RH = /66 CH1 = /100 CH2 = /40

PHYS 202 Test #3 3/20/19 Dr. Holmes NAME_____

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

1) For the following wavelengths (in vacuum), give the type of light (microwave, x-ray, IR, etc; if VISIBLE, give the color, i.e., green, red, etc). Also give the frequency for each of the wavelengths:

WAVELENGTH	TYPE (color)	FREQUENCY
6.0×10^{-10} m	[1] **x-ray**	[1] **5.0×10^{17} Hz**
5.0×10^{-8} m	[1] **UV**	[1] **6.0×10^{15} Hz**
4.0×10^{-6} m	[1] **IR**	[1] **7.5×10^{13} Hz**
3.0×10^{-4} m	[1] **microwave**	[1] **1.0×10^{12} Hz**
2.0×10^{-1} m	[1] **radio**	[1] **1.5×10^{9} Hz**

2) a) What is the speed of light in air?

[2] **3×10^8 m/s**. b) What is the speed of light in glass of index of refraction = 1.88)?

[2] **1.6×10^8 m/s**. c) If light of wavelength 678 nm in air is used, what is the wavelength of this light in the glass?

[2] **361 nm**.

On entering the glass (from the air), does the light of part c:

d) change color? If yes, what is the color in glass:

[2] **No**

e) change frequency? If yes, what is the frequency in glass:

[2] **No**

3) A light ray coming from glass (n_{glass}=1.88) toward air (n_{air} = 1.00) strikes the glass/air surface at an angle of 44° with respect to the SURFACE.

a) What is the angle of REFLECTION as measured from the SURFACE?

[2] **44^o**.

b) What is the angle of REFLECTION as measured from the NORMAL?

[2] **46^o**.

c) What is the angle of the light TRANSMITTED into the glass as measured from the NORMAL? (if totally reflected, write TIR)

[6] **22.5^o**.

d) Would it be possible for a ray of light in the glass to be totally reflected from the air?

[2] **Yes**.

e) Is it possible for the ray of light in the air to be totally reflected from the glass?

[2] **No**.

4) A person is **nearsighted** and can see things clearly only if they are 88 cm away or nearer.
a) What focal length should the person's glasses (lenses) have if they are designed to let the person see something at a far viewing distance of 100 m clearly?

[4] **-88.8 cm**.

b) Draw a diagram showing the position of the eye, the lens, the object and the image. [4]

c) Is the image provided by the lens upright or inverted?

[3] **upright**.

d) Is the lens a converging or diverging lens?

[3] **diverging**.

e) Draw a diagram of the lens and be sure to indicate positive or negative curvatures for each side of the lens and show clearly whether it is thinner at the edges or in the middle: [2]

5) A lens of focal length 88 mm (8.8 cm) is used as a magnifying glass. a) What is the magnifying power of the lens when used correctly?

[6] **3.84 X**. b) Draw a diagram showing the object, the lens, its focal length, the eye, the object and the image. [4]

c) Design a lens that has the above focal length of 88 mm, that is, specify n_{glass}, R_1 and R_2 and draw a picture of the lens: [6]

n_{glass} _____ R_1 _____ R_2 _____ picture: .

FOR PROBLEMS 6 AND 7 USE THE FOLLOWING INFORMATION: A 35 mm camera (film size is 24 mm x 36 mm) uses a lens with a focal length of 88 mm and the f-stop setting is 2 (which means the diameter of the opening to the lens is 1/2 the focal length, or 44 mm). You take a picture of a newspaper located 77 meters away. For purposes of calculation assume that the wavelength of the light is one in the middle of the visible spectrum. [If you do not know what wavelength this is, you may ask and I will give it to you but you will be marked down one point.]

6) a) What is the object distance?

[2] **77 m**. b) What is the image distance? (Note: if this distance is close to the focal length, make sure your answer clearly shows whether it is the same, slightly larger or slightly smaller than the focal length)

[3] **88.1 mm**. c) If the print size on the paper is 3.0 mm in height, what is the image height on the film?

[3] **3.43×10^{-6} m**. d) Is the image upside down or right-side-up?

[2] **upside down**. e) Is the magnification positive or negative?

[2] **negative**.

7) a) What is the smallest angle that this camera (f=88 mm) using this f-stop (f/D = 2) can resolve based on the Rayleigh criterion?

[4] **8.74×10^{-4} deg = 1.53×10^{-5} rad**. b) What angle does the print size (3.0 mm) make when viewed from 77 meters away?

[4] **2.23×10^{-3} deg = 3.90×10^{-5} rad**.

c) Assuming the camera has quality lenses and a fine grain film, can the picture the camera takes be enlarged big enough and clearly enough so that you can read what the newspaper said (definitely, just barely, not quite, definitely not) ?

[2] **just barely / not quite**.

8) a) Design a microscope that gives a magnification of exactly 880X, i.e., specify the following: [8]

M = -880 s_{obj} = _____

L = _____ s'_{obj} = _____

f_{obj} = _____ s_{eye} = _____

f_{eye} = _____ s'_{eye} = **-25 cm**

b) Draw a diagram showing the following: position of both lenses, the eye and the object; also indicate on the diagram the distances: L, s_{obj} , s'_{obj} , s_{eye} and s'_{eye} . [4]