

PHYS 212 Laboratory Exam
May 6, 2004

Name _____
Score _____

Show all work for full credit!

$$s = \sqrt{\langle x^2 \rangle - \langle x \rangle^2}$$

$$\text{standard deviation of the mean} = \frac{s}{\sqrt{N}}$$

$$\text{Poisson distribution standard deviation} = \sqrt{a}$$

$$I = \frac{1}{R} \Delta V$$

$$n = \frac{c}{v}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$R(t) = R_0 e^{-Bt} = R_0 e^{-\frac{\ell n 2}{T} t}$$

$$K_{\max} = E_{\text{photon}} - W = hf - W$$

$$P_2 = \cos^2(\theta_2 - \theta_1)$$

$$m\lambda = d \sin \theta \quad E_n = \frac{-13.6}{n^2} \text{ eV} \quad E_{\text{photon}} = E_{\text{upper}} - E_{\text{lower}} = E_1 \left[\frac{1}{n_{\text{upper}}^2} - \frac{1}{n_{\text{lower}}^2} \right]$$

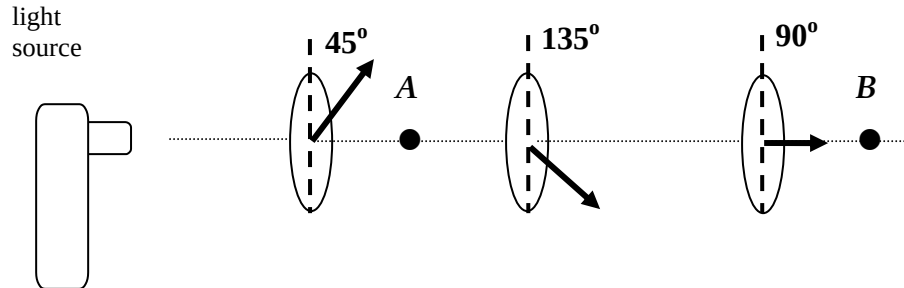
$$\psi''(x) = -(E - U_0 x^2) \psi(x) \quad \psi(x + \Delta x) = \psi(x) + \Delta x \psi'(x) \quad \psi'(x + \Delta x) = \psi'(x) + \Delta x \psi''(x)$$

- 1.** (pts) Verizon is examining the capability of their network to handle phone calls. A representative states that the network can handle 1,000,000 calls in a 10 minute interval at peak calling time. The average peak call rate during a 10 minute interval has been measured to be 985,000. Over the last week, two days had peak call rates during a ten minute interval as 988,000 and 987,000. Is the network large enough or does it need to be upgraded to handle more traffic (circle a choice below)? Justify your answer quantitatively.

UPGRADE

DON'T UPGRADE

2. (pts) Examine the following configuration of ideal identical polarizers. The transmission axis for each polarizer is initially vertical. Each polarizer is then rotated by an angle as shown in the figure.



- a) Determine the final intensity of the beam as measured at the point B given that the intensity at the point A is I_0 .
- b) The middle polarizer is now rotated to an angle of 55 degrees relative to vertical. Find the intensity at B given that the intensity at the point A is I_0 .

3. (pts) In the “Interference of Light” lab, you shined a red laser through various sets of single-, double-, and multiple slits. You then observed the patterns of red light on a white board.

a) For a single slit of width 0.08 mm, one group found the central red spot on the screen to be 4.2 cm wide. When the slit width was changed to 0.04 mm, how wide was the central red spot on the screen? (circle one)

0.04 mm 1.05 cm 2.1 cm 4.2 cm 8.4 cm 16.8 cm

b) The laser light passed through a slide with multiple-slits being illuminated; the center of the pattern on the screen looked like this, where the dark spots on the diagram represent bright red spots on the screen.



How many slits were being illuminated to make this pattern? (circle one)

