جامعة بيرزيت

BIRZEIT UNIVERSITY

Physics Department

Physics 112

Experiment1

Linear and Nonlinear Elements

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Student's No.:

Partner's name:
Partners No.:

9

Section: 8

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Abstract:

1. The aim of experiment: is to explore the behaviour of some circuit components, and decide if the relation between I and V is linear or non-linear.

2. The main result is that the carbonic resistor is a linear component, whereas the diode and the light bulb are ~~not~~ non-linear.

The resistance $R = 265\ \Omega$

note: the light bulb is linear component at low current, and non-linear at high current

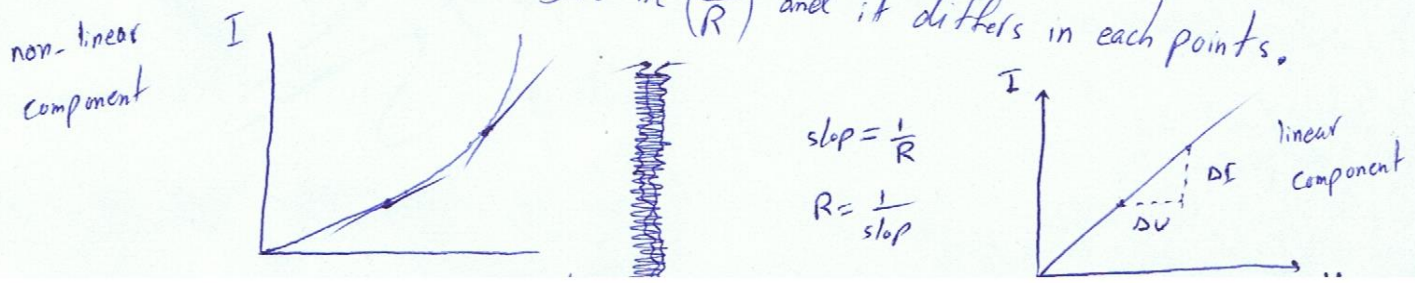
Theory:

In general, circuit components are either linear or non-linear, we determine This by plotting the relation between current and voltage (I-V) characteristics

If the line generated is straight line, then we call this component as linear component, and if the useed component is resistor, we call it ohmic-resistor, because it applies Ohm's Law $V = IR$ (only applied with linear relation between I,V)

On the other hand, if the relation (I-V) characteristics results a non-straight line, we call it non-linear component.

With linear component, we notice that the slop of the straight line gives $\frac{\Delta I}{\Delta V}$, $\frac{1}{R}$, but in non-linear components, the slop is differen in each point, so we have to to take the slop of tangent line to give the $\left(\frac{1}{R}\right)$ and it differs in each points.



Experiment No.1: Linear and non-Linear Circuit Components

Student's Name: _ __ Student's No.:_

Partner's Name: _ __ Partner's No.:_

Data:

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)
0.2	0.76	0.40	0.01	0.01	6.01	0.5	81.8
0.4	1.54	0.45	0.05	0.02	11.65	1.0	111.2
0.6	2.28	0.50	0.17	0.03	16.46	1.5	137.2
0.8	3.04	0.53	0.35	0.04	21.4	2.0	160.8
1.0	3.79	0.55	0.53	0.05	26.0	2.5	178.6
1.2	4.54	0.57	0.81	0.06	30.2	3.0	204.0
1.5	5.69	0.60	1.34				
1.6	6.06	0.62	2.31				
1.7	6.44	0.64	3.77				
1.8	6.79	0.66	5.26				
1.9	7.18	0.68	8.64				
2.0	7.56	0.70	12.81				

19/7/2024.

