Objectives: 1) To determine an experimental value for Planck's constant.
2) To determine the work function of the metal in the photo-sensor.

Theory: In order to determine an experimental value for Planck's constant, we must combine a number of theories and equations about the photoelectric effect that we learned in class. Max Planck created the first of these in 1900.

Eq1: $$E = hf = h\left(\frac{c}{\lambda}\right)$$

This formula states that the size of a quantum of energy equals the frequency of the oscillator or the inverse of the wavelength multiplied by Planck's constant.

The next principle involved comes from Einstein himself. He theorised that, to release an electron through the photoelectric effect, a mininmum energy was required. He called this the work function.

Eq 2: $$\phi = h \cdot f_0$$

Any extra energy given to the electron by the photon would be expressed in the form of kinetic energy. Combining this fact with Eq 2 gives:

Eq3: $$E = \phi + E_k = \phi + eV_0$$

Where e is the charge of 1 proton and V_0 is the retarding potential that eliminates all current.

Combining Eq 3 with Eq 1 gives a new equation that can be used to compare the wavelength of the incident light with the retarding potential:

Eq 4: $$h\frac{c}{\lambda} = \phi + eV_0$$

This equation can be simplified into a linear relation:

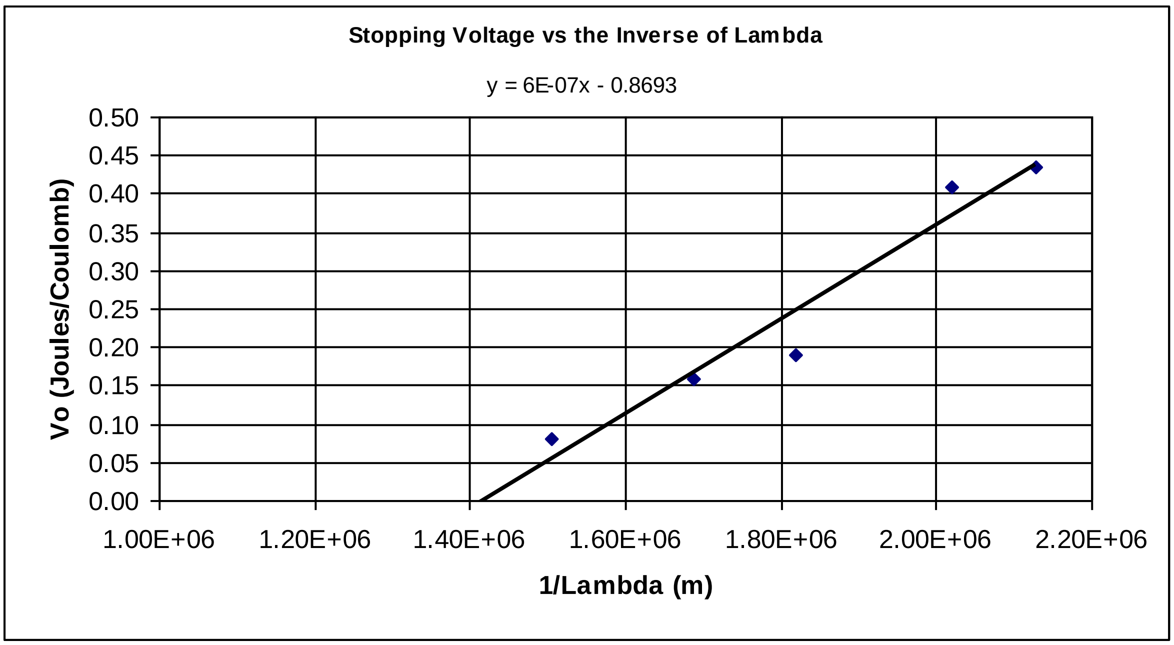
Eq 5: $$V_0 = \frac{hc}{e}\left(\frac{1}{\lambda}\right) - \frac{\phi}{e}$$

Where the slope is $\frac{hc}{e}$ and the y-intercept is $-\frac{\phi}{e}$.

Data:

Lambda	1/lambda	Vo
6.65E-07	1.50E+06	0.08
4.70E-07	2.13E+06	0.44
4.95E-07	2.02E+06	0.41
5.50E-07	1.82E+06	0.19
5.93E-07	1.69E+06	0.16

Data Analysis:



Results: Planck's Constant

$$slope = \frac{hc}{e} = 6\times10^{-7}$$

$$\therefore h = 3.2\times10^{-34}$$

Work Function

$$-\frac{\phi}{e} = .8693$$

$$\therefore \phi = 1.39\times10^{-19}$$

Cutoff Wavelength

$$0 = 6\times10^{-7}\cdot\frac{1}{\lambda} - .8693$$

$$\lambda_c = 690\,nm$$

$$\%\ difference = \left|\frac{3.2\times10^{-34} - 6.626\times10^{-34}}{3.2\times10^{-34} + 6.626\times10^{-34}}\right|\cdot 200 = 69.73\%$$

<u>Uncertainty</u>:

Due to the incredibly small value of Planck's constant, an accurate experimental value is nearly impossible with the instruments we were using. Since the precision of the equipment is beyond our control, we have an acceptable uncertainty of between 50 and 100 %. So long as our experimental value is of the correct magnitude, we will consider this experiment a success and our theories verified.

<u>Conclusion</u>:

Our experimental value of Planck's constant was well within the limits set by experimental uncertainty. We could have acquired more precise data if the computer interface had been used to find the exact value of V_0 instead of a multisensor, but all in all, this lab was successful in determining the value of Planck's constant.