Aneesh Panchal
2K20/A6/56
24-06-2021

EXPERIMENT - 6

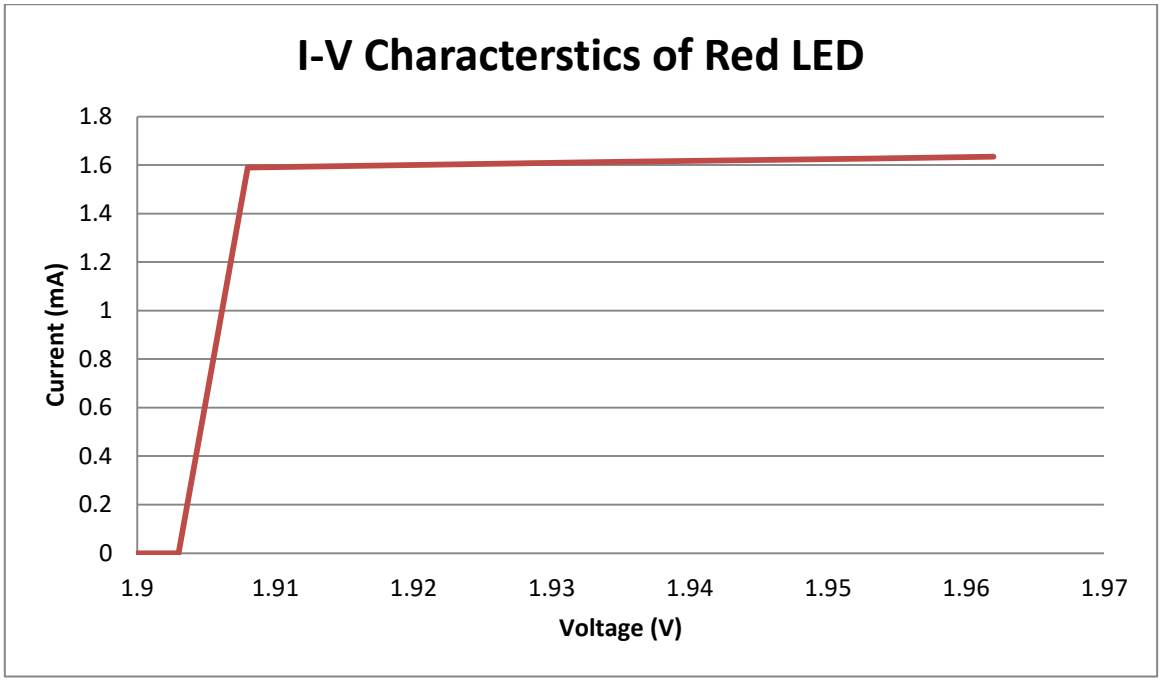
AIM:

To draw the I-V characteristics for Light Emitting Diode (LED) and determine the value of Planck's constant.

Observations:

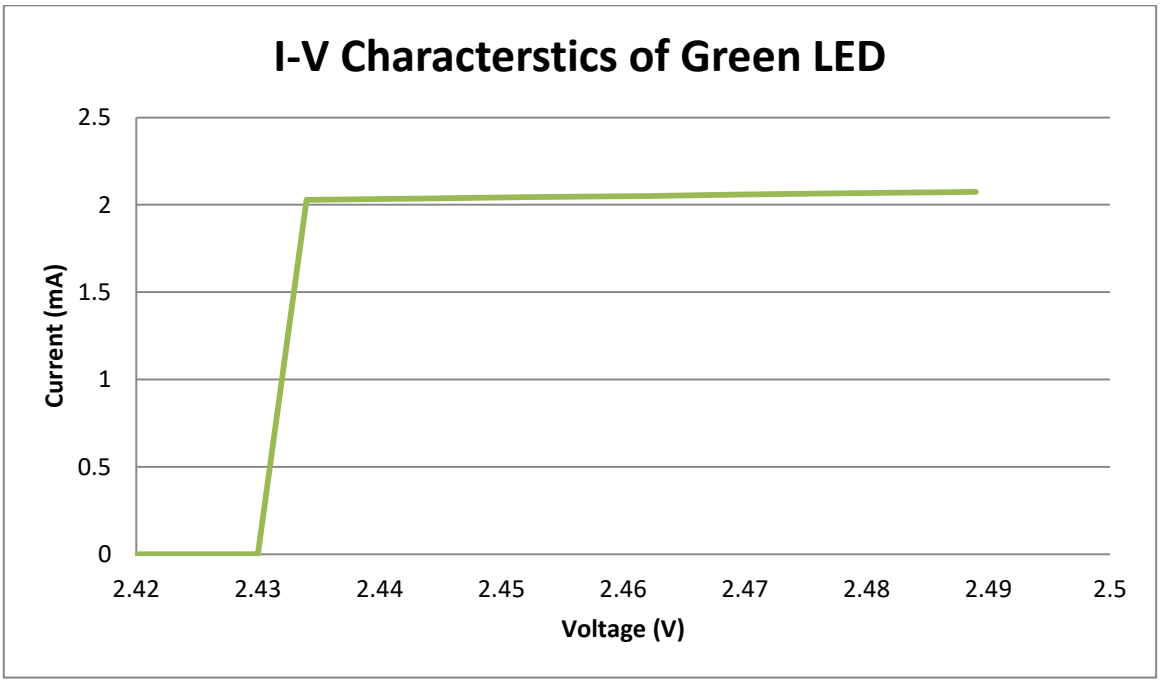
Case I: Red LED (wavelength, λ = 650nm)