Exp.1 : Linear and Non-linear Elements

Graph 1 : Carbon resistor

V (volt)	I (mA)
0.2	0.76
0.4	1.54
0.6	2.28
0.8	3.04
1.0	3.79
1.2	4.54
1.5	5.69
1.6	6.06
1.7	6.44
1.8	6.79
1.9	7.18
2.0	7.56

Using the LINEST function excel to find the slop :

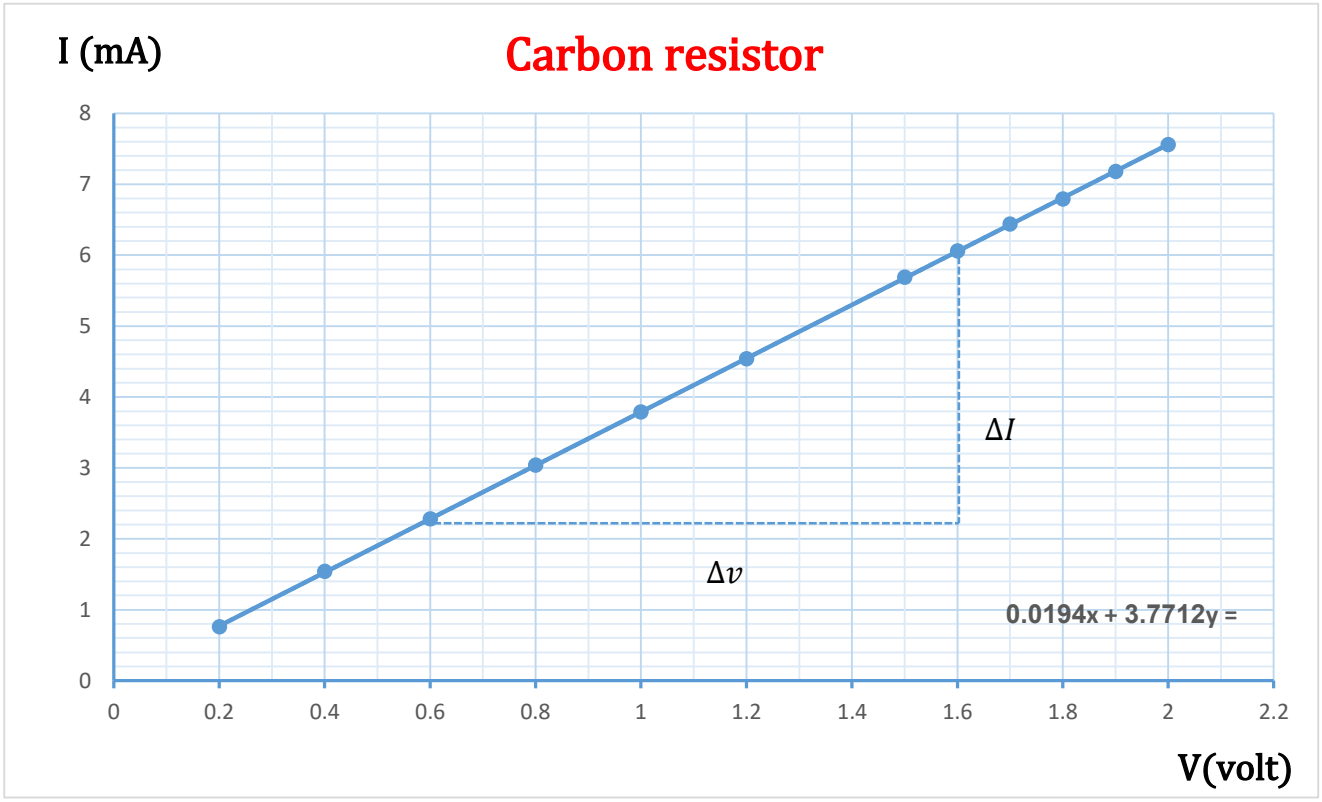
$$\text{Slop} = \frac{1}{R} = 3.7712 \ \frac{mA}{v} = 3.7712 \times 10^{-3}\Omega^{-1}$$

$$\text{R} = \frac{1}{slop} = \frac{1}{3.7712\times10^{-3}} = 265.16\ \Omega$$

Or using points (0.6, 2.28), (1.6, 6.06):

$$\text{Slop} = \frac{\Delta I}{\Delta v} = \frac{(6.06-2.28)\times10^{-3}}{1.6-0.6} = 3.78 \times 10^{-3}\Omega^{-1}$$

