Date 08-10-2021

Expt. No. 3 Page No. 1

Experiment → Determination of Planck's Constant

Aim:

To determine Planck's constant by measuring the turn-on voltage of several LED's

Apparatus: Planck's constant kit.

Formula:

$$h = E\lambda / c \quad Js$$

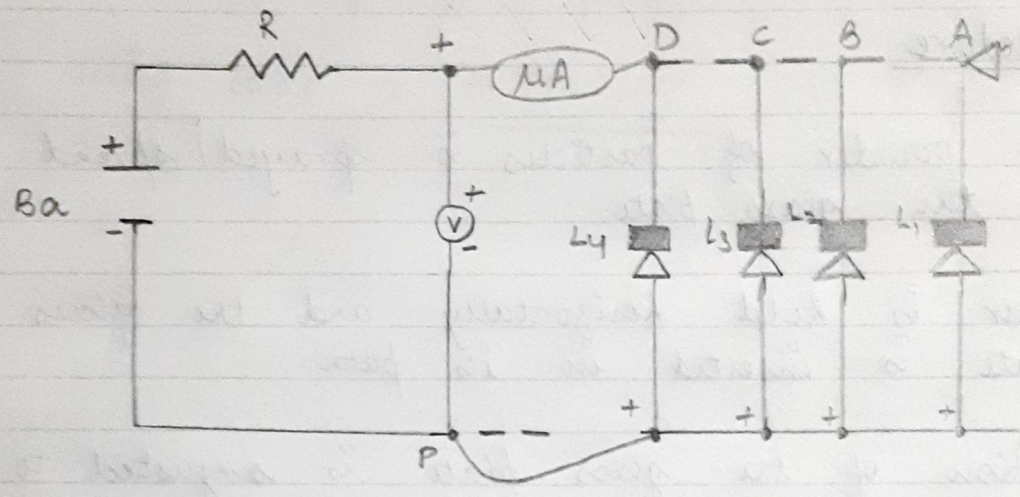
E = energy of light, $\lambda$ = wavelength of light emitted by LED and c - velocity of light

Principle:

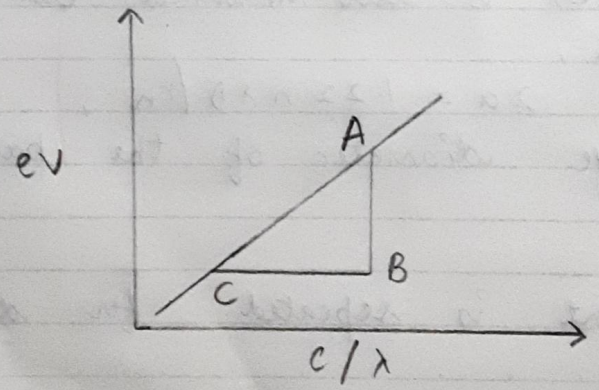
The height of potential barrier across the p-n junctions is reduced when it is connected to forward bias. At a particular input voltage the height of potential barrier becomes very low and the LED starts glowing. This is called turn on voltage.

Teacher's Signature :

## * Planck's constant set-up




## * Graph




$$h = \frac{AB}{BC}$$

## * Determination

$e = 1.6 \times 10^{-19}$ C , $C = 3 \times 10^8$ m/s

| LED | Wavelength ($\lambda$) nm | Turn on voltage ($V_0$) volt | Energy $E = eV_0$ | $h = E\lambda/C$ Js |
|---|---|---|---|---|
| Red | 650 | 1.81 | $1.6 \times 10^{-19} \times 1.81 = 2.896 \times 10^{-19}$ | $627.4 \times 10^{-20}$ |
| Orange | 600 | 2.06 | $3.296 \times 10^{-19}$ | $659.2 \times 10^{-20}$ |
| Green | 550 | 2.35 | $3.76 \times 10^{-19}$ | $\$ \$ 33 \times 10^{-20}$ |
| Blue | 450 | 2.62 | $4.192 \times 10^{-19}$ | $628.8 \times 10^{-20}$ |
| | | | | Mean $h = 651.18 \times 10^{-20}$ |

## * Observation

$E_g = eV_0 = h\nu = hc/\lambda$

$h = eV_0\lambda/c$ Js

Charge of electron $e = 1.6 \times 10^{-19}$ C

Speed of light $C = 3 \times 10^8$ m/s

## * Result

Planck's constant = (i) By theory → 651.18 Js

(ii) By Graph → Js

## Procedure

Circuit connections are made as shown in the circuit diagram as on panel. The wavelength of the given LED's are noted in the tabular column. The terminal P is connected to LED $L_1$. The supply voltage is varied slowly by varying the fine voltage knob of the regulated power supply. The voltmeter reading is noted down when the LED just glows this is the turn on voltage ($V_0$) for LED $L_1$. The same procedure is repeated for the other LEDs $L_2$, $L_3$ and $L_4$ by connecting the respective terminal. In each case the turn on voltage $V_0$ is noted. A graph of energy ($E = eV_0$) along y-axis and frequency ($\gamma = c/\lambda$) along x-axis is plotted.

The slope of the graph gives the Planck's constant.