S. No.	Voltage (V) (Volts)	Current (I) (milli Ampere)
01.	1.903	0.000
02.	1.908	1.590
03.	1.917	1.597
04.	1.926	1.605
05.	1.935	1.613
06.	1.944	1.620
07.	1.953	1.627
08.	1.962	1.635



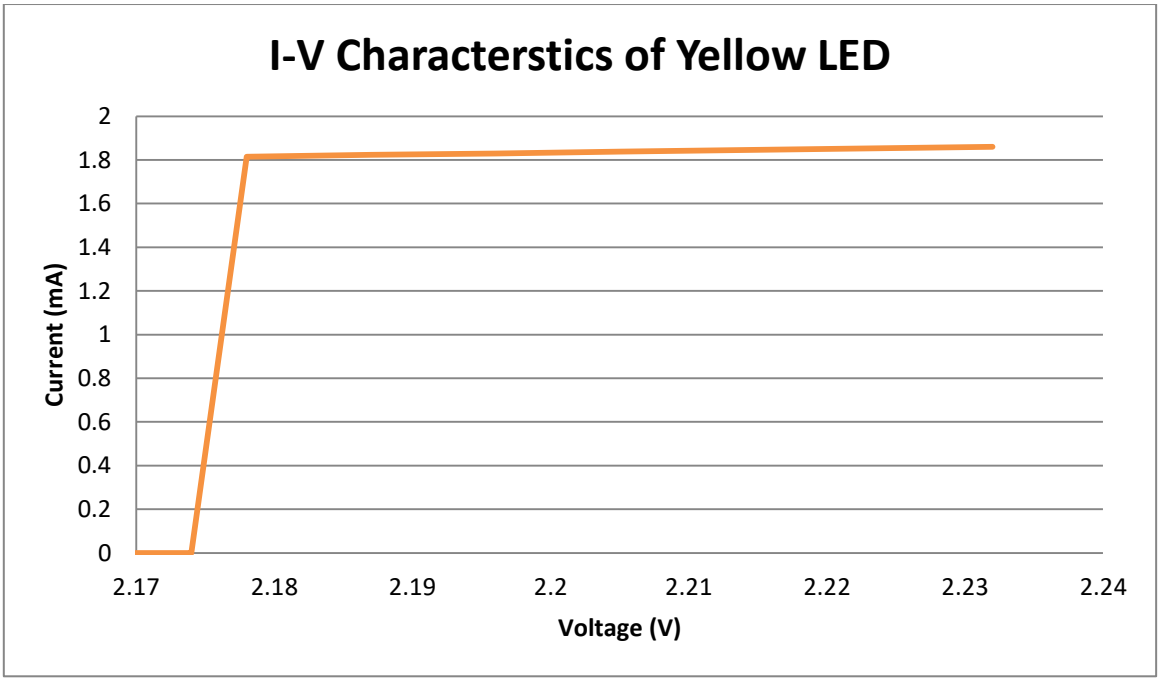
Case II: Green LED (wavelength, λ = 510nm)

