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Experiment - 4

* Aim:-
Determination of plank's Constant.

* Apparatus Required:-
0 - 10 V power supply, a one way key, a rheostat, digital millimeter, digital voltmeter and 1k resistor and different known wavelength of LED.

* Theory:-

1) Plank's Constant (h), a physcial constant was introduced by german physiciat named max planck in 1900. The significance of Plank's Constant is that quants (small packets of energy).
Can be determind by frequency of radition and Plank's constant.
2) It describe's the behavior of particles and waves at atomic level as well as the particle nature of light.
3) An LED is a two terminal semiconductor light source. In the unbiased condition a potential barrier is developed across the p-n junction of the LED's reduced at a particular voltage the height of potential barrier become very low and the LED starts glowing, in the forward

biased condition electron crossing the junction are excited, and when they return to their normal state, energy is emitted. This particular voltage is called the knee voltage.

The light energy emitted during forward biasing is given:-

$$E = \frac{hc}{\lambda} \longrightarrow (1)$$

where, c = velocity of light
h = plank's constant
λ = wavelength of light.

If v is the forward voltage applied across the LED it begins to emit light (the knee voltage), the energy given to electrons crossing the junction, is.

$$E = ev \longrightarrow (2)$$

Equating (1) & (2) we get

The knee voltage V can be measured for LED with different values of λ (wavelength of light).

$$V = \frac{hc}{e}\left(\frac{1}{\lambda}\right) \longrightarrow (3)$$

Plank's Constant = $\frac{hc}{e}$

Using the known value $\frac{e}{c} = 5.35 \times 10^{-28} \frac{CS}{m}$

Alternatively, we can write Eqn 3 as.

$$h = \frac{e}{c} \lambda v$$

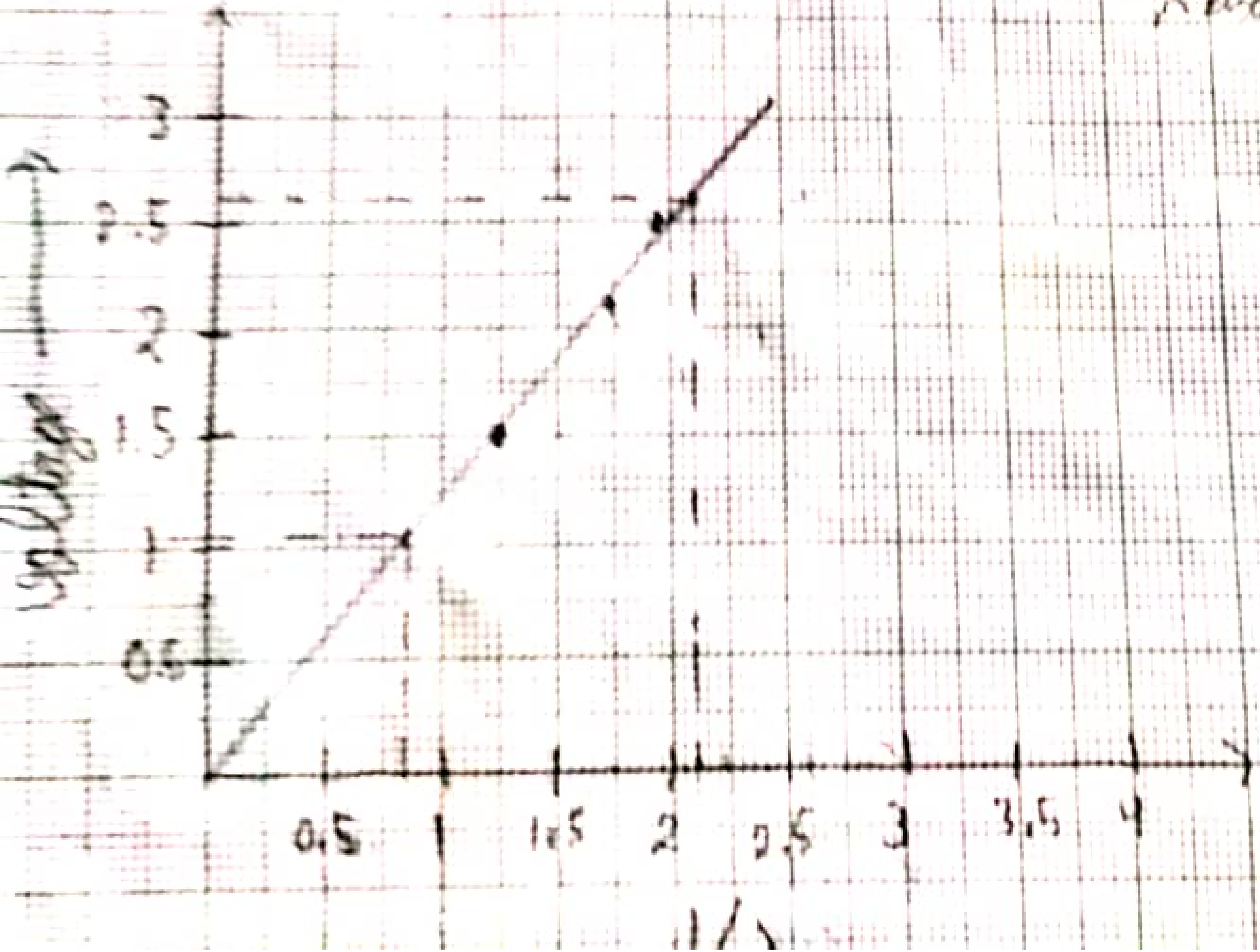
* Observation Table 1:-

	Colour	wavelength	knee voltage	$\lambda \times v$
1	Red LED	650×10^{-9}	1.59	1035.5
2	yellow LED	570×10^{-19}	2.17	1236.9
3	Infrared LED	1250×10^{-9}	1.12	1018.08
4	Green LED	510×10^{-9}	2.43	1239.3
5	Blue LED	476×10^{-9}	2.61	1216.2

