Prelab #5: The Photo-electric Effect

3.0 Watch the videos and read the manual first, and record how much time you spent on this effort (2pt)

~30 mins

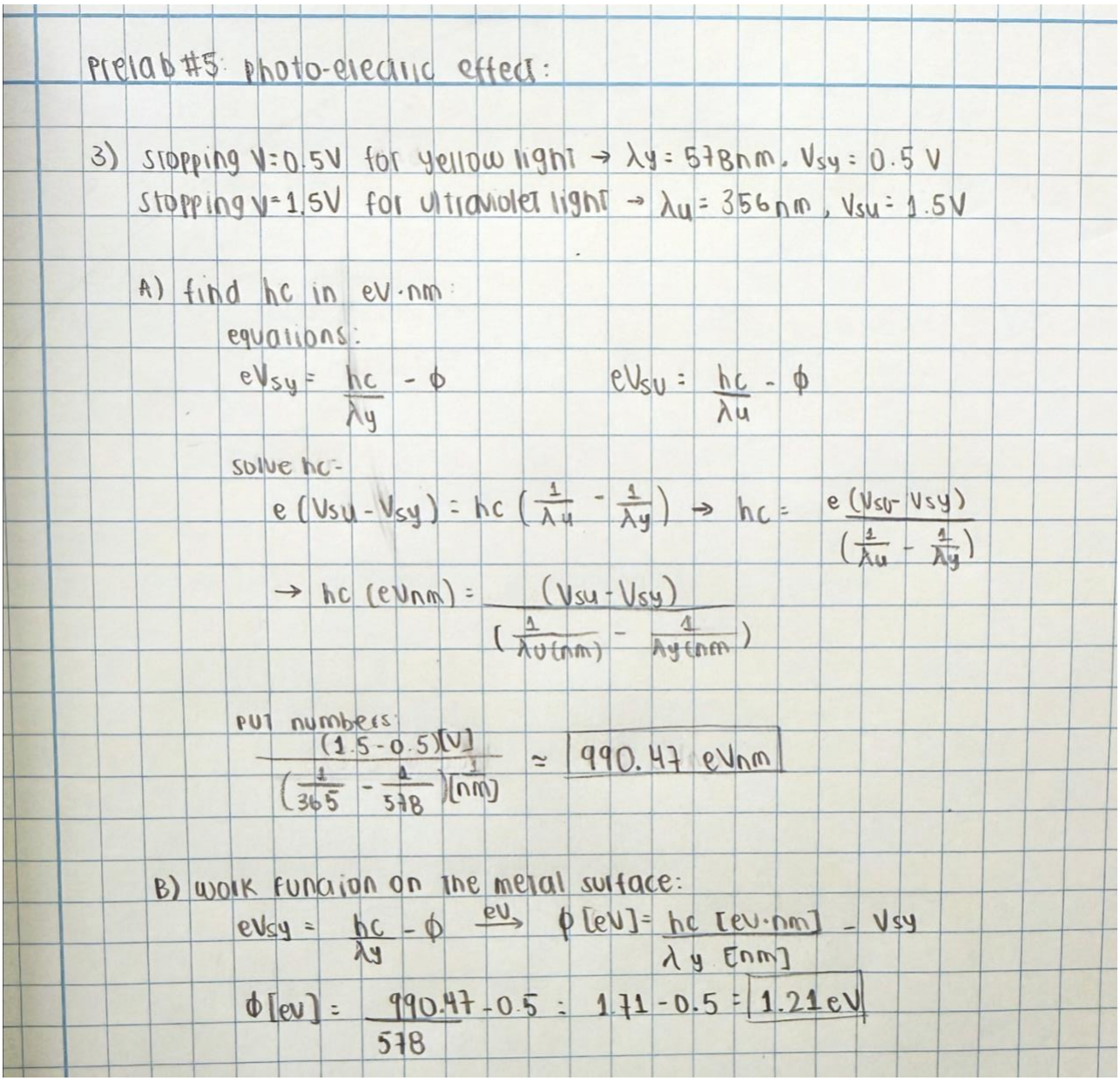
3.1 Summarize the experiment in no more than 5 sentences: What physics phenomenon are you investigating, what will you be measuring (observables), what physics constants will you be determining from this experiment (2pt)

In the photoelectric effect experiment we study how light can make electrons leave a metal surface. We do it by shining different colors of light from a mercury lamp in to a metal surface and measure the voltage needed to stop the electrons from moving (stopping voltage). We record the wavelength and voltage for each color. Using this, we calculate 2 values: hc which connects light energy and wavelength, and the work function that shows how strongly the electrons are held by the metal.

Assume you have determined that the stopping voltage for the yellow light is 0.5V and it is 1.5V for the ultraviolet light.

A. Determine the value of hc? The wavelengths of the mercury spectrum can be found in the manual. Express the results using the unit of ev*nm (3pt)

B. Determine the work function of the metal surface. (3pt)



Prelab #5: photo-electric effect:

3) stopping V=0.5V for yellow light → $\lambda_y = 578nm$, $V_{sy} = 0.5\ V$
stopping V=1.5V for ultraviolet light → $\lambda_u = 356nm$, $V_{su} = 1.5V$

A) find hc in eV·nm:

equations:

$eV_{sy} = \frac{hc}{\lambda_y} - \phi$ $\qquad eV_{su} = \frac{hc}{\lambda_u} - \phi$

solve hc:

$e(V_{su} - V_{sy}) = hc\left(\frac{1}{\lambda_u} - \frac{1}{\lambda_y}\right) \rightarrow hc = \frac{e(V_{su} - V_{sy})}{\left(\frac{1}{\lambda_u} - \frac{1}{\lambda_y}\right)}$

$\rightarrow hc\ (eVnm) = \frac{(V_{su} - V_{sy})}{\left(\frac{1}{\lambda_{u(nm)}} - \frac{1}{\lambda_{y(nm)}}\right)}$

put numbers:

$\frac{(1.5 - 0.5)[V]}{\left(\frac{1}{365} - \frac{1}{578}\right)\left[\frac{1}{nm}\right]} \approx \boxed{990.47\ eVnm}$

B) work function on the metal surface:

$eV_{sy} = \frac{hc}{\lambda_y} - \phi \xrightarrow{eV} \phi[eV] = \frac{hc\ [eV \cdot nm]}{\lambda_y\ [nm]} - V_{sy}$

$\phi[eV] = \frac{990.47}{578} - 0.5 = 1.71 - 0.5 = \boxed{1.21eV}$