S. No.	Voltage (V) (Volts)	Current (I) (milli Ampere)
01.	2.430	0.000
02.	2.434	2.029
03.	2.443	2.036
04.	2.453	2.044
05.	2.462	2.051
06.	2.470	2.059
07.	2.479	2.066
08.	2.489	2.074



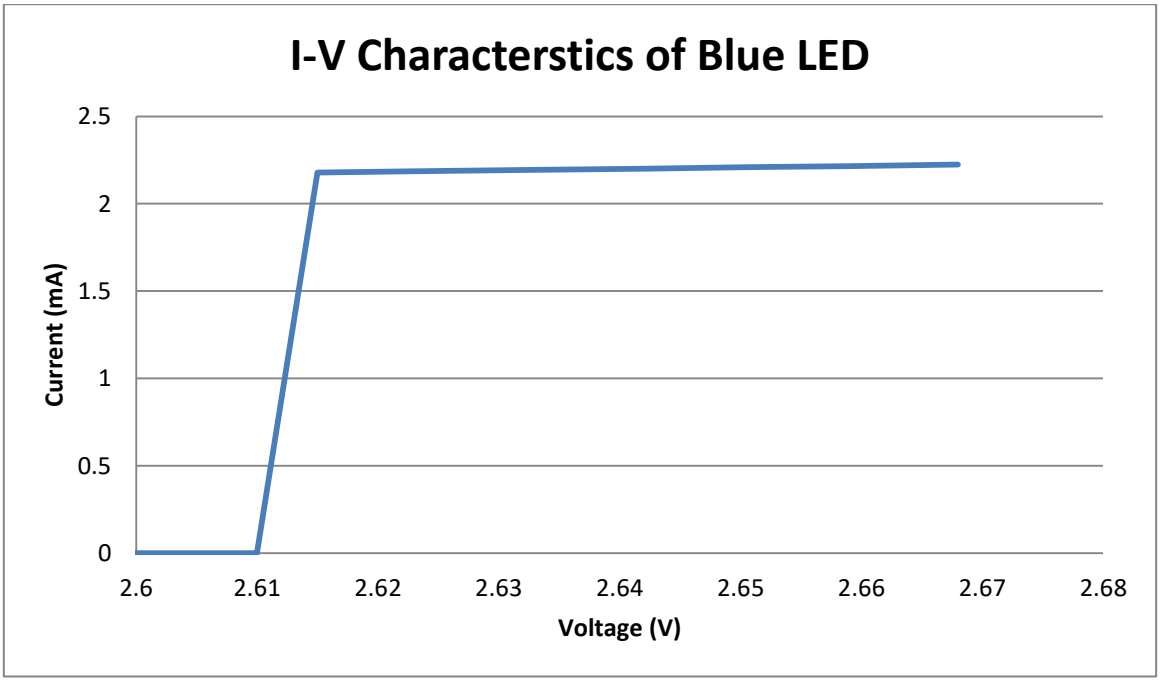
Case III: Yellow LED (wavelength, λ = 570nm)

S. No.	Voltage (V) (Volts)	Current (I) (milli Ampere)
01.	2.174	0.000
02.	2.178	1.815
03.	2.187	1.823
04.	2.196	1.830
05.	2.205	1.838
06.	2.214	1.845
07.	2.223	1.853
08.	2.232	1.860



