Physics 116b

Fourth Practice Examination Due Dec. 2, 2001

Name:____

Please circle your section:

Section 1 2 3 4

Instructions

This is a practice examination. Put answers in the boxes provided, or circle the best answer. If numerical answers are needed, you must include units. Any work needed to justify the answer must be shown in the space provided. A correct answer without the necessary justifying work may not receive any credit. You may use the formula sheet off the back of the exam.

Total point scores for each problem will appear in the table below and in ( ) beside each problem number. Do what is easiest first.

Point Tallies for the Exam Problems

Problem	Max Score	Actual Score
1	18	
2	16	
3	20	
Total		

1: (Circle the Correct Response, 2 points each)

a) What is the focal length of the lens in your eye when you can focus an object at your near point? (Assume that the distance from your lens to the back of your eye is 2.0 cm, that your near point is 15 cm in front of your lens, and that the liquid on either side of your lens has $n = 1.00$ just like air.)

I) 2.0 cm
II) 23 cm
III) 17 cm
IV) 2.3 cm
V) 1.8 cm

b) An object, 6.0 m in height, is located 25.0 m in front of a convex (diverging) mirror with radius of curvature $|R| = 20.0$ cm. What is the apparent size and orientation of the image produced by the mirror?

I) 210 cm erect
II) 2.4 cm erect
III) 2.4 cm inverted
IV) 4.8 cm erect
V) 4.8 cm inverted

c) You've just noticed a fish swimming around in the water at the bottom of your well (hmmm, how old IS the professor?). It looks like the fish is 1.00 $ft.$ below the surface of the water. Where is the fish really located? ($n_{water} = 1.33$)

I) 0.752 $ft.$ below the surface
II) 1.33 $ft.$ below the surface
III) 10.0 $ft.$ below the surface
IV) on the surface
V) above the surface

1: (Circle the Correct Response, 2 points each) contd.

d) At what angle do you observe the 4th order maximum relative to the central maximum when 400 nm light is incident normally on two slits separated by 0.025 mm ?

I) 1.83^0
II) 2.75^0
III) 3.67^0
IV) 4.13^0
V) 39.8^0

e) Suppose a 5.0 meter diameter telescope were constructed on the far side of the moon. The viewing there would be excellent. To prove this to yourself, what would be the separation between two objects that could just be resolved on the planet Mars in 500 nm light? (Neglect atomospheric effects on Mars and use a Mars-Moon distance of 80.5 million kilometers in your calculation.)

I) 9.8 km
II) 8.1 km
III) 6.6 km
IV) 4.9 km
V) 4.1 km

f) You are using a diffraction grating to try and resolve 2 spectral lines that are close together. Unfortunately, you can only see the first order maxima, and the "line" on the wall is too blurry to tell you if there are 2 distinct lines there. Which of the following would likely help you get better resolution (There may be more than one answer):

I) Increase the intensity of the light source
II) Put a small slit in front of the grating
III) Get a similar grating but with more lines/cm
IV) Get a similar grating but with less lines/cm
V) Illuminate more of the grating with the source
VI) Rotate the grating

1: (Circle the Correct Response, 2 points each) contd.

g) You notice that for a material with work function of $\Phi = 2.20\ eV$, the photons from your light source are unable to force electrons off the surface of the material via the photoelectric effect. How should you modify your light source to force electrons to leave the surface via the photoelectric effect?

I) Increase the intensity of the light source
II) Increase the wavelength of the light
III) Decrease the wavelength of the light
IV) Focus the light on one spot of the material

h) An X ray of $\lambda_{incident} = 0.0021\ nm$ stikes a carbon target and a scattered photon is observed to come from the target at an angle of 40^0 relative to the incident X ray. What is the wavelength of this scattered photon?

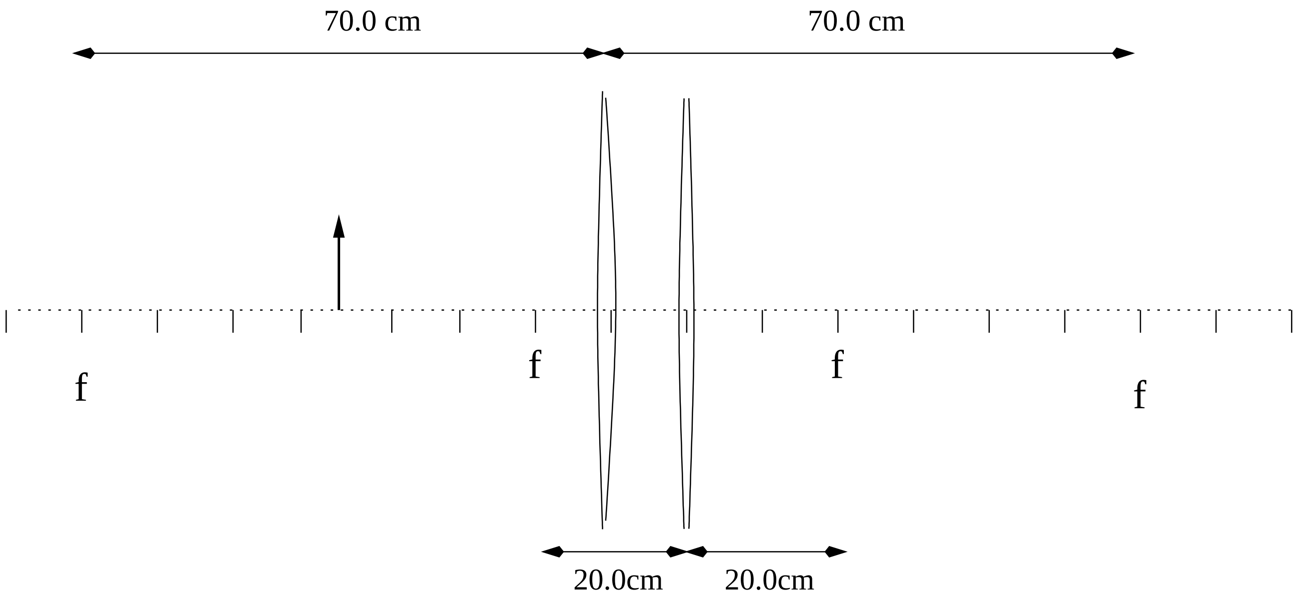
I) 3.7 nm
II) 0.27 nm
III) 0.0064 nm
IV) 0.0027 nm
V) 0.0015 nm

