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EXPERIMENT: No. 7 Planck's Constant

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- **AIM:** To determine the value of Planck's constant using electroluminescence process

- **APPARATUS:** LEDs, digital voltmeter, micro-ammeter, and ten turn linear potentiometer

- **FORMULA USED:**

$$V_0 = \frac{hc}{e}\lambda^{-1}$$

Where, V_0 → Barrier potential
λ → Wavelength
c → Speed of light
e → electronic charge
h → Planck constant

→ 'h' can be found by obtaining the slope of $V_0\lambda^{-1}$ curve
→ 'V_0' can be obtained from V-I plot.

- **RESULT:**

The value of Planck's constant was found to be 5.73×10^{-34} Js

• OBSERVATION TABLE:

→ I-V Characteristics

BLUE		GREEN		YELLOW		RED	
V	I (mA)	V	I (mA)	V	I (mA)	V	I (mA)
0	0	0	0	0	0	0	0
0.1	0	0.1	0	0.1	0	0.1	0
0.2	1	0.2	1	0.2	1	0.2	1
0.3	2	0.3	2	0.3	2	0.3	2
0.4	3	0.4	3	0.4	3	0.4	3
0.5	4	0.5	4	0.5	4	0.5	4
0.6	5	0.6	5	0.6	5	0.6	5
0.7	6	0.7	6	0.7	6	0.7	6
0.8	7	0.8	7	0.8	7	0.8	7
0.9	8	0.9	8	0.9	8	0.9	8
1	9	1	9	1	9	1	9
1.1	10	1.1	10	1.1	10	1.1	10
1.2	11	1.2	11	1.2	11	1.2	11
1.3	12	1.3	12	1.3	12	1.3	12
1.4	13	1.4	13	1.4	13	1.4	13
1.5	14	1.5	14	1.5	16	1.5	17
1.6	15	1.6	15	1.6	25	1.6	37
1.7	16	1.7	16	1.7	82	1.62	47
1.8	17	1.8	17	1.74	192	1.64	68
1.9	18	1.9	18	1.77	300	1.66	100
2	19	2	20	—	—	1.68	174
2.1	20	2.1	24	—	—	1.69	224
2.2	22	2.2	38	—	—	1.7	285
2.3	27	2.3	78	—	—	—	—
2.4	73	2.4	211	—	—	—	—
2.42	122	2.41	240	—	—	—	—
2.45	234	—	—	—	—	—	—

→ $1/\lambda$, Barrier Potential

LED Colour	Wavelength (λ)	$1/\lambda$ (nm^{-1})	Barrier potential (V_0)
Blue	450	2.22×10^{-3}	2.3
Green	520	1.92×10^{-3}	2.1
Yellow	580	1.72×10^{-3}	1.6
Red	630	1.59×10^{-3}	1.5

- CALCULATIONS:

$$m_{(\text{slope})} = \frac{N\Sigma x_i y_i - \Sigma x_i \Sigma y_i}{N\Sigma x_i^2 - (\Sigma x_i)^2}$$

$$= \frac{4(10.138 \times 10^6) - (29.68 \times 10^6)}{4 \times (9.5 \times 10^{12}) - (27.88 \times 10^{12})}$$