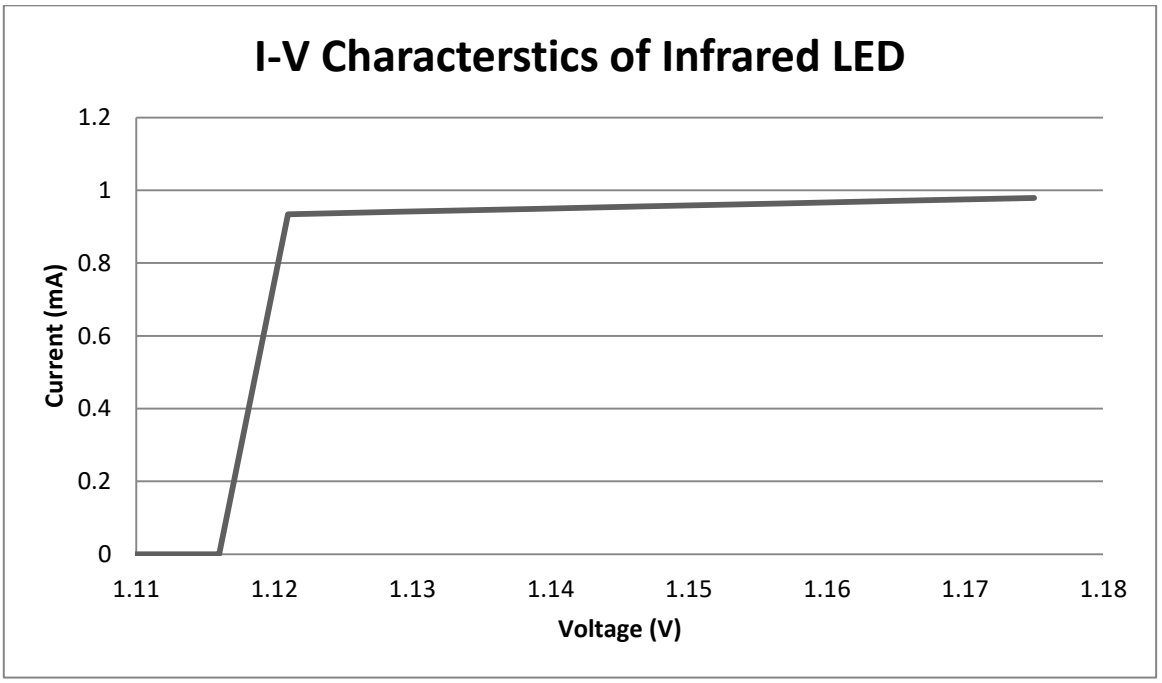
Case IV: Blue LED (wavelength, λ = 475nm)

S. No.	Voltage (V) (Volts)	Current (I) (milli Ampere)
01.	2.610	0.000
02.	2.615	2.179
03.	2.623	2.186
04.	2.632	2.194
05.	2.642	2.201
06.	2.651	2.209
07.	2.659	2.216
08.	2.668	2.224



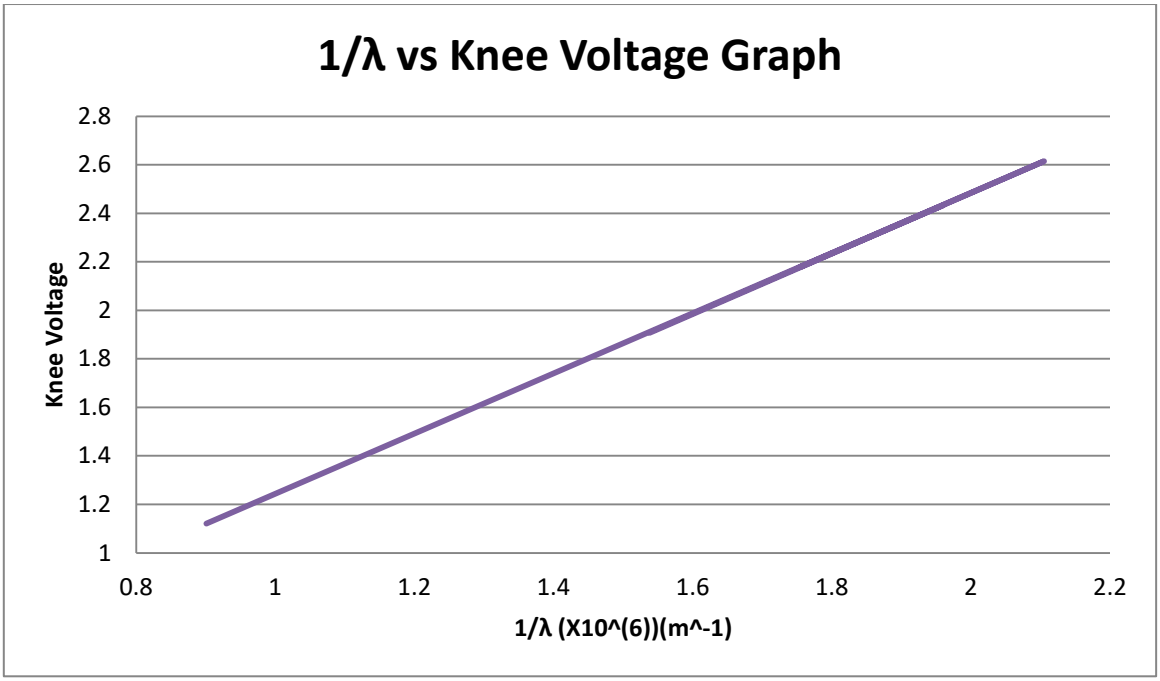
Case V: Infrared LED (wavelength, λ = 1110nm)

