PHYSICS 252: TEST 2 10/7/15 Dr. Varriano NAME:_____

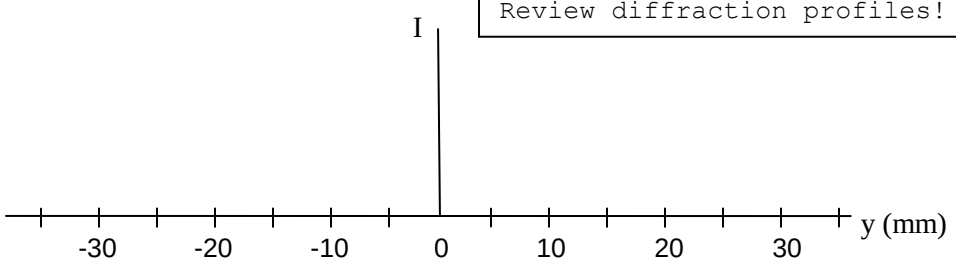
Do all 8 problems. The point value for each problem is indicated next to the problem number. Show all of your work in the space provided to receive partial credit. You may use additional sheets of paper if necessary. Be sure to turn in the additional sheets with your name written on each sheet. Put your final answer to each question on the line provided unless instructed otherwise.

---

1. [14 pts]
Red light (λ_o = 667 nm) is sent through a single, narrow slit that is 0.2 mm wide. The resulting diffraction pattern is observed on a screen 3 meters from the slit.

(a) Sketch the intensity (*I*) of the light on the screen versus position (*y*) on the screen on the axes below. Pay attention to the *y* values. The center of the pattern is at *y* = 0.

Review diffraction profiles!



(b) How many millimeters wide is the central diffraction peak?

20 mm

(c) Which of the following will cause the central diffraction peak to decrease its width? (Circle number(s) before the correct answer(s). There may be more than one correct answer.)

① switch to a green wavelength
2. move screen farther from slit
③ use a wider slit

2.[20 pts]
When Hydrogen gas is excited, it emits light at specific wavelengths. One of these wavelengths appears red with a wavelength of 658 nm and another appears violet. Suppose that you send the emitted light through a diffraction grating with a grating constant of 600 lines/mm.

(a) How many nanometers are there between consecutive lines on the grating?

1667 nm

(b) At what angle do you see the red light in the first order spectrum?

23.2°

(c) Does the violet light appear at a smaller, larger, or the same angle in the first order diffraction spectrum?

smaller

(d) What is the highest order number that the grating can produce for the red light? Find the diffraction angle of the red light for this order.

Highest Order No. 2

Angle 52.1°

3. [12 pts]
Part of a soap bubble appears orange (λ_o = 600 nm) when you view it with reflected sunlight. The index of the soap film is 1.33.

(a) What is the smallest thickness that this part of the bubble can be? (Answer in nm.)

112.8 nm

(b) For the thickness in (a), what is the longest wavelength of light that is predicted to not reflect from the bubble?

300 nm

(c) Another part of the soap bubble has a thickness less than the value in (a). Does this other part appear reddish or bluish?

bluish

4.[14 pts]
Suppose you have a green laser pointer (λ_o = 532 nm), a ruler, and some slides with different shaped apertures. One aperture is a circular hole, one is a single slit, and the other is a pair of slits whose centers are separated by 0.5 mm.

(a) When you shine the light through the pair of slits, the centers of two consecutive bright fringes on a far wall are separated by 4 mm. How far is the wall from the slits?

3.76 m

(b) You replace the pair of slits with the single slit. You measure the width of the central diffraction peak on the wall. You then replace the slit with the circular hole and measure the width of the Airy disk on the wall. This width is equal to the previously measured width of the single slit's central diffraction peak. If *a* is the width of the slit and *D* is the diameter of the circular hole, then what must be true? (Circle the one correct choice.)

$a = D$ $a > D$ (circled) $a < D$

(c) You are informed that the single slit is 1 mm wide. What must be the diameter of the circular hole?

1.22 mm

(d) If you now switch to a red laser pointer, what will happen to the diameter of the Airy disk on the wall? You still have the same distance between the circular hole and the wall. (Circle the one correct choice.)

1. It will decrease. (circled) 2. It will increase. 3. It will not change.

5.[5 pts]
When light passes through a circular aperture and diffracts, it will form an Airy pattern on a screen downstream. Sketch such a pattern below. Label Airy's disk and one of Airy's rings.

Review diffraction profiles!

6. [20 pts]
A 70 mm focal length lens is used in a camera with an adjustable circular aperture to take a photo of a sign that is 3 meters from the lens. The lens is free of aberrations and the performance of the lens and aperture is diffraction limited.

(a) Find the necessary resolution angle so that the camera can resolve two points on the sign that are separated by half of a millimeter. Express the angle in arc seconds.

34.4"

(b) How wide should the aperture be to achieve this resolution? (Use a wavelength of 580 nm, near the middle of the visible spectrum.)

4.24 mm

(c) How far should the film be from the lens?

71.7 mm

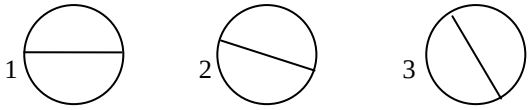
(d) What is the minimum separation distance of two imaged points on the film? Express your answer in microns.

12 μm

(e) If you photographed the sign using only one color of light, would you get better resolution if you used blue light or red light?

blue

7. [10 pts]
Three beams of linearly polarized light with the electric field oriented horizontally are sent through each of the three polarizers shown below. The angle between the transmission axis and the horizontal axis is 0° for Polarizer 1, 15° for Polarizer 2, and 70° for Polarizer 3.



(a) List the polarizers by number in order from the one that will absorb the most light to the one that will absorb the least light.

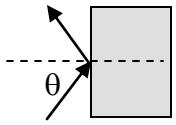
3 2 1

absorbs most absorbs least

(b) Now suppose that a beam of unpolarized light passes through Polarizer 1. The intensity of the light transmitted through the polarizer is I_o. Then the beam passes through Polarizer 2. What percentage of I_o passes through Polarizer 2?

93.3&

8.[5 pts]
Unpolarized light travelling in air reflects off of a block of glass as shown in the picture. The refractive index of the glass is 1.65.



(a) At what angle of incidence will more of the light be linearly polarized, 50° or 60°?

60°

(b) At what angle of incidence will the light be completely linearly polarized?

58.8°