Photoelectric effect

Following Einstein's work, shining a light on a material will transfer momentum to electrons knocking the electrons off of the material. The electrons receive energy from the photon, and part of the energy is lost overcoming the potential barrier at the metal (which is called the work function). The consequence is this: the maximum kinetic energy which the emitted electrons will have is given by:

$$KE_{max} = hf_{photon} - \phi$$

where the work function is given by φ. At it's heart, this is an expression of energy conservation. In order to measure this kinetic energy, the emitted electrons are captured on the plate of a capacitor. As more and more electrons are emitted, the potential difference across the capacitor builds up until eventually the current from the emitted electrons drops to zero. It is really a rather remarkable bit of engineering, in my opinion, to use the actual photocurrent to produce the reverse potential which eventually stops the electrons.

After the electron current has ceased (which is indicated by the reverse potential holding constant), a measurement is made of the reverse potential, V. From this, the maximum kinetic energy of the electrons is obtained by:

$$KE_{max} = eV$$

The light for today's experiment comes from a mercury vapor lamp. It is important to switch the lamp on only once for today's lab (I'll do that). The light from the mercury vapor lamp is separated into separate lines through a diffraction grating and a lens. You should focus individual lines on the slit in the photocell one at a time. Push the zero control on the photocell box to short the capacitor. Then release it. On the voltmeter, you will observe the reverse potential slowly increase and then level off at a maximum value. On your spreadsheet, next to the corresponding frequency, record the maximum voltages observed. You will then fit your data to a linear fit. The slope will be given by:

$$slope = \frac{h}{e}$$

The work function will be related to the x-axis intercept by

$$\phi = h f_0$$

This work function is different for different materials. Pasco did not mention what the material is in this particular photocell, so there is no standard for comparison here. The y-intercept is also related to the work function: it is

$$y_{intercept} = \frac{\phi}{e}$$

Incidentally, for the yellow band, use the yellow filter. For the green band, use the green filter if available. If your green band data varies significantly from my earlier measurement, you may consider discarding this one data point.