RH = /44 CH1 = /80

PHYS 252 TEST #2 02/13/19 Dr. Holmes NAME Key

DO ALL EIGHT PROBLEMS. THE WORTH OF EACH PROBLEM IS AS MARKED [ ] BESIDE THE SPACE FOR THE ANSWER. SHOW YOUR WORK FOR PARTIAL CREDIT.

1) Laser light is directed through a double slit with a distance of 0.125 mm between slits and each slit having a width of 0.025 mm. The screen is 9 meters away. The pattern on the screen has bright spots separated by 3.5 cm. a) What is the wavelength of the laser light?

[6] **486 nm**.

b) What type of light is this (IR, UV, visible, etc. - if visible, specify the color: blue, green, red, etc.)?

[2] **blue**. c) If the distance between the slits is decreased, will the distance between adjacent bright spots [increase, decrease, or remain the same]?

[2] **increase**.

d) If the width of each of the two slits is decreased, will the distance between adjacent bright spots increase, decrease, or remain the same?

[2] **same**.

e) If the wavelength of the light is decreased, will the distance between adjacent bright spots increase, decrease, or remain the same?

[2] **decrease**.

2) Laser light of wavelength 632 nm is directed through a single slit and the pattern is displayed on a screen 9 meters away. a) If the slit is 0.075 mm wide, how wide is the full width of the central maximum? (full width is from the dark spot on one side to the dark spot on the other side of the central bright spot)

[6] **15.2 cm**. b) If the width of the single slit is decreased, will the full width of the central maximum [increase, decrease, or remain the same]?

[2] **increase**.

c) If the wavelength of the laser is decreased while the slit width is held constant, will the full width of the central maximum [increase, decrease, or remain the same]?

[2] **decrease**.

3) A sound wave of frequency 440 Hz is incident on a door of width .75 meters. (Assume the speed of sound in air is 540 m/s.) a) What is the angle for the first minimum as the sound spreads out behind the door due to the diffraction effects?

[8] **none**.

b) If the frequency were 270 Hz instead, what would the angle for the first minimum be?

[4] **none**.

4) A Michelson interferometer is to be used to measure the index of refraction of a certain gas at a certain pressure. A tube of inside length 5 cm with transparent ends is placed in one arm of the interferometer. Light of wavelength 540 nm (in vacuum) is used. Initially the tube has vacuum inside it (no gas). As the gas is slowly let into the tube, 40 fringes (bright to dark back to bright) are counted. What is the index of refraction of this gas at the final pressure?

[6] **1.00022**.

b) If red light were used instead, would there be [more, the same, or less] fringe shifts for the same experiment?

[2] **less**. c) If accuracy were extremely important, which color (green or red) would be better to use to measure the index of refraction?

[2] **green**.

5) An anti-reflective coating on a lens is of a material of index of refraction of 1.44 and the glass of the lens has an index of refraction of 1.76.

a) How thick should the coating be if it is designed to **minimize** the reflection of yellow light near normal incidence?

[6] **95.5 nm**. b) Will some colors be reflected more than others? (if yes, which colors will be reflected more)

[2] **yes, violet & red**.

6) In a certain brightly lit situation, the pupil of a certain person's eye contracts so that it is 2 mm in diameter. a) Assuming that the lens and focusing features of the eye are very good and diffraction is the only limitation on the ability to see clearly, what is the smallest angle that this person can resolve? express this angle

a) in degrees: b) in arc-minutes: c)in radians:

[6] **0.0192^{o}**. [2] **1.15 rad** [2] **0.00034**

d) If the light becomes less bright and the pupil expands to 4 mm in diameter to increase the light admitted, will the person be able to see small detail more clearly or less clearly?

[2] **more clearly**.

7) A camera with a 50 mm focal length lens takes a picture of an object 120 cm long using an f-stop of 2 and time exposure of 1/240 sec.
a) If the film is 24 mm x 36 mm in size, and the image of the 120 cm long object is to fill up the long side of the film (36 mm side), how far away should the object be from the camera?

[4] **1.717 m**. b) How far should the lens be from the film? (If the distance is close to the focal length, be sure to indicate whether the distance is a little more than or a little less than the focal length.)

[4] **51.5 mm**. c) What is the diameter of the opening to the lens for this f-stop?

[3] **25 mm**. d) How close can two points of light on the object be to be resolvable on the film assuming the film itself does not limit this and lenses are as perfect as possible?

[6] **46.1 μm**. e) What is the distance between the image of the dots of part d above on the film?

[6] **1.38 μm**. f) If an f-stop of 8 is used, how close can the two points of light on the object be to be resolvable on the film?

[3] **184 μm**. g) What time exposure should be used to obtain the same amount of light for the film using the f-stop of 8 setting?

[2] **1/15 sec** .

8) Sunlight in June reflects off the calm (flat) surface of a pond.
a) Can polaroid sunglasses help cut out the reflected glare (answer: yes or no)?

[2] **Yes**.

b) Will these sunglasses cut out more, the same, or less glare at 3 pm (assume angle of sun with water is 42 degrees) than at noon (assume angle of sun with vertical is 12 degrees) ? (Answer either: more, same, less, does not apply) ?

[2] **more**. c) Which polarization should polarized sunglasses cut out: the horizontal, or the vertical, or doesn't matter, or both, or neither (i.e., the polaroids are useless in cutting out glare)?

[2] **horizontal**.