Lab2

Started: Mar 9 at 12am

Quiz Instructions

** **Academic integrity:** Many of the questions in this report will need to be typed in. You need to write in your own words. Copying and pasting from another source is cheating and an academic integrity violation form will be filed.

This is your first lab which is about waves. You will need to download the Phet simulation which is a JAVA program. Make sure to try this before the due date. You may need to download JAVA to make this work. Labs involved open ended questions that will be graded "by hand." **As such you get ONLY ONE attemp**t to complete this assignment. You can find the simulation here http://phet.colorado.edu/en/simulation/wave-interference.

Question 1

8 pts

Download the simulation from http://phet.colorado.edu/en/simulation/photoelectric and open it.

Set the light color to red with the slider. Bring up the light intensity slowly toward 100%. Does the light have sufficient energy to dislodge the electrons from the sodium target? Do you see any blue dots representing electrons moving?

- yes
- no

Question 2

8 pts

Use the Options menu (up & left) to select "Show Photons". Move the intensity slider back and forth. What is the intensity of light actually controlling in terms of photons?

HTML Editor

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Question 3

8 pts

Test with yellow light and green light. At what wavelength are the electrons first dislodged from the surface of sodium? Make sure to write your units.

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Question 4

8 pts

The wavelength that you just found corresponds to a frequency called the threshold frequency (using the relation speed = wavelength x frequency). For sodium, the threshold frequency is 5.66×10^{14} Hz. With the color slider at the threshold frequency (or threshold wavelength found in Question 3), what does increasing the intensity do in the experiment?

- more electrons are ejected
- less electrons are ejected
- nothing changes

Question 5

8 pts

With the intensity at 50%, slide the color slider to shorter wavelength (blue or smaller). What effect does higher frequency (shorter wavelength) have on the ejection of the electrons?

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Question 6

8 pts

Return the color slider to the color that just barely ejects electrons from the metal (Question 3). What is the energy of the photon in electron-volts (eV) for this color (or frequency)? Look at the course content website to find the formula for the energy of a photon (the formula that Einstein proposed). You can approximate Planck's constant h to be 4×10^{-15} eV s, and the threshold frequency f is approximately 6×10^{14} Hz.
This is the **cost in energy needed to eject each electron** out of the metal.

- 0.24 eV
- 2.4 eV
- 24 eV
- 24×10^{2} eV

Question 7

8 pts

Slide the wavelength to 430 nm (violet light) (approximately $f = 7 \times 10^{14}$ Hz). Calculate the energy of this photon in eV.

- 1 eV
- 2.8 eV
- 2.8×10^2 eV
- 400 eV

Question 8

8 pts

Keep the wavelength at 430 nm. Electrons are now ejected with a noticable speed. They have extra kinetic energy compared to the electrons that were just barely ejected in Question 6.

How much kinetic energy do they have (in eV, electron-volts)? I am a looking for a number and an explanation. How much extra energy do they have compared to the electrons in Question 6?

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Question 9

9 pts

The simulation makes watching electrons easy but in real life we don't see electrons. In order to figure out what is going on we put the sodium target inside of a vacuum tube and we connect the cathode and anode to a voltage source. Let's play with that a bit. Set the intensity to 50% and the wavelength near 200 nm (ultraviolet). Starting with zero voltage, slide to +5 Volts. **What do you observe regarding the motion of electrons**. **What is the current in the circuit?** The number in the bottom right part is given in amps.

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Question 10

9 pts

With the wavelength held at 200 nm, ajust the electric potential difference (by adjusting the voltage V) between the plates to just barely stop the electrons. Record this value and write it below. This is the stopping potential.

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Question 11

9 pts

Explain how can we find the energy of the photons by simply measuring the stopping potential?

Hints: The stopping potential measure what kind of energy for which particle, the electron or the photon? What steps do you need to take to retrace all the way back to the energy of the original photon?

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Question 12

9 pts

Choose one part of the photo-electric experiment **that cannot be explained** by assuming that light is a wave. Why do we need the concept of light as a particle? (Look at course content website for some help there.)

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