* Observation Table 2:-

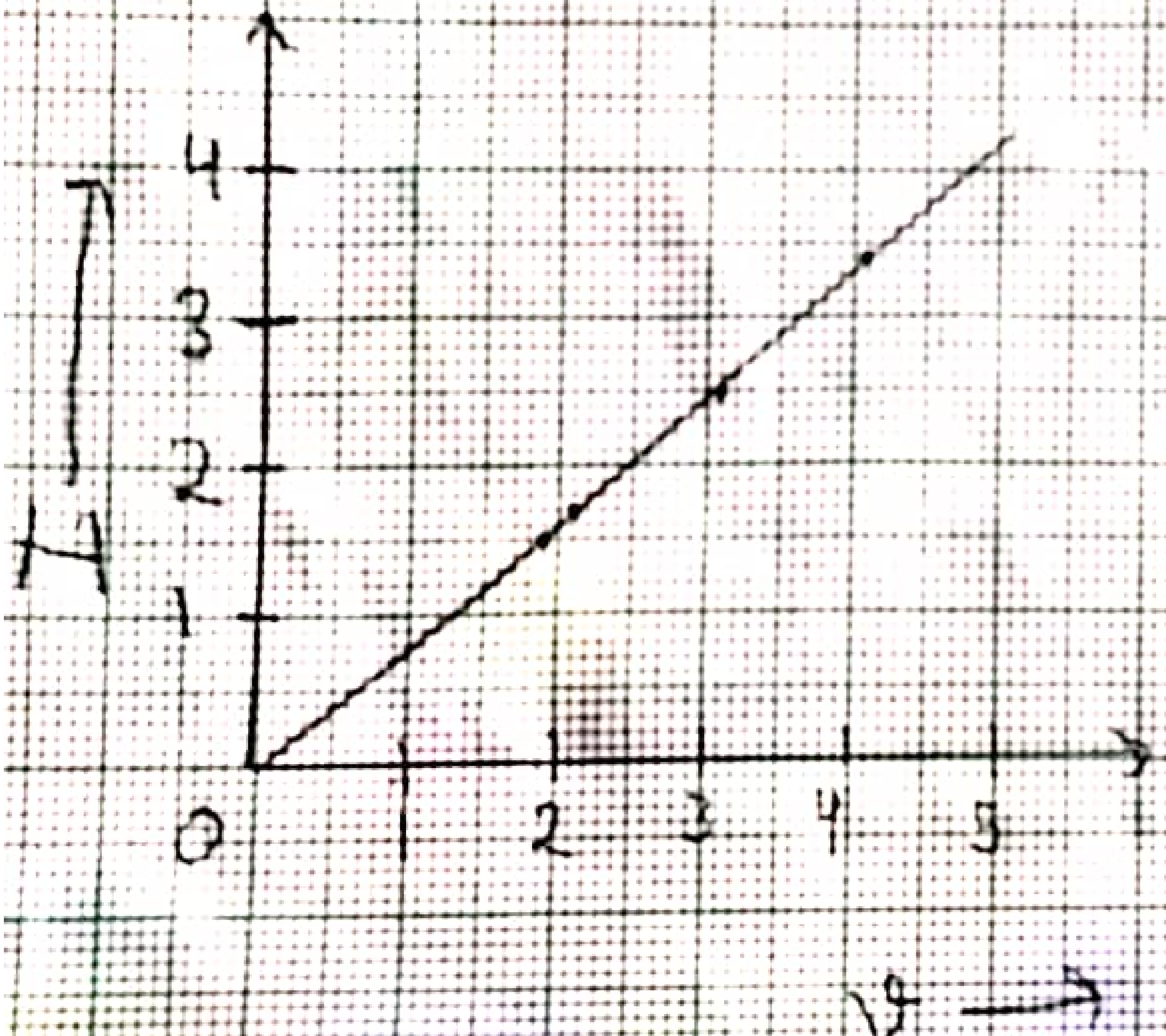
S.No	Voltage (V)	Current (I)
1)	1.908	1.592
2)	2.102	1.751
3)	3.100	2.584
4)	4.104	3.420

Y-axis => 1 box = 0.5 unit
X-axis => 1 box = 0.5 unit



X axis ⇒ 1cm = 1unit

Y axis ⇒ 1cm = 1unit



* Calculations :-

$$Slope = \frac{y_2 - y_1}{x_2 - x_1} = \frac{2.43 - 2.17}{(1.96 - 1.75) \times 10^6}$$

$$\Rightarrow \frac{0.26}{0.21} \times 10^{-6} = 1.2 \times 10^{-6}$$

$$Solpe = \frac{hc}{e}$$

$$Slope \times \frac{e}{c} = h$$

where, $h = 1.2 \times 10^{-6} \times 5.33 \times 10^{-28}$.

$h = 6.396 \times 10^{-34}$

$\simeq 6.626 \times 10^{-34}$

From the graph we get,

$$\frac{1}{\lambda} = 0.8 \times 10^{12}$$

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$$\lambda = \frac{1}{0.8} \times 10^{-12}$$

Also, $\lambda = 1.25 \times 10^{-12}$

$\lambda = 1250 \text{ nm}$

wavelength of Infrared LED = 1250nm

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* Results:-

Plank's Constant = 6.626×10^{-34}

wavelength of IR LED = 1250 nm

wavelength of blue LED = 476 nm