$$R = \frac{1}{slop} = \frac{1}{3.78\times10^{-3}} = 264.55\ \Omega$$

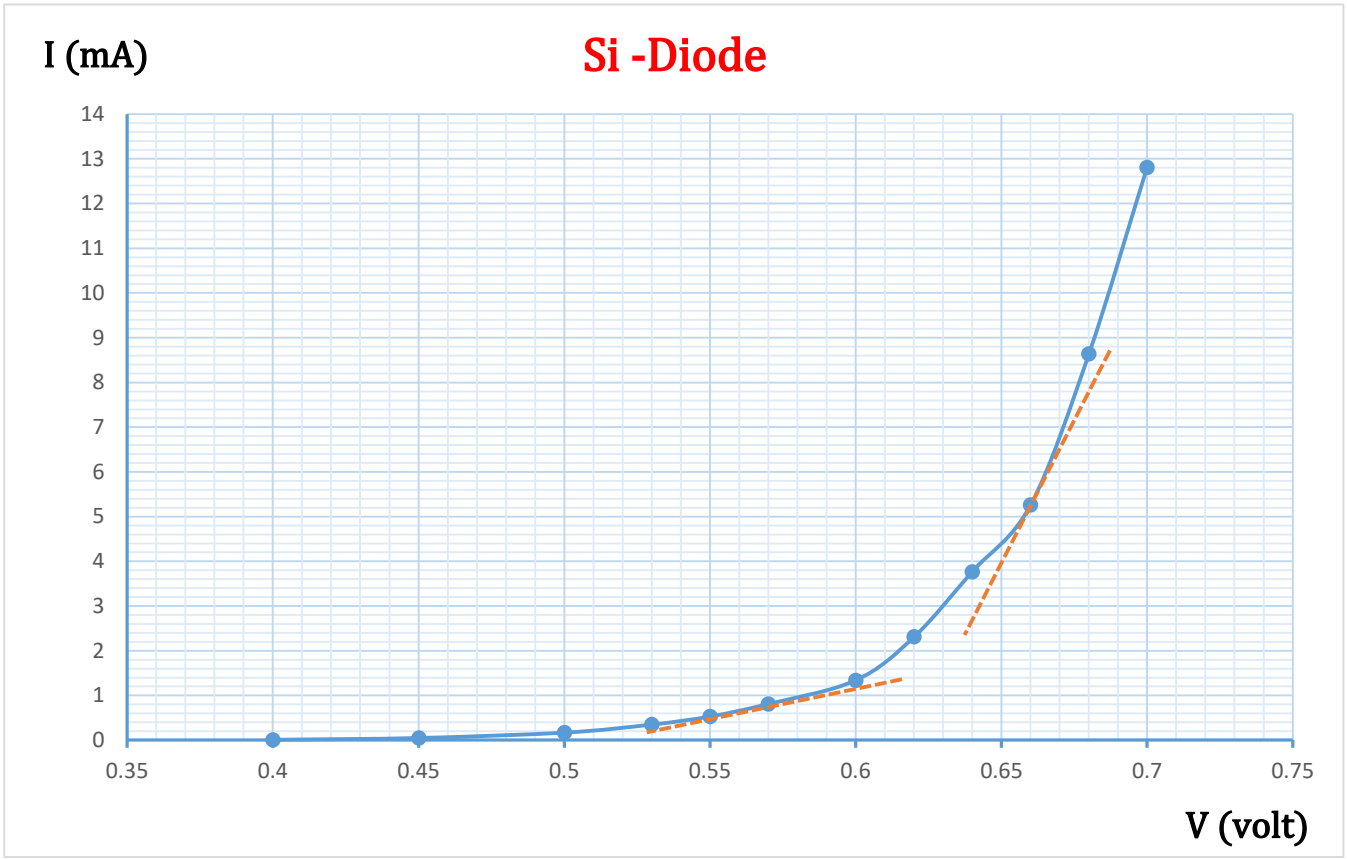


Graph 2 : Silicon diode

V(volts)	I(mA)
0.40	0.01
0.45	0.05
0.50	0.17
0.53	0.35
0.55	0.53
0.57	0.81
0.60	1.34
0.62	2.31
0.64	3.77
0.66	5.26
0.68	8.64
0.70	12.81

We notice that the points (0.57, 0.81), (0.66, 5.26) have different tangent lines (in orange), and the slop of second tangent line is bigger than the first one, by the equation $R = \frac{1}{slop}$, this means that the resistance at the first point is bigger than the second point.

So, we have different values of R at different points.

