This print-out should have 11 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

Please notice that for your homework to be considered towards your grade, it needs to be submitted one hour before the corresponding recitation starts.

PLEASE REMEMBER THAT YOU MUST CARRY OUT YOUR CALCULATIONS TO AT LEAST THREE SIGNIFICANT FIGURES. YOUR ANSWER MUST BE WITHIN ONE PERCENT OF THE CORRECT RESULT TO BE MARKED AS CORRECT BY THE SERVER.

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001 (part 1 of 1) 3 points

Diffraction is most noticeable when

1. $\frac{d}{\lambda} \to 0.$

2. $\lambda << d.$

3. $\frac{\lambda}{d} \to 0.$

4. $\lambda = d.$

5. $\frac{d}{\lambda} \to \infty.$

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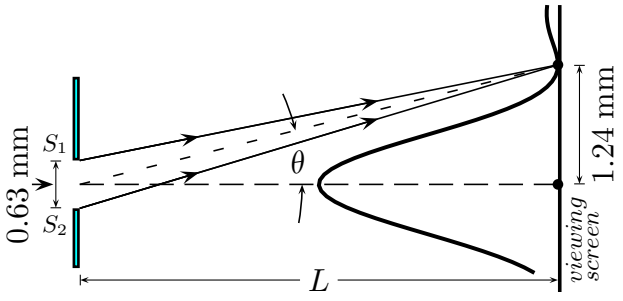
002 (part 1 of 2) 5 points

Light of wavelength 917 nm illuminates a single slit of width 0.63 mm.



At what distance L from the slit should a screen be placed if the first minimum in the diffraction pattern is to be 1.24 mm from the central maximum? Answer in units of m.

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003 (part 2 of 2) 4 points

What is the width of the central maximum? Answer in units of mm.

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004 (part 1 of 2) 4 points

Light of wavelength 600 nm is incident on a long narrow slit.

Find the angle of the first diffraction minimum if the width of the slit is 2 mm. Answer in units of mrad.

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005 (part 2 of 2) 5 points

Find the angle of the first diffraction minimum if the width of the slit is 0.2 mm. Answer in units of mrad.

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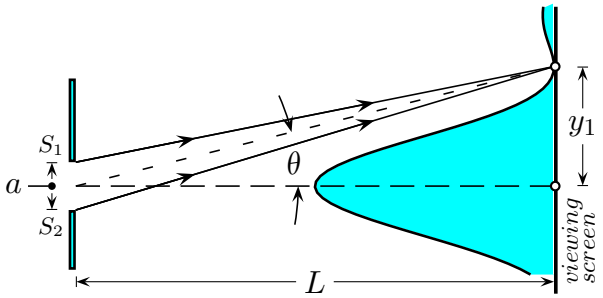
006 (part 1 of 2) 5 points

Hint: Use a small angle approximation; *e.g.*, $\sin\theta = \tan\theta$.

Consider the setup of a single slit experiment. The wavelength of the incident light is λ.

The slit width and the distance between the slit and the screen is specified in the figure.



Find the position $y = y_1$ of the first intensity minimum.

1. $y_1 = \frac{2\,\lambda\,L}{a}$

2. $y_1 = \frac{\lambda\,L}{a}$

3. $y_1 = \frac{a\,L}{\lambda}$

4. $y_1 = \frac{a\,L}{2\,\lambda}$

5. $y_1 = \frac{\lambda\,L}{2\,a}$

6. $y_1 = \frac{\lambda\,a}{L}$

7. $y_1 = \dfrac{\lambda\, a}{2\, L}$

8. $y_1 = \dfrac{2\, a\, L}{\lambda}$

9. $y_1 = \dfrac{2\, \lambda\, a}{L}$

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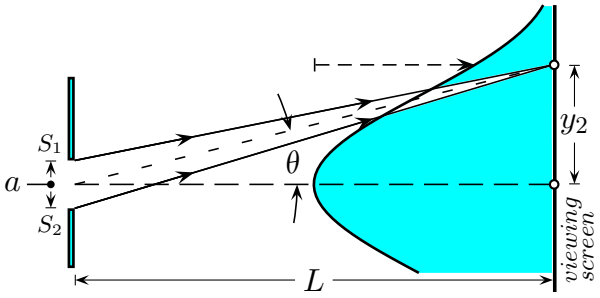
007 (part 2 of 2) 5 points

Denote the intensity on the screen at y_2 by I_2 and the intensity on the screen at $y = 0$ by I_0. Let the fist dark fringe fall at y_1, and let $\mathcal{R} = \dfrac{y_2}{y_1}$.



Find the intensity ratio $\dfrac{I_2}{I_0}$.

1. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \mathcal{R}\, y_2/L)}{\pi\, \mathcal{R}\, y_2/L}\right]^2$

2. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \mathcal{R}\, \delta_2/L)}{\pi\, \mathcal{R}\, \delta_2/L}\right]^2$

3. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \mathcal{R}\, L/\delta_2)}{\pi\, \mathcal{R}\, L/\delta_2}\right]^2$

4. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, y_2/\delta_2)}{\pi\, y_2/\delta_2}\right]^2$

5. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \delta_2/y_2)}{\pi\, \delta_2/y_2}\right]^2$

6. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \mathcal{R})}{\pi\, \mathcal{R}}\right]^2$

7. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \mathcal{R}\, y_2/\delta_2)}{\pi\, \mathcal{R}\, y_2/\delta_2}\right]^2$

8. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \mathcal{R}\, L/y_2)}{\pi\, \mathcal{R}\, L/y_2}\right]^2$

9. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \mathcal{R}\, \delta_2/y_2)}{\pi\, \mathcal{R}\, \delta_2/y_2}\right]^2$

10. $\dfrac{I_2}{I_0} = \left[\dfrac{\sin(\pi\, \delta_2/L)}{\pi\, \delta_2/L}\right]^2$

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008 (part 1 of 1) 5 points

Light of wavelength 546 nm from a mercury arc falls on a diffraction grating ruled with 20200 lines/in.

What is the angular separation between the first-order images on either side of the central maximum? (Caution: do not use small angle approximation here.) Answer in units of °.

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009 (part 1 of 2) 5 points

A diffraction grating is 5.14 cm long and contains 8810 lines per 2.37 cm interval.

What is the resolving power of this grating in the third order?

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010 (part 2 of 2) 5 points

If two monochromatic waves incident on this grating have a mean wavelength of 538 nm, what is their wavelength separation if they are just resolved in the third order? Answer in units of nm.

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011 (part 1 of 1) 4 points

X-rays of wavelength 0.212 nm are reflected from a certain crystal, and the first-order maximum occurs at an angle of 12.1°.

What is the interplanar spacing of this crystal? Answer in units of nm.