

GENERAL PHYSICS LAB 2 - PHYS112

Experiment 1: Linear and Non-Linear Circuit Elements

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Section: 7

(1) Abstract:

Aim of the experiment:

To find the relationship between the current passing through a circuit component and the potential difference, characteristics for different elements, also to see if it is linear or non-linear circuit components.

The Methods:

carbon resistor, Si diode, light bulb, wiring, variable resistance), source of current and potential difference

The main result is:

The relationship in carbon resistor and low-current light bulb is linear, while diode and light bulb with high current are nonlinear

(2) Data:

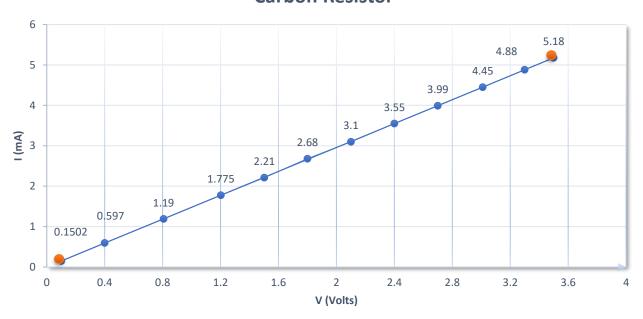
Set V power supply = 5 Volts

Carbon Resistor		Si Diode		Light bulb (low currents)		Light Bulb (high currents)	
V (Volts)	I (mA)	V(Volts)	I (mA)	V (Volts)	I (mA)	V (Volts)	I (mA)
0.1	0.1502	0.35	0.9	0.010	6.9	0.5	84.2
0.4	0.597	0.40	0.42	0.02	12.1	1.0	117.6
0.806	1.19	0.45	0.51	0.03	17.6	1.5	141.9
1.202	1.775	0.50	0.065	0.04	23.2	2.0	158.6
1.502	2.21	0.54	0.167	0.05	28.6	2.5	178.5
1.8	2.68	0.58	0.468	0.06	34.2	3.0	193.8
2.1	3.1	0.62	1.246				
2.4	3.55	0.65	1.8				
2.7	3.99	0.68	5.23				
3.0	4.45	0.70	8.3				
3.3	4.88	0.72	17.6				
3.5	5.18	0.74	31.9				

(3) Calculations and Graphs:

A - carbon Resistor:

I vs V Carbon Resistor



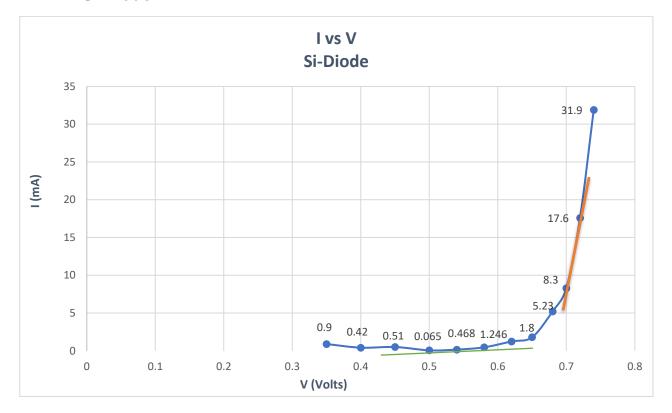
According to the diagram above, which shows the relationship between I and V according to Ohm's law Prove that the carbon resistor is a linear element.

The slope at (0.1, 0.1502) and (3.5, 5.18):

$$\frac{1}{R} = \frac{\Delta I}{\Delta V} = \frac{(5.18 - 0.1502) \times 10^{-3}}{(3.5 - 0.1)} = 1.479 \times 10^{-3} \Omega^{-1}$$

$$R = \frac{1}{1.479 \times 10^{-3}} = 675.971 \ \Omega$$

B - Si Diode:



According to the diagram above, which shows the relationship between I and V, it is proved that Si Diode does not obey Ohm's law and it is a nonlinear element.

