Name: _____

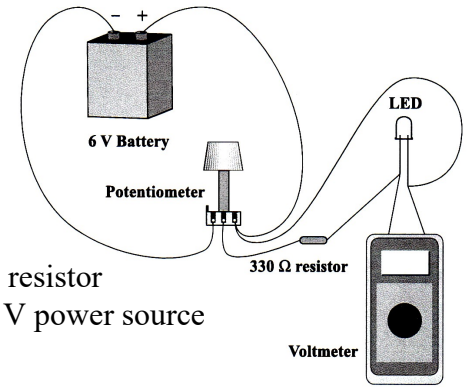
Date: _____

SPH4U **Lab: Measuring Planck's Constant**

The energy lost by a single electron that passes through a light-emitting diode (LED) is converted into the energy of one photon of frequency *f*. Planck's constant, *h*, "couples" the energy and frequency of a photon.

$$E = e\Delta V = hf$$

E: energy (J) *e*: electron charge (1.60×10^{-19} C) ΔV = potential diff. (V)
h: Planck's constant *f*: frequency (Hz)



Purpose
To approximately measure Planck's constant, *h*.

Apparatus
- set of 5 LEDs of various colours
- voltmeter and leads, assorted leads
- 1 kΩ potentiometer (variable resistor)
- 330 Ω resistor
- 6 or 9 V power source

Method

CAUTION: Do not stare directly at a brightly lit LED. Pack # _____

1. Connect the negative terminal of the power source to the left terminal of the potentiometer ("pot"), and the positive terminal to the right terminal. Turn the knob fully clockwise.

2. Connect the 330 Ω resistor between the central and right terminals of the pot. Connect the free lead to the other end of the resistor.

3. Place the LED in series with the resistor, by connecting the free lead to the shorter wire of the LED and making sure the longer wire of the LED is placed closer to the positive terminal of the source. Connect the voltmeter across the LED *only*.

4. One person will view the LED using the viewing tube. Using the pot, slowly turn the knob counterclockwise until the LED just barely lights. The other person will record this "threshold voltage." It might be useful to go back and forth a few times to make sure of your reading. Also, check that the sign of the voltmeter is as you expect (i.e., the voltmeter shouldn't have a negative sign when the positive lead is to the right of the resistor. DO NOT LEAVE THE LED LIT FOR TOO LONG.

Colour	λ (nm)	f (10^{14} Hz)	$V_{threshold}$ (V)
red			
orange			
yellow			
green			
blue			

5. Turn the pot back to zero, and repeat this measurement for a different LED. Be sure to always turn the pot back to a 0 V reading before connecting the next LED.

6. Summarize your results in a data table like the one on the previous page in Logger Pro 3.x or a spreadsheet. The wavelengths are written on the package of LEDs.

7. Create a graph of potential difference versus frequency and determine the slope of the line of best fit. *Note:* make the units of frequency 10^{14} Hz.

Submit ONE FILE PER GROUP showing: The completed data table, graph, and Notes box **on one page.** Print as a pdf and submit using assignment submission form.

Analysis

1. Based on the slope of the graph is _____.

2. Rearrange the equation on the previous page to determine what the slope *should* be.

3. Calculate the percent difference between your experimental value for Planck's constant and the accepted value ($h = 6.626 \times 10^{-34}$ Js).

4. Determine the uncertainty for your slope.

5. Does your line of best fit pass through the origin? Why or why not? *Should* it?

Questions

1. How good is your result? Discuss with reference to your uncertainty and your percent error.

2. Determine some possible sources of error for this experiment. *Hint:* what assumptions have you made about the equipment you used?

3. If the LED heats up, how might this affect your result?

4. Compare your result with those obtained by other groups. Why can you not expect all groups in your class to obtain the same h value?

INDIVIDUAL SUBMISSION:
Write an abstract summarizing the lab and submit using the assignment submission form. Put your completed notes (this packet) into your lab book.