Photoelectric Effect

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March 31, 2011

1 Introduction

Using theoretical knowledge of the photoelectric effect and photoelectrons, determine Planck's constant and the work function of the metal.

1.1 Apparatus

A mercury discharge tube is placed in front of a cathode in a vacuum diode, separated by a high freuency cut-off filter. Photoelectrons are released and two potentiometers are used to control the retarding voltage between the cathode and the anode. A galvanometer, voltmeter, and voltage source are also used. The voltage source is two 1.5 V batteries in series.

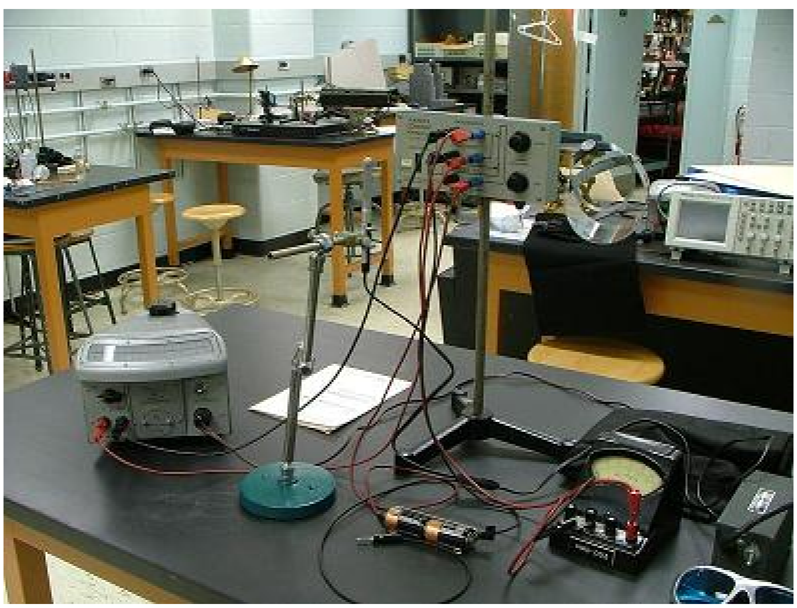
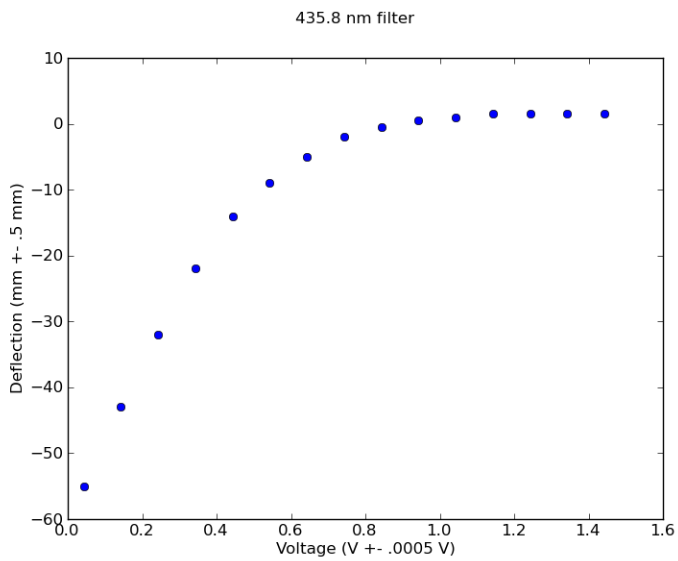


