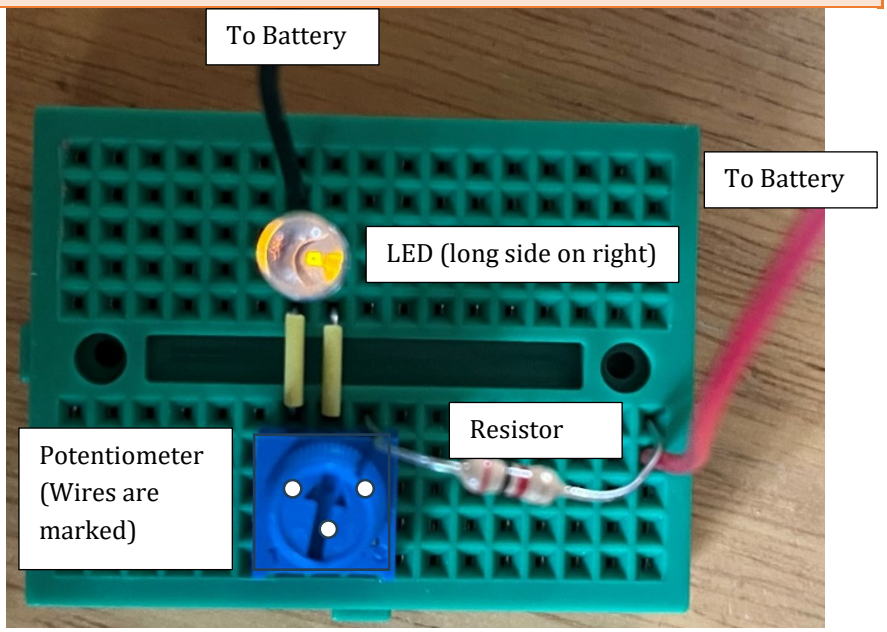
Physics 12-05 Find Planck's Constant Lab ***Name:*** _____

Objective: Find the value of Planck's Constant using LEDs

Materials

- Breadboard
- Several different colors of LEDs (not white)
- 2 jumper wires
- Potentiometer
- 100 Ω resistor
- Battery holder for 2 AA batteries
- 2 AA batteries
- Voltmeter (multimeter)
- Viewing tube (straw)



Theory

The amount of electrical energy is found by $E = qV$ where q is the charge in coulombs and V is the potential difference or voltage. This energy is converted into light by the light-emitting diode (LED). An electron moves from one piece of semiconductor to another releasing a photon of a specific wavelength. The energy of the photon is $E = hf$ where h is Planck's constant ($6.62607015 \times 10^{-34}\ J \cdot s$) and f is the frequency of the photon.

Setting these two equations equal to each other produces

$$qV = hf$$

$$V = \frac{h}{q}f$$

A graph of frequency vs. voltage should produce a straight line with a slope of $\frac{h}{q}$.

Procedure (DON'T LOOK AT BRIGHTLY LIT LED!)

1. Build the circuit on the breadboard. The columns (5 spaces) are connected, so that everything on the same column is connected. There is no connection across the big break between the columns.
2. Rotating the dial on the potentiometer will adjust the amount of current reaching the LED. Put the viewing tube directly over the LED so that the LED is inside the tube. Adjust the potentiometer until the LED is just barely producing light. You want it to be the dimmest light possible.
3. Use the voltmeter to measure the voltage across the LED by touching the probes to each side of the LED wires. Record this voltage in the table on the back.
4. Remove that LED from the circuit and insert a different color. Repeat steps 2 and 3 for each color of LED.
5. Convert the wavelengths to frequencies by using $c = f\lambda$. Use c = 299,792,458 m/s.
6. Graph the frequency and voltage date of the graph. Use the frequency as the x-axis and voltage as the y-axis.
7. Use a graphing calculator, or similar, to find the equation of the best-fitting line. _____
8. The slope should be $\frac{h}{q}$ where the charge is an electron. Use the $m = \frac{h}{q}$ to find h. h = _____ Js
9. Find the percent error between your result and the accepted value of $6.62607015 \times 10^{-34}\ J \cdot s$

$$\%\ error = \frac{experiment - theoretical}{theoretical} \times 100\%$$

   % error = _____
10. What are some sources of error?

11. As the energy of the photon increases what happens to its frequency? _____
12. As the energy of the photon increases what happens to its wavelength? _____
13. As the wavelength increases, what happens to the color? _____

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Color	Wavelength (average) (nm)	Frequency (Hz)	Voltage (V)
Red	635		
Orange	595		
Yellow	585		
Chartreuse (yellow green)	565		
Green	535		
Blue	465		
Purple	400