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**DETERMINATION OF PLANCK CONSTANT**

**Objective:**

The objective of this experiment is to experimentally determine Planck’s constant by investigating the relationship between the forward bias voltage applied to a p-n junction, its threshold value, and the wavelength of light emitted by different color LEDs (Light Emitting Diodes). Planck's constant, denoted by ℎ, is a fundamental physical constant used to describe the energy of a photon. By measuring the energy related to the bias voltage threshold value and the wavelength of light emitted by LEDs, we can calculate Planck's constant using the formula.

*E*= *q*⋅*V*0 / *λ*

**E is the energy of the photon**

**q is the charge on the electron,**

**V0​ is the threshold voltage, and**

**λ is the wavelength of light emitted by the LED.**

​​

THEORY

Planck's constant, ℏ[reduced planck constant], is a fundamental constant in quantum mechanics that relates the energy of a photon to its frequency or wavelength. It is defined by the equation:

E = HF = HC / *λ*

->E is the energy of the photon,

->F is the frequency of the photon,

-> c is the speed of light in vacuum,

->λ is the wavelength of the photon.

**In the context of LEDs, when a forward bias voltage is applied to a p-n junction, electrons from the semiconductor's conduction band recombine with holes from the valence band, releasing energy in the form of photons. This energy is proportional to the forward bias voltage ( Vo ) applied across the diode. Therefore, the energy of the emitted photon ( E) can be calculated as E = q.Vo ​ , where q is the charge on the electron.**

Apparatus

* Arduino UNO/NANA
* IN219 Wattmeter
* 5kOHMS resistor
* 10kOHMS potentiometer
* Red, yellow, green, white LEDs

Procedure:

This experiment consists of two parts:

**Part 1: Measurement of Wavelength**

->Set up the electrical circuit based on the provided schematic.

->Open the OceanView software and load the provided project file.

->Power up the circuit and adjust the potentiometer until the LED is lit up.

->Place the integrating sphere over the LED and adjust until the peak is about ¾ of the height of the screen.

->Pause the live spectrum updates and record the values of the peak wavelength and its Full Width at Half Maximum (FWHM).

->Repeat the above steps for all provided LEDs to produce a data table with peak wavelengths for each LED.

**Part 2: Measuring the Threshold Voltage**

Set up the circuit as described in the provided schematic.

Upload the provided code to the Arduino to collect voltage and current data from the wattmeter.

Gradually increase the voltage across the LED by turning the potentiometer until the voltage is greater than 0.5V.

Copy the data from the serial monitor into a spreadsheet, replacing any negative current values with 0.

Repeat the above steps for all provided LEDs.

Analysis

**THRESHOLD VOLTAGE FOR YELLOW [jupyter notebook]**

A screenshot of a computer

Description automatically generated

A computer code with colorful text

Description automatically generated with medium confidenceA graph with a line

Description automatically generated

THRESHOLD VOLTAGE VS CRRENT FOR RED

A graph with red lines

Description automatically generated

THRESHOLD VOLTAGE GREEN

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A graph with green dots

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A screenshot of a computer

Description automatically generated

A graph with a line

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Yellow wavelength = 584.771nm

**Resistor in the Circuit:**

1. Current Limitation: LEDs are sensitive to overcurrent, which can lead to their failure. The resistor limits the current flowing through the LED, ensuring it operates within its safe operating range.
2. Voltage Regulation: LEDs have a specific forward voltage at which they start conducting. The resistor helps regulate the voltage across the LED by dropping the excess voltage from the power supply.
3. Protection: The resistor acts as a protective element, limiting the current flow in case of a short circuit or sudden surge, thus preventing damage to the LED.
4. Stability: By adding a resistor in series with the LED, the circuit's stability improves, reducing the impact of fluctuations in the power supply voltage or changes in the LED's characteristics over time.

IN SHORT, HAVING A RESISTOR IN THE CIRCUIT WILL LIMIT THE FLOW OF CURRENT THROUGH THE LED HAVING A SAFE RANGE OF CURRENT, VOLTAGE REGULATION, REGULATING THE VOLTAGE BY REMOVING ANY EXCESS VOLTAGE, PROTECTION AND STABILITY

**Impact of Color Dome Plastic Enclosure:**

Effect on Results:

By altering the transmission and diffusion of light emitted by the LED, the plastic enclosure, also known as the color dome, of the LED may have an impact on the experimental outcomes. The dome's ability to filter or scatter light will depend on its composition and color, which will change the detector's measurements of intensity and spectrum distribution.

POSSIBLE SOURCE OF ERROR

* LED manufacturing differences lead to variations in properties like voltage requirements and brightness, impacting measurements.
* Ambient Conditions: Environmental changes such as temperature and light levels can alter component performance, introducing errors.
* Instrument Mistakes: Measurement tools like voltmeters may provide inaccurate readings, affecting data precision. Positioning and Alignment:
* Misalignment of LEDs or detectors can result in incorrect measurements, akin to aiming a laser off-target. Calibration Problems:
* Inaccurate instrument calibration can lead to incorrect readings, necessitating proper adjustment for precise measurements.

conclusion