6}\,rad}$

b) $D\sin(3.5\times10^{-6}) = 1.22(570\times10^{-9})$ $D = \frac{1.22(570\times10^{-9})}{\sin(3.5\times10^{-6})} \approx \boxed{0.1947\,m}$

4) $\lambda = 248\,nm$ $F = 0.625\,cm$ $D = 1.3\,cm$ $\phi_{laser} = 1\,cm$



1. $\sin\theta = \frac{1.22\lambda}{D(laser)}$ $d = \frac{2\lambda f}{1\,cm}$ $= \boxed{378.2\,nm}$

2. Min resolvable line separation? $\frac{w}{2} \approx \boxed{189\,nm}$

3. $\lambda = 157\,nm$ min res dist $\approx \boxed{120\,nm}$