S. No.	Voltage (V) (Volts)	Current (I) (milli Ampere)
01.	1.116	0.000
02.	1.121	0.934
03.	1.129	0.941
04.	1.139	0.949
05.	1.147	0.956
06.	1.157	0.964
07.	1.165	0.971
08.	1.175	0.979



Case: Knee Voltage and Wavelength

S. no.	LED	Wavelength	Knee Voltage	$1/\lambda\ (X10^6 m)$
01.	Red colour	650 nm	1.908	1.53846154
02.	Green colour	510 nm	2.434	1.96078431
03.	Yellow colour	570 nm	2.178	1.75438596
04.	Blue colour	475 nm	2.615	2.10526316
05.	Infrared	1110 nm	1.121	0.90090090



Calculations:

Speed of light, c = 3 x10^{8} m/s

Charge on electron, e = 1.6022 x10^{-19} C

Standard value of Planck's constant, h = 6.626 x10^{-34} $kg\ m^2\ s^{-1}$

Case I: Red LED

Wavelength, λ = 650 nm

Knee Voltage, V = 1.908 V

Planck's constant, $h_r = \frac{\lambda V e}{c} = \frac{650\ X\ 1.908\ X\ 1.6022}{300} X10^{-34} = 6.6235\ X10^{-34} kg\ m^2\ s^{-1}$

Error Percentage, $e_r = \frac{6.6235 - 6.626}{6.626} X100 = 0.0377\%$

Case II: Green LED

Wavelength, λ = 510 nm

Knee Voltage, V = 2.434 V

Planck's constant, $h_g = \frac{\lambda V e}{c} = \frac{510\ X\ 2.434\ X\ 1.6022}{300} X10^{-34} = 6.6296\ X10^{-34} kg\ m^2\ s^{-1}$

Error Percentage, $e_g = \frac{6.6296 - 6.626}{6.626} X100 = 0.05433\%$

Case III: Yellow LED

Wavelength, λ = 570 nm

Knee Voltage, V = 2.178 V

Planck's constant, $h_y = \frac{\lambda V e}{c} = \frac{570\ X\ 2.178\ X\ 1.6022}{300} X10^{-34} = 6.6302\ X10^{-34} kg\ m^2\ s^{-1}$

Error Percentage, $e_y = \frac{6.6302 - 6.626}{6.626} X100 = 0.06339\%$

Case IV: Blue LED
Wavelength, λ = 475 nm
Knee Voltage, V = 2.615 V
Planck's constant, $h_b = \frac{\lambda V e}{c} = \frac{475\ X\ 2.615\ X\ 1.6022}{300} X10^{-34} = 6.6337\ X10^{-34} kg\ m^2\ s^{-1}$
Error Percentage, $e_b = \frac{6.6337-6.626}{6.626} X100 = 0.11621\%$

Case V: Infrared LED
Wavelength, λ = 1110 nm
Knee Voltage, V = 1.121 V
Planck's constant, $h_i = \frac{\lambda V e}{c} = \frac{1110\ X\ 1.121\ X\ 1.6022}{300} X10^{-34} = 6.6455\ X10^{-34} kg\ m^2\ s^{-1}$
Error Percentage, $e_i = \frac{6.6455-6.626}{6.626} X100 = 0.2942952\%$

Average Percentage Error
$e = \frac{e_r+e_g+e_y+e_b+e_i}{5}$
$e = \frac{0.0377+0.05433+0.06339+0.11621+0.2942952}{5} = 0.11318504\%$

Case: From Knee Voltage and Wavelength graph
Slope of graph, m = $\frac{2.4-1.9}{1.91-1.5} X10^{-6} = 1.243\ X10^{-6}\ Vm$
Planck's constant, $h_o = \frac{e*m}{c} = \frac{1.6022\ X\ 1.243\ X\ 10}{3} X10^{-34} = 6.63845\ X10^{-34} kg\ m^2\ s^{-1}$
Error Percentage, $e_o = \frac{6.63845-6.626}{6.626} X100 = 0.1879\%$

Results:

Experimental value of Planck's constant is $6.63845\ X10^{-34} kg\ m^2\ s^{-1}$ with error percentage of 0.1879%.