$$= \frac{(40.552 - 29.68) \times 10^6}{(38 - 27.88) \times 10^{12}}$$

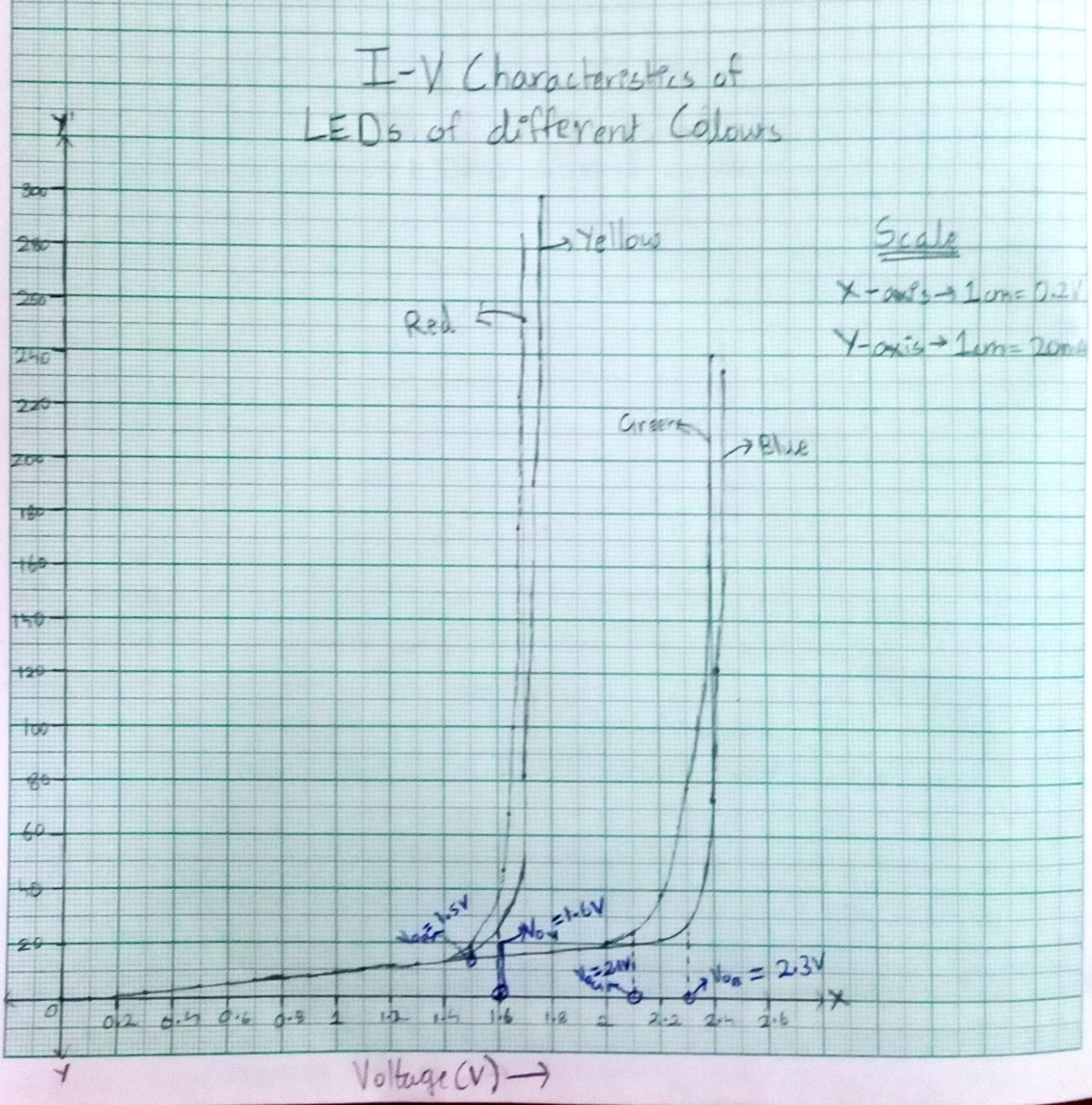
$$= \frac{10.872}{10.12} \times 10^{-6}$$

