**MP – Mr. Nicastro** **Lab Activity: Measuring Planck's Constant**

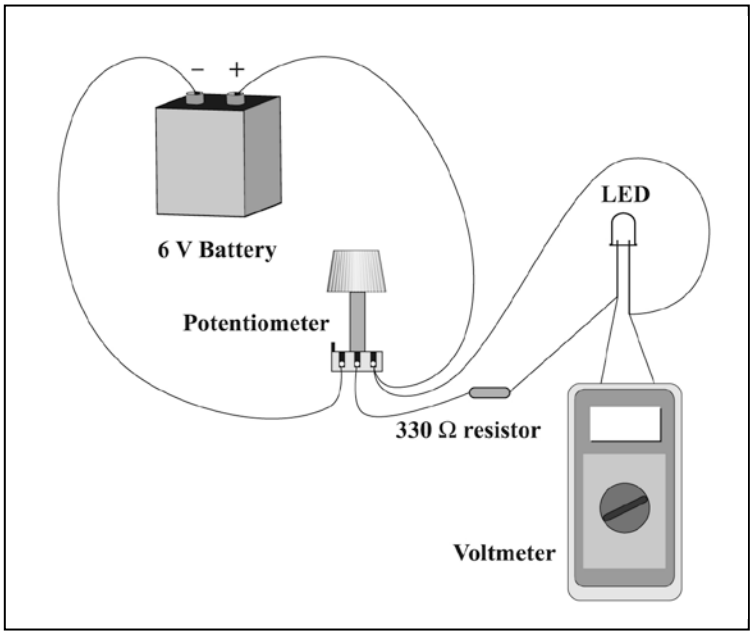
**(adapted from The Perimeter Institute of Theoretical Physics)**

**Aim:** To demonstrate the quantization of light and to measure Planck's constant (*h*).

**Background:** The energy lost by a single electron that passes through a light-emitting diode (LED) is converted into the energy of one photon.

$$e\,\Delta V = h\,f$$

$e$ = elementary charge = $1.6 \times 10^{-19}$ C
$\Delta V$ = potential difference across LED
$f$ = frequency of a photon emitted by LED




**Materials**
Set of 5 LEDs
6 V battery
1 kΩ potentiometer
330 Ω resistor
voltmeter
5 connecting leads

**CAUTION**
**Do not stare *directly* at a *brightly* lit LED.**

**Procedure**

1. Orient the potentiometer so that the terminals are pointing towards you. Turn the knob fully clockwise. Connect the negative terminal of the battery to the left-hand terminal of the potentiometer and the positive terminal of the battery to the right-hand terminal of the potentiometer, as shown in the diagram.
2. Connect any one of the LEDs to the 330 Ω resistor using a wire. Connect both of these components between the central and right-hand terminals of the potentiometer as shown in the diagram (with the *longer* wire of the LED attached to the *right-hand* terminal).
3. Connect the voltmeter across the LED.
4. Slowly increase the potential difference across the LED by turning the potentiometer knob counterclockwise until the LED **just begins** to glow. Record the potential difference at which this happens. Go backwards and forwards past the point at which the LED just begins to glow a few times to locate it as accurately as possible.
5. Repeat Step 4 for all the other LEDs. Always turn the potentiometer knob fully clockwise before changing LEDs so the initial voltage across each LED is 0 V.
6. Summarize your results in a table similar to the following:

| Color of LED | Red | Amber | Yellow | Green | Blue |
|---|---|---|---|---|---|
| Frequency ( x $10^{14}$ Hz ) | 4.54 | 5.00 | 5.08 | 5.31 | 6.38 |
| Potential Difference (V) | | | | | |

**Analysis**
1. Plot a graph of potential difference (y-axis) versus frequency (x-axis).
2. Draw the line of best fit and measure its slope. Use this slope to calculate Planck's constant by using the equation $e\Delta V = hf$ .

**Questions**
1. What is the percentage error in your calculated value for Planck's Constant?
2. A green laser pointer produces 530 nm light with a power rating of 1.0 mW. How many photons does the laser produce each second?
3. Weather reports monitor ultraviolet (UV) light levels. Why is UV light a concern?