**Introduction**

**(good theory section, paraphrase)**

When a photon of light of wavelength λ and sufficient energy strikes a metal surface, an electron will be ejected from the surface. The kinetic energy *KE* of the ejected electron will be less than the energy of the incident photon by the amount of work necessary to strip the electron away from the surface. The amount of work varies with the depth of the electron in the metal surface. This is expressed by the following inequality:

c

where *W* is known as the *work function* of the surface, and where *h* is Planck’s constant, and *c* is the speed of light. The maximum kinetic energy of the photoelectrons is usually measured by finding the voltage V necessary to stop all such electrons from reaching a positively biased collector. Thus we get:



where *e* is the electron charge, and Φ is the voltage associated with the work function.

Rewriting the previous equation, we get:



Thus if we plot a graph of V versus the reciprocal of the wavelength, and fit a straight line to it, we can obtain Planck’s constant from the slope of that line, and the work function voltage from the y-intercept of the line. Solving for Plank’s Constant we get:

# Procedure

1. Arrange the photoelectric (PE) apparatus and the mercury light source so that the light is at the same height as the opening to the photoelectric cell. Insert the blue (436 nm.) filter between them. Connect the voltage output from the apparatus to the DVM.

2. Turn the voltage knob on the PE apparatus to the maximum (all the way clockwise), then switch on the light source and the PE apparatus. Adjust the zero knob so that the nanoammeter reads zero. Now SLOWLY turn the voltage knob down to zero (all the way counterclockwise). If the nanoammeter needle goes off scale, move the light source farther away. Arrange the light source so that when the voltage knob is at zero, the meter reads 10 or 12 nA. (Set to 12 Na, move light source to make it read this.)

3. Now record the voltage for a series of current values such as 10,8,6,4, 2, and 1 nA. You should turn the voltage knob to maximum and reset the zero after each measurement. (Make sure meter reads 12 nA before taking each measurement. If not so, adjust position of light source till it is so. )

4. Turn off the equipment, and replace the blue filter with the green (546 nm.) one. Repeat procedures 2 and 3.

5. Turn off the equipment. Replace the green filter with the red (690 nm.), and replace the mercury light source with the incandescent source. Repeat procedures 2 and 3.

6. Turn off the equipment and remove the red filter and light source. Replace it with the diffused He-Ne laser (633 nm.). Repeat the procedures.

**Calculations**

For each of the four wavelengths,

1) **Plot** a graph of current vs voltage and **plot** a graph of current vs voltage squared ( v2 ).

(Volts on Y axis, current on X axis)

2) Determine which is best fit using LINEST. (Use same fit for all four wavelengths.)

Explain in choice in results, use LINEST stats to su rt.

3) Use LINEST to determine Y intercept value and its error.

This is the Stopping Voltage measurement.

(Add Instrument error for voltage reading to LINEST Error if necessary.)

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4) Now **plot** the Stopping Voltage versus Inverse Wavelength (

5) Use LINEST to find the Y Intercept value and its error.

This is the Work Function Voltage.

(Add Instrument error for voltage reading to LINEST Error if necessary.)

From the results above:

6) **Calculate** Plank’s Constant for each Wavelength, with error propagation, using the work function voltage found above.

7) Use LINEST to find the slope (s) and its error on the Stopping voltage vs Inverse Wavelength plot.

8) Use the slope to **calculate** Plank’s Constant and its error.

You will have 5 values of Planks Constant to give in your results.

1) Compare all values of Planks Constant found in Results. How accurate are the results?

2) Is there any difference in accuracy for the two different methods. Was there a trend in the results? Which way was most accurate?

3) Determine greatest source of error for both methods. Suggest how to reduce this error. Are there any other errors that are significant? How can we reduce those errors?

In calculations section I expect:

Two Calculations plus error propagation, with Values and Errors for each input.

1) ; 4 sets of Inputs V and (LINEST, Instrument, & Total Error)

2) ; Input s = slope from V vs . (Only LINEST Error)

Six plots with LINEST statistics.

1) One plot bad fit, four plots good fits for current and voltage.

2) One plot V vs .