The slope at (0.7, 8.3) and (0.72, 17.6):

$$\frac{1}{R1} = \frac{\Delta I}{\Delta V} = \frac{(17.6 - 8.3) \times 10^{-3}}{(0.72 - 0.7)} = 0.465 \,\Omega^{-1}$$

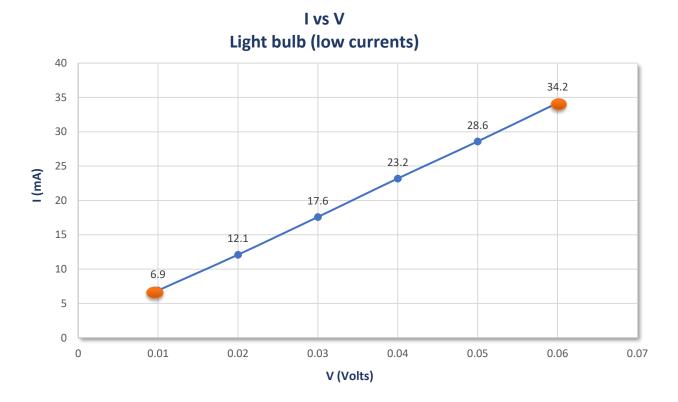
$$R1 = \frac{1}{0.465} = 2.1505 \ \Omega$$

The slope at (0.5, 0.065) and (0.58, 0.468):

$$\frac{1}{R2} = \frac{\Delta I}{\Delta V} = \frac{(0.468 - 0.065) \times 10^{-3}}{(0.58 - 0.5)} = 5.0375 \times 10^{-3} \Omega^{-1}$$

$$R2 = \frac{1}{5.0375 \times 10^{-3}} = 198.511 \ \Omega$$

C – Light bulb (low currents):



According to the diagram above, which shows the relationship between I and V according to Ohm's law Prove that the light bulb (with low currents) is a linear element.

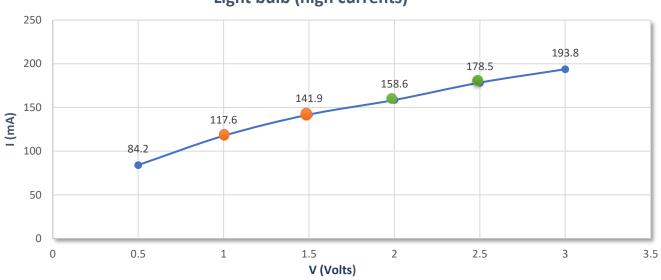
The slope at (0.01, 6.9) and (0.06, 34.2):

$$\frac{1}{R} = \frac{\Delta I}{\Delta V} = \frac{(34.2 - 6.9) \times 10^{-3}}{(0.06 - 0.01)} = 0.546 \,\Omega^{-1}$$

$$R1 = \frac{1}{0.546} = 1.8315 \Omega$$

D – Light bulb (high currents):

I vs V Light bulb (high currents)



According to the diagram above, which shows the relationship between I and V the light bulb (with high currents) does not obey Ohms and it is a nonlinear element.

%The slope at (1.0, 117.6) and (1.5, 141.9):

$$\frac{1}{R1} = \frac{\Delta I}{\Delta V} = \frac{(141.9 - 117.6) \times 10^{-3}}{(1.5 - 1.0)} = 0.0486 \,\Omega^{-1}$$

$$R1 = \frac{1}{0.0486} = 20.5761 \ \Omega$$

The slope at (2.0, 158.6) and (2.5, 178.5):

$$\frac{1}{R2} = \frac{\Delta I}{\Delta V} = \frac{(178.5 - 158.6) \times 10^{-3}}{(2.5 - 2.0)} = 0.0398 \,\Omega^{-1}$$

$$R2 = \frac{1}{0.0398} = 25.1256 \ \Omega$$

(4) Conclusions:

Components that exhibit IV characteristics in a straight line are referred to as linear. Components that do not have IV characteristics along a straight line are referred to as nonlinear components.

A light bulb with low currents is a linear component because the I-V characteristic of the relationship between current and voltage is linear, but a light bulb with high currents is a non-linear component because the I-V characteristic of the relationship between current and voltage is nonlinear.

According to the experiment results, the resistance of carbon is a linear component because the relationship between current and voltage is linear.

The diode is nonlinear because the I-V characteristic of the relationship between current and voltage is nonlinear Ohm's law is known as the product of the current passing through a resistance at a constant temperature.