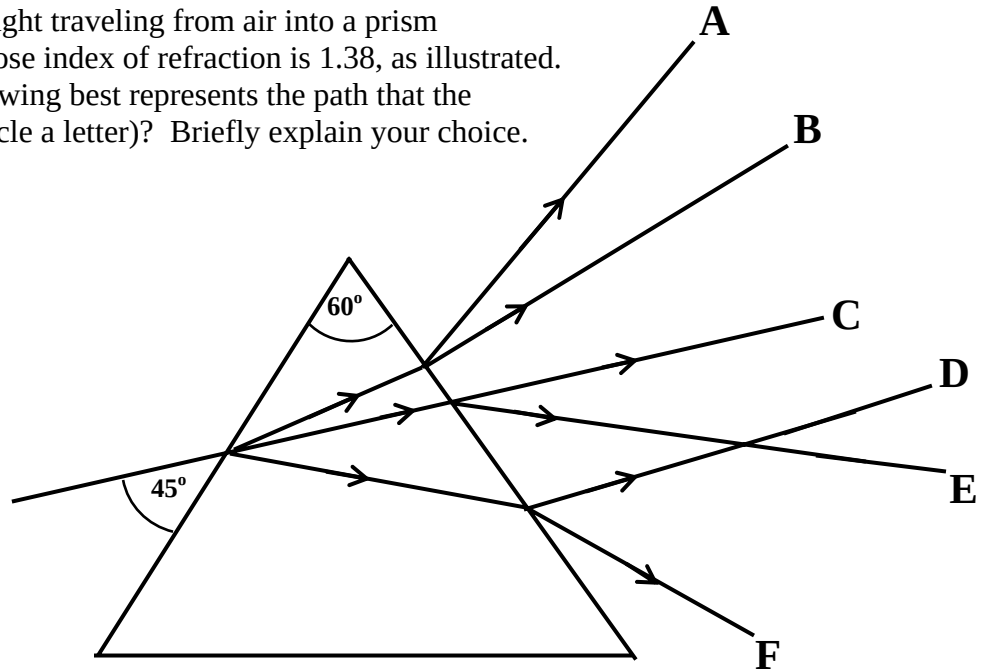
2 3 4 5 6 can't be determined

4. (pts) In the Emission Spectra lab, you calibrated your spectrometer by observing the green line of mercury vapor ($\lambda = 546.1 \text{ nm}$) to calculate d . Suppose your partner used the green line in the 2nd order spectrum to get the angle $\theta = 19.1^\circ$, but you calculated d under the assumption that the observed line was in the 1st order spectrum.

Using this calibration, you found the red line of hydrogen to have a wavelength of $\lambda = 326 \pm 2 \text{ nm}$. Your lab instructor noticed the error and asked you to recalculate the wavelength of the red hydrogen line.

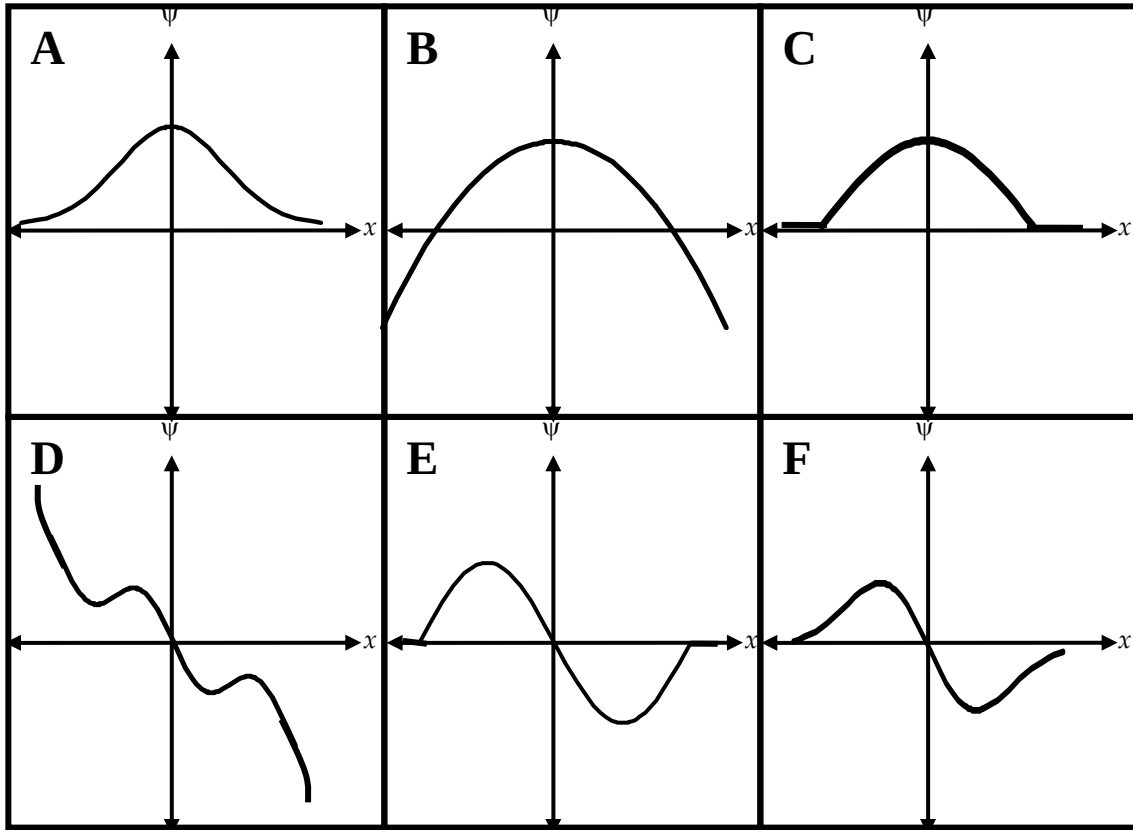
Determine the corrected, recalculated value for the red line of hydrogen, using the same data.