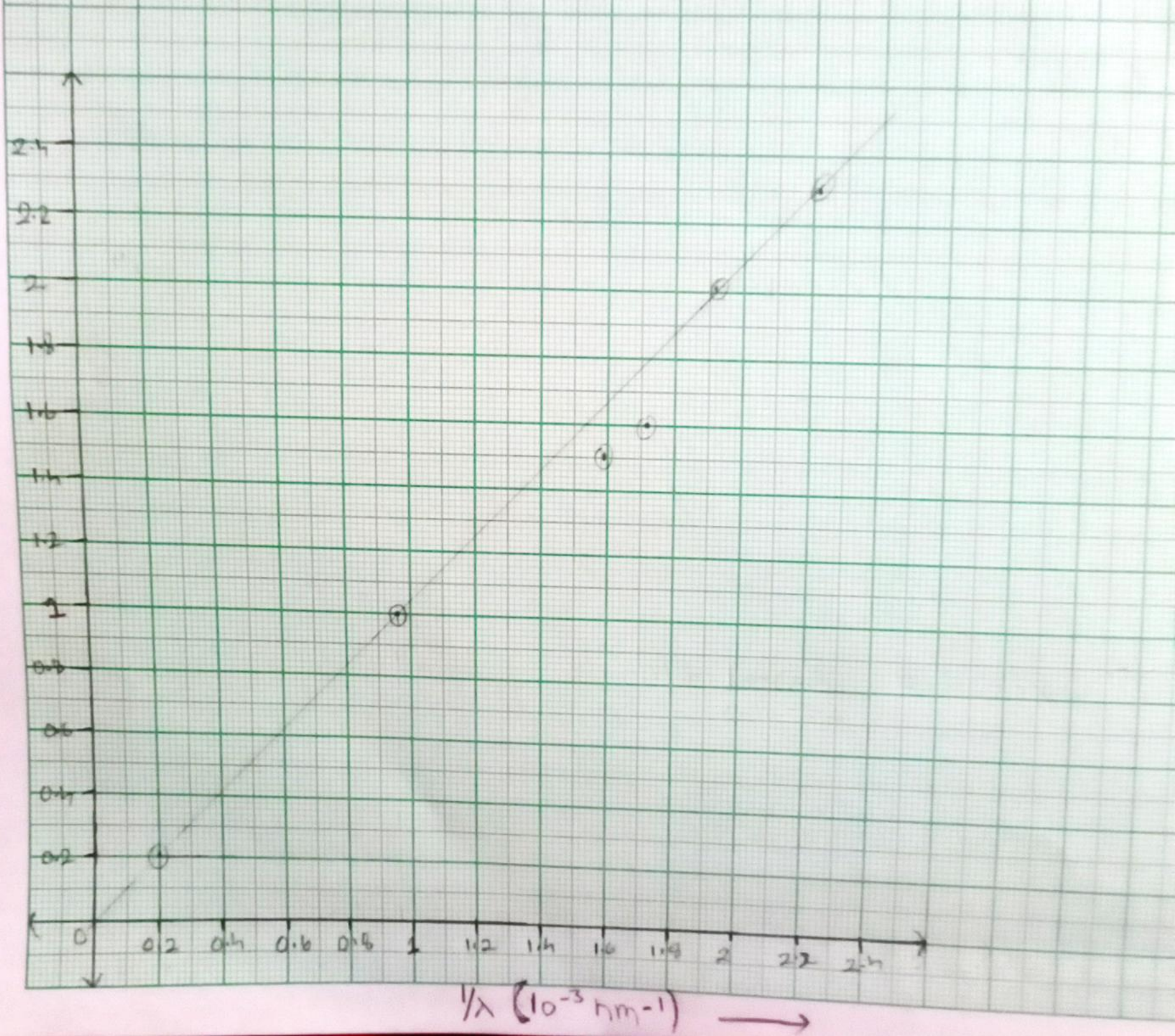
$$\boxed{m = 1.074 \times 10^{-6}}$$

$$\frac{c}{e} = \frac{3 \times 10^8}{1.6 \times 10^{-19}} = 1.875 \times 10^{27}$$

$$\frac{m}{4e} = h = \frac{1.074 \times 10^{-6}}{1.875 \times 10^{27}} = 0.573 \times 10^{-33} \Rightarrow \boxed{h = 5.73 \times 10^{-34}\ J\text{-}s}$$

I-V Characteristics of LEDs of different Colours




2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
1/λ (10⁻³ nm⁻¹)