

Energy of a Photon Demo

P6-8022

BACKGROUND:

Did you know that blue light photons have higher energy than red? We assume that all colors contain basically the same amount of energy. Sure it is demonstrated that dark colors, black especially, absorb more heat but what about how much energy (photons) each color itself contains?

It turns out that just as colors vary across the spectrum, so does the amount of energy their photons contain and the amount of energy it takes in a circuit to produce visible colored light. The Energy of a Photon Demonstrator will show the relationship of the wavelength of a color versus how much energy the photons contain. This also will illustrate that the more energy needed in a system results in more energy out of the system.

Light emitting diodes, LEDs, convert the energy change of one electron into one light photon. With the Energy of a Photon Demonstrator connected to a Genecon (or variable power source) slowly increase the energy of the electrons by increasing the voltage across the LEDs and you will see that the red LED comes on at the lowest voltage then the green and finally the blue at the highest voltage. But then what happens we add infrared or ultraviolet light into the mix? That is for you to experiment with your Energy of a Photon Demonstrator.

Lab Contribution: This lab activity was contributed Jim Nelson, retired physics teacher. Get Jim's student lab activity to determine the value for Planck's Constant: http://www.arborsci.com/Data_Sheets/Planck_LED.pdf

ENERGY OF A PHOTON DEMO CONTENTS:

4 LEDs (Red, green, blue, IR)

4 100 ohm resistors

Small circuit breadboard

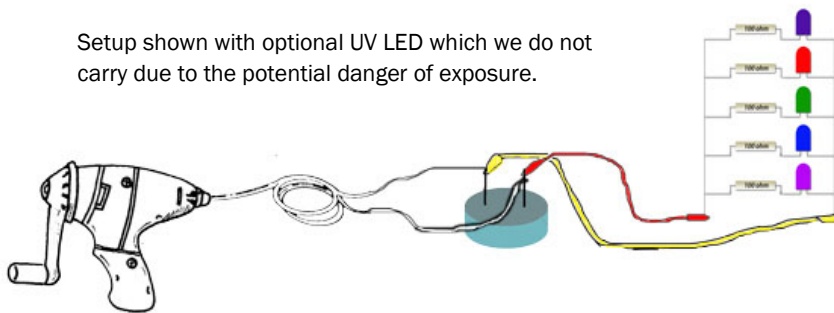
The Energy of a Photon Demonstrator comes completely assembled. All that is needed is a variable power source such as a Genecon and as an option, a one farad capacitor. Connecting the capacitor in parallel with the Energy of a Photon Demonstrator allows for a more controlled and smoother change in voltage across the circuit.

Begin by connecting the leads of the Genecon directly to the terminals of the LED circuit and strongly turn the handle of the Genecon in one direction. If the circuit LEDs do not light, turn the handle in the opposite direction. Next

Connect the leads of the Genecon (or variable power source) to one of the terminals of the 1 farad capacitor. Connect Alligator Jumper wires between the capacitor terminals and the LED circuit terminals. Note: The LED circuit will have a positive and negative terminal. If at first your circuit test does not light the LEDs, try reversing the polarity.

By turning the Genecon handle or increasing the voltage on your variable power supply you'll be charging the capacitor. Notice that first the red LED comes on, then the green and finally the blue. Then repeat the process of raising the voltage. When you first see light in the red LED, use a voltmeter to measure the voltage across the LED. Continue to measure at the green and blue LEDs and compare the results.

Setup shown with optional UV LED which we do not carry due to the potential danger of exposure.



If you have the IR and UV LEDs installed: Was the Red LED really the first to come on? Better check again. You can use the viewfinder of any digital camera or cell phone to see when the IR LED lights up. What about the last LED to light? Was it the Blue?

HOW IT WORKS:

The negative electrons have high energy at the negative terminal of the power supply. In the LED they enter the N-type semiconductor and drop all of their energy at the junction with a P-type semiconductor as they fall into holes. This energy is emitted as electromagnetic radiation, visible light in LEDs. The electrons then return to the positive terminal of the battery. In an incandescent bulb the electrons drop their energy gradually as they travel through the filament. Their electrical energy is converted to thermal energy. This thermal energy is then converted into electromagnetic radiation. **Wavelengths info:** Infrared 940nm, Red 660nm, Green 568nm, and Blue 468nm