5. (pts) Consider light traveling from air into a prism made of glass, whose index of refraction is 1.38, as illustrated. Which of the following best represents the path that the light ray takes (circle a letter)? Briefly explain your choice.



6. (pts) The rate of production of alpha particles from a radioactive sample is measured to be 27,000 counts/second at an initial instant. At another instant 20 minutes later it is found to be 9,000 counts/second. What is the count rate 40 minutes after the initial measurement?

7. (pts) In the lab “Numerical Determination of Energy Level,” you determined the shapes of physically acceptable wavefunctions. You are given the following proposed wavefunctions.

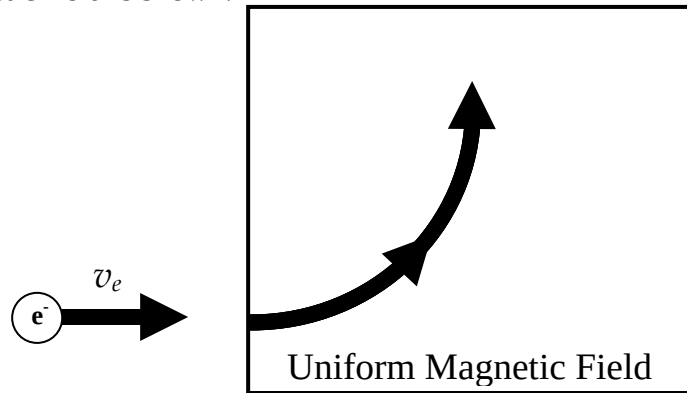


a) Identify and write down the letters for **any** wavefunctions which are physically **unacceptable**:

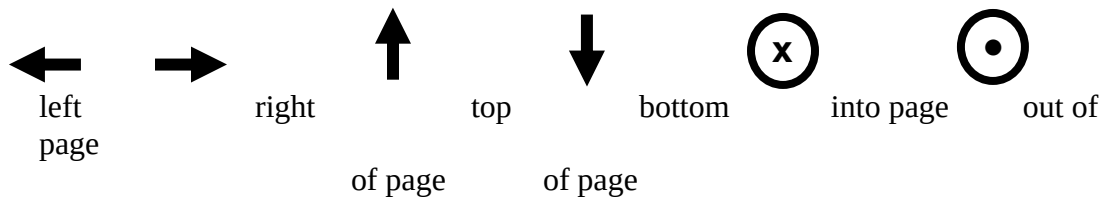
b) Identify and write down the letter for the ground state of the harmonic oscillator potential as used in the lab:

c) Identify and write down the letter for the first excited state of the harmonic oscillator potential as used in the lab:

8. (pts) An electron is accelerated from rest through a potential difference ΔV , reaching a speed v_e , traveling to the right. The electron then enters a region of uniform magnetic field. A portion of the trajectory of the electron in this uniform magnetic field is shown.



a) What is the direction of the magnetic field? (circle one)



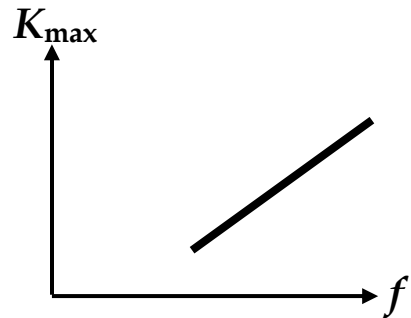
b) The magnetic field is doubled. What happens to the radius of curvature of the electron's trajectory? (circle one)

- | | | |
|---------------------------|---------------------------|---------------------|
| increases by more than 2x | increases by 2x | remains the same |
| decreases by 2x | decreases by more than 2x | can't be determined |

9. (pts) In a photoelectric effect experiment, you shine light of different frequencies on a metal plate, and determined the maximum kinetic energy of electrons ejected from the metal surface. You obtain the following results:

