

Determination of Planck's Constant (h)

Using Light Emitting Diodes (LEDs)
Based on Lab Manual.

Aim & Apparatus

Aim: To determine the value of Planck's constant (h) using Light Emitting Diodes (LEDs) of different colors.

Apparatus :

- Planck's Constant determination kit (with built-in variable power supply and voltmeter)
- Various colored LEDs (Red, Orange, Green).
- Connecting patch cords.
- Temperature-controlled oven.

Formula :

Planck's Equation: Energy carried by a photon is $E = hf = hc / \lambda$

LED Activation: When forward-biased, current flows at a specific threshold voltage (V_0).

Energy Balance: At initiation, electrical energy equals photon energy: $e \cdot V_0 = hc / \lambda$

Working Equation: $h = (e \cdot V_0 \cdot \lambda) / c$

Where:

- e = Elementary electric charge (1.602×10^{-19} C).
- c = Speed of light in vacuum (3.0×10^8 m/s).
- λ = Wavelength of the emitted photon.

Experimental Data

- **Wavelengths (λ) of used LEDs:**

LED	Red	Orange	Yellow	Green
Wavelength in nanometres	700	600	570	550

- **Observation Table :**

1. • Applied Voltage (V) vs. Forward Current (I) is tabulated to observe characteristics.
2. • $\ln(I)$ vs. Voltage is plotted to isolate the true activation threshold voltage (V_0).

Experimental Data

RED LED:

s.no	Applied voltage (v)	Current (uA)	ln(I)
1	0.5	0	-
2	1.0	0	-
3	1.4	02	0.69
4	1.50	20	2.99

Experimental Data

Orange LED:

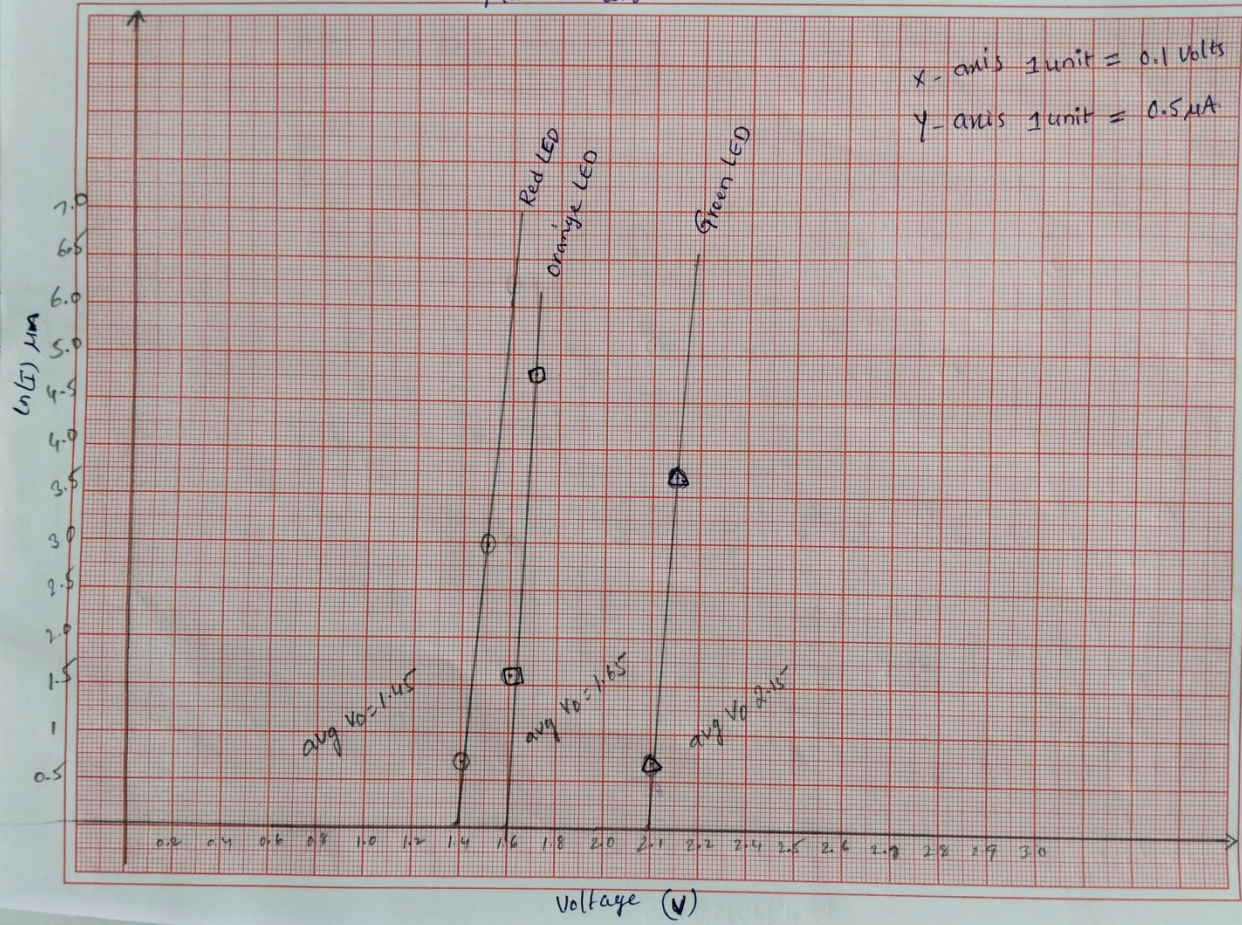
S.NO	Applied voltage (V)	Current (uA)	ln(I)
1	0.5	0	-
2	1.0	0	-
3	1.6	5	1.6
4	1.7	123	4.81

Experimental Data

GREEN LED:

s.no	Applied voltage (v)	Current (uA)	ln(I)
1	0.5	0	-
2	1.0	0	-
3	2.10	6	1.60
4	2.20	163	5.09

Planck's constant



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Graph & Threshold Voltage

- Graph Coordinates from :**

LED	Red	Orange	Green
Threshold voltage	1.45v	1.65v	2.15v

Calculations

- **Formula: $h = (e \cdot V_0 \cdot \lambda) / c$**
- 1. Red LED:
 - $h_{\text{red}} = (1.602 \times 10^{-19} * 1.45 * 700 \times 10^{-9}) / 3.0 \times 10^8$
 - $= 5.4201 \times 10^{-34} \text{ J}\cdot\text{s}$
- 2. Orange LED:
 - $h_{\text{orange}} = (1.602 \times 10^{-19} * 1.65 * 600 \times 10^{-9}) / 3.0 \times 10^8$
 - $= 5.2866 \times 10^{-34} \text{ J}\cdot\text{s}$
- 3. Green LED:
 - $h_{\text{green}} = (1.602 \times 10^{-19} * 2.15 * 550 \times 10^{-9}) / 3.0 \times 10^8$
 - $= 6.3100 \times 10^{-34} \text{ J}\cdot\text{s}$

Final Result & Conclusion

- **Average Value Calculation:**

- $h_{\text{avg}} = (h_{\text{red}} + h_{\text{orange}} + h_{\text{green}}) / 3$

- $h_{\text{avg}} = (5.42 + 5.29 + 6.31) \times 10^{-34} / 3$

- $= 5.67 \times 10^{-34} \text{ J}\cdot\text{s}$

- **Conclusion:**

1. • The experimental value of Planck's Constant is found to be $5.67 \times 10^{-34} \text{ J}\cdot\text{s}$.
2. • The standard value is $6.626 \times 10^{-34} \text{ J}\cdot\text{s}$, demonstrating structural alignment with theory.