Measuring Planck's Constant Through LEDs

Pablo Montejo-Tabora, Maddox Du, Luca Hurtado-Borsa, Matteo Hurtado-Borsa

Bellaire High School, Harvard John A. Paulson School of Engineering and Applied Sciences

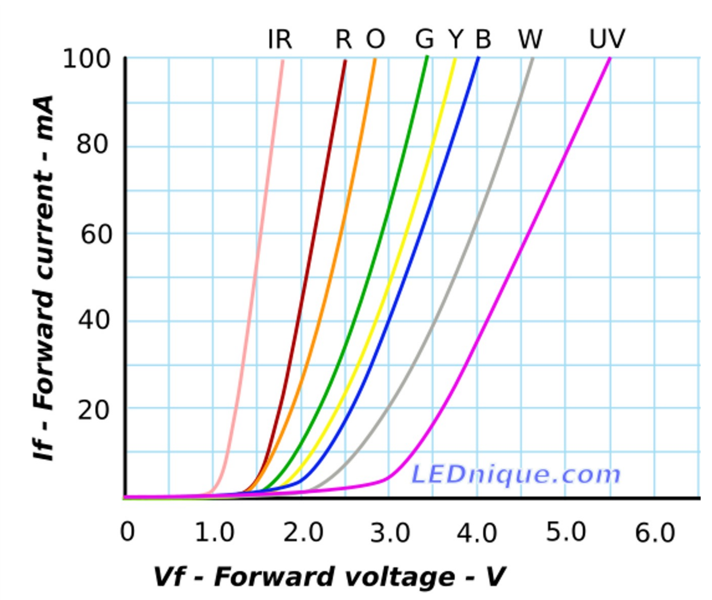
Harvard John A. Paulson School of Engineering and Applied Sciences

Background on Planck's Constant

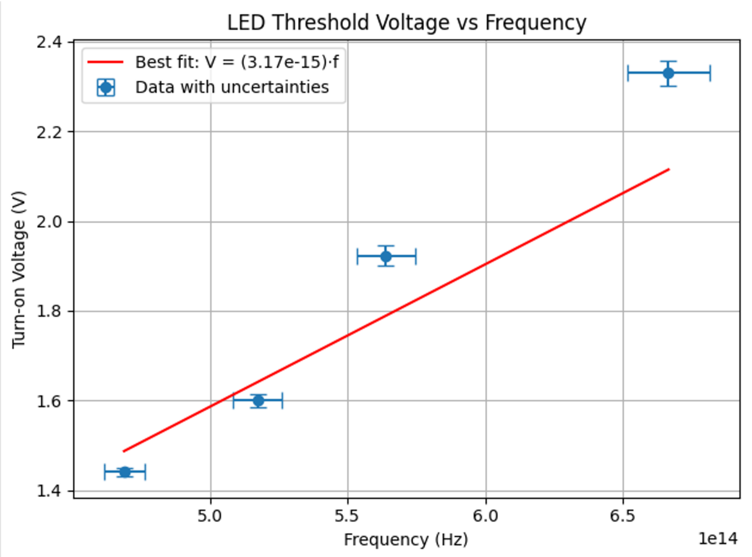
- Planck's constant is a universal constant that defines the quantum nature of energy and how the energy of a photon relates to its frequency. However, energy of a certain photon frequency cannot go to zero because Max Planck discovered that this is false and that energy comes in discrete steps or packets, called photons for light. Planck's constant was discovered by Max Planck in the beginning of the 20th century. He was working to find a formula to describe the radiant energy emitted as black-body radiation which is the energy shown by all objects based on its heat.
- Here, we measure Planck's constant experimentally by seeing what the minimum energy to emit photons of certain energy (wavelength)
- Planck's constant helps explains how quantum mechanics and modern electronics including computer chips, solar panels and lasers function.

Results

E = h*F
E is the energy
h is the Planck's constant
F is frequency
df = |d(c/λ)/dλ| * Δλ = (c / λ^2) * Δλ
df = uncertainty in frequency
Planck's constant = 6.626 × 10^-34 J·s
Our measurements = 5.08 x 10^-34 J*s
Percent Error= 23.30%
Combine voltage uncertainties: total = sqrt(**Σ**^2 + meter^2)



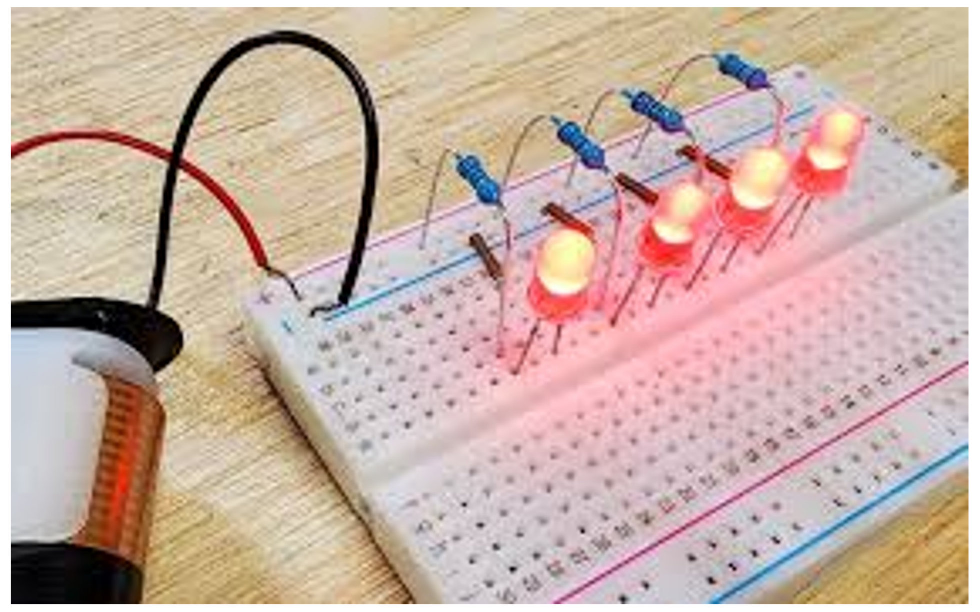
IV Curve



Turn-on Voltages Plotted

Percent error calculation
percent_error = abs((slope - expected_slope) / expected_slope) * 100
Measured h = 5.08e-34
Percent Error=(3.17e-15-(6.63e-34/1.60e-19))/(6.63e-34/1.60e-19)
Percent Error= 23.30%

Materials and Construction



For our experiment we used,
- an arduino,
- 4 different LEDs,
- a potentiometer,
- a multimeter,
- a resistor
- and a breadboard.

We used these components to measure the lowest energy we could input into the LEDs and still have enough photons for visible light. First, we connected the arduino 5V pin and GND pin to the red and black (+ and -) rails of the breadboard. Next, we wired up the potentiometer, connecting the appropriate pins to the power rails and the output to a resistor which was then connected to the positive terminal of the LED. Finally, we connected the negative terminal of the LED to the ground rail of the breadboard. We then turned the potentiometer all the way down. We looked at the LED through a cardboard box, slowly adjusting the potentiometer until we saw a tiny amount of light. The voltage was measured with the multimeter and this process was repeated three times for each colored LED, and the average of the trials were used in the calculations.

Analysis

Our experiment had a somewhat large margin of error because we were using normal classroom tools which do not have the highest level of accuracy. For our experiment we also did not use any sort of machine to detect photos. We simply put the LEDs into a dark box and looked inside to try to see the least amount of light them. We are also using LEDs which we do not know the exact wavelengths of.

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