i) Electrons are incident normally on a crystal with a spacing between atoms of $d = 0.215\ nm$. What kinetic energy is required if we want to see a first order diffraction maxima at an angle of 45^0? (Hint: Treat this like 2 slit diffraction using matter (de Broglie) waves!)

I) 65 eV
II) 54 eV
III) 46 eV
IV) 8160 eV
V) 5770 eV

(show your work! 6 points each (Ray diagram is 4 pts.))

2) Suppose you have 2 lenses separated by 10.0 cm. Light from an object at 36.0 cm in front of the center of the first lens, enters the first lens, focal length, f = 70.0 cm, and then enters the second lens, focal length, f = 20.0 cm. Where is the image from this 2 lens system located? Please draw a ray diagram to illustrate your answer. Determine the overall magification as well.



q(final) =

(to the right of the 2nd lens)

M(overall) =

3) You have performed a photoelectric effect experiment and have the data shown in the table below. From the data, please determine Plank's constant, h, and the work function for the material you used in the photoelectric apparatus. You will find it useful to graph the data in a convenient form for your calculations. (I.e. not all data points are useful for your estimate!) Show your work and briefly explain your results.

Wavelength	| Vstop |
579.1 (nm)	0.02 (Volts)
577.0	0.00
546.1	0.03
435.8	0.60
404.7	0.81
365.0	1.14

h=

(8 pts.)

O=

(8 pts.)

Explanation of results and graph (4 pts.)

Equations

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}, \qquad M=-\frac{q}{p}=\frac{h'}{h}, \qquad M_{overall}=M_1\cdot M_2\cdot M_3...$$

$$|f|=|R/2|\ (mirror), \qquad \frac{n_1}{p}+\frac{n_2}{q}=\frac{n_2-n_1}{R}, \qquad \frac{1}{f}=(n-1)(\frac{1}{R_1}-\frac{1}{R_2})$$

$$d\sin(\theta) \ = \ m\lambda \quad Double\ slit, \qquad 2d\sin(\theta) \ = \ m\lambda \quad Bragg$$

$$a\sin(\theta) \ = \ m\lambda \quad Single\ slit, \quad \theta_{res}=\frac{\lambda}{a}\ \ (slit), \quad \theta_{res}=1.22\ \frac{\lambda}{D}\ \ (hole)$$

$$d\sin(\theta) \ = \ m\lambda\ \ Diffraction\ grating, \quad Resolving\ Power,\ R=mN=\frac{\lambda}{\Delta\lambda}$$

$$\phi=0,2\pi,4\pi,6\pi... \quad Constructive\ Interference \quad \Delta x=0,\ \lambda,\ 2\lambda,\ 3\lambda...$$

$$\phi=\pi,3\pi,5\pi... \quad Destructive\ Interference \quad \Delta x=\lambda/2,\ 3\lambda/2,\ 5\lambda/2...$$

$$\phi=K_n\Delta x, \quad K_n=\frac{2\pi}{\lambda/n}, \qquad \phi=\pi\ \ (if\ n_1<n_2)\ \ \Delta x=\lambda/2$$

$$\lambda_{max}T=0.2898\times10^{-2}\ m\ K, \qquad E=\frac{hc}{\lambda}=hf\ (photons!)$$

$$KE_{max}=E_{photon}-\Phi, \qquad KE_{max}=eV_{stop}, \qquad E_{threshold}=\Phi\ (Work\ Function)$$

$$\lambda_{scattered}-\lambda_{incident}=\frac{h}{m_ec}(1-\cos(\theta))$$

$$\Delta x\Delta p_x\geq\frac{h}{4\pi}, \qquad \Delta E\Delta t\geq\frac{h}{4\pi}, \qquad \lambda=\frac{h}{p}=\frac{h}{mv}(DeBroglie), \qquad KE=\frac{p^2}{2m}$$

Constants

$h \ = \ 6.626\times10^{-34}J\ s$

$c \ = \ 2.9979\times10^{8}\ m/s$

$e \ = \ 1.6022\times10^{-19}\ C$

$m_e\ c^2 \ = \ 0.511\times10^{6}\ eV$

$hc \ = \ 1239.8\ eV\ nm$

$1\ eV=1.6022\times10^{-19}J$

$M_{electron} \ = \ 9.11\times10^{-31}\ kg$