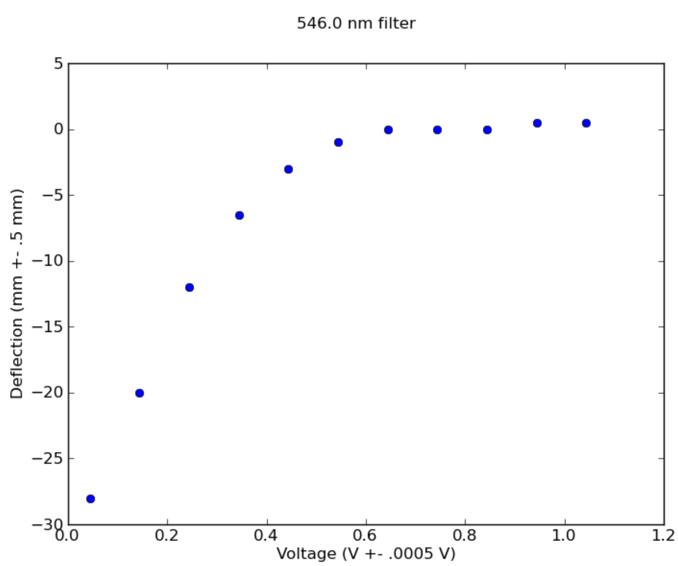
Figure 1: Apparatus

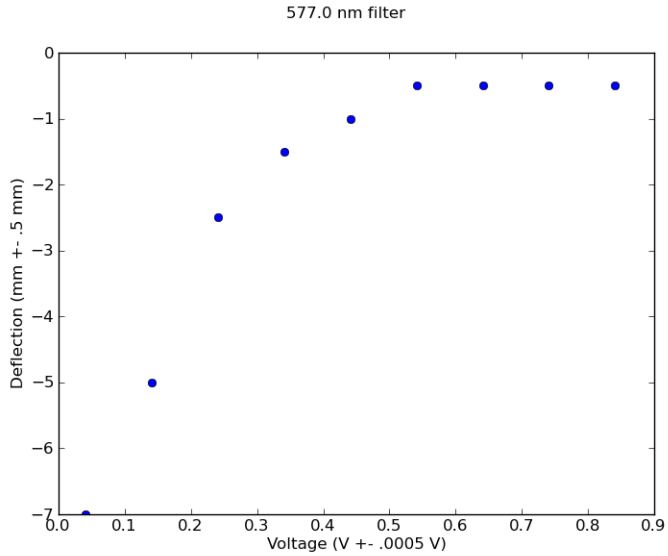
2 Theory

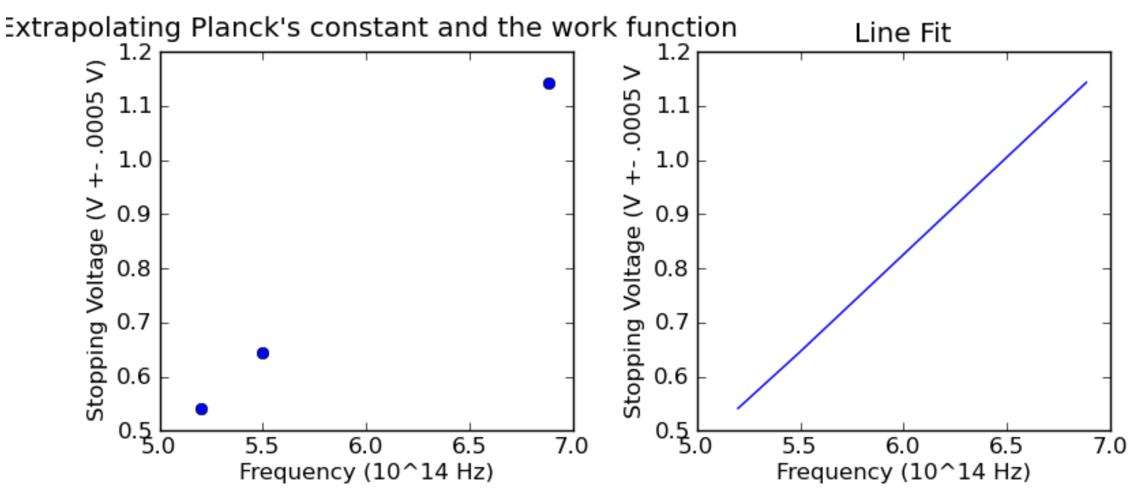
This section of the manual is clear and concise, with the exception of this passage, "Electrons inside the metal whose energy is less than K_{max} will be ejected with less energy." I'm pretty sure they meant to write, "Less than E_{max}," because electrons inside the metal aren't yet described by some photon energy hν.

3 Data






577.0 nm filter
Deflection (mm +- .5 mm)
Voltage (V +- .0005 V)
0
−1
−2
−3
−4
−5
−6
−7
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9


Extrapolating Planck's constant and the work function
Line Fit
Stopping Voltage (V +- .0005 V)
Stopping Voltage (V +- .0005 V
Frequency (10^14 Hz)
Frequency (10^14 Hz)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
5.0
5.5
6.0
6.5
7.0

4 Calculations

Using the value for the slope of the line fit through stopping voltage plotted against photon frequency:

$$V_s = \frac{h}{e}\nu - \frac{\phi}{e}$$

$$\frac{h}{e} = 3.579x10^{-15}$$

$$h = (3.579x10^{-15})(1.60217646x10^{-19}) = 5.734x10^{-34}$$

5 Error Analysis

There was uncertainty in the voltage and galvanometer The voltage readings were accurate out to three decimal places, so the uncertainty in these readings is $\pm.0005$ V. The distance represented between two ticks on the galvaometer is 1 mm, so the uncertainty in these readings is $\pm.5$ mm.

$$\%Error = \frac{|5.734x10^{-34} - 6.626x10^{-34}|}{6.626x10^{-34}} = 13.5\%$$

6 Conclusion

I obtained reasonable results and I saw what I expected to see. My result was on the same order of magnitude as the constant I was aiming to calculate, and wasn't very far off. I sufficiently understood this lab.

7 Questions

1. Do the flourescent lights near your lab bench produce an effect?

Yes, it produced a deflection of 1 mm to the left of the zero.

2. Record the sensitivity of the galvanometer which is pasted on it.

110 nominal ohms is the only thing written on the galvanometer. I tried to find the sensitivity by plugging in the batteries, but the current they supplied caused a displacement on the galvanometer which was far too large to read. Sensitivity for galvanometers is defined as some current (usually in milliamps) per mm.