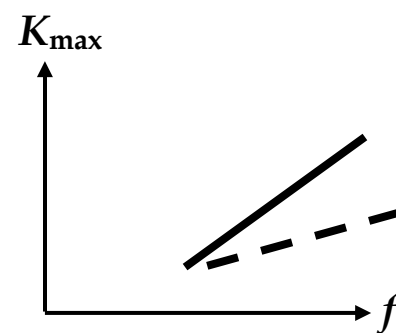
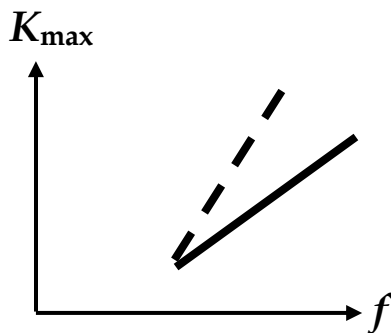
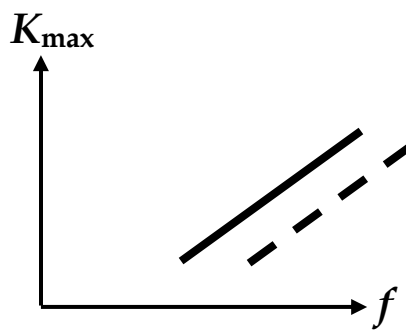
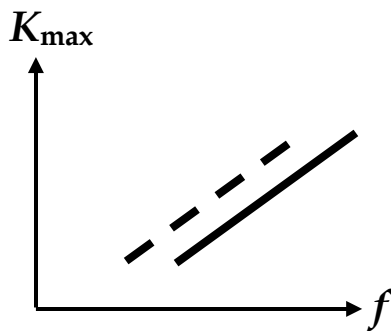
f (Hz)	4.84×10^{14}	6.0×10^{14}	7.5×10^{14}
$K_{\max}$ (eV)	1	1.48	2.1

When you plot maximum kinetic energy vs. frequency, you obtain a straight line as sketched on the right:

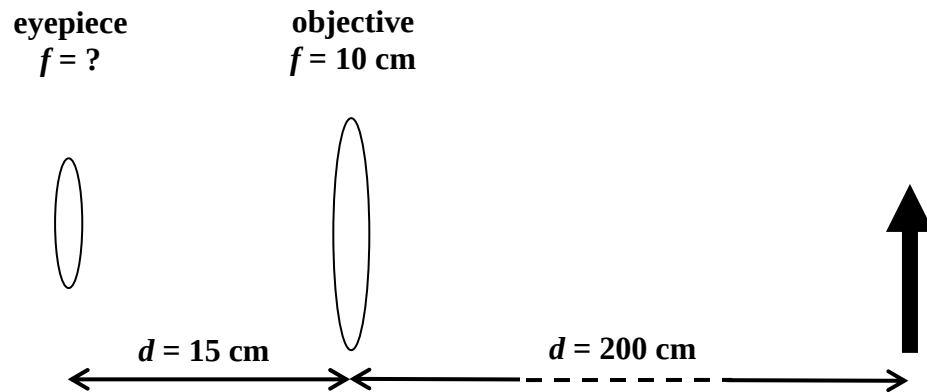


- a) At what value of frequency does this straight line intersect the x-axis?

- b) You repeat this experiment, this time using a metal with a higher binding energy (work function.) Which of the following best indicates the graph you would obtain when you plot maximum kinetic energy vs. frequency? The solid line is the previous data set, and the dashed line is the new data. (Circle one)



10. The diagram below shows lenses arranged as a telescope, so that when looking through the eyepiece, the arrow is in focus.



- a) Determine the focal length of the eyepiece. Show all work.
- b) This telescope was then used to view a very distant object. The eyepiece was:
- (i) left at the same distance from the objective.
 - (ii) moved closer to the objective.
 - (iii) moved further away from the objective.
 - (iv) There is insufficient information to determine how the eyepiece was moved.

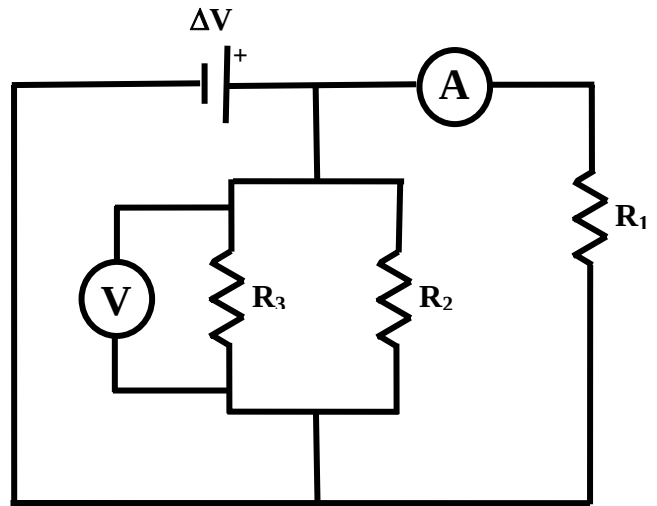
11. Given the following circuit diagram:

$$\Delta V = 12 \text{ V}$$

$$R_1 = 10 \, \Omega$$

$$R_2 = 3 \, \Omega$$

$$R_3 = 3 \, \Omega$$



a) Use a Kirchoff Rule and Ohm's Law to determine the current through R_3 . Show all work.

b) What is the reading on the voltmeter?

3 V

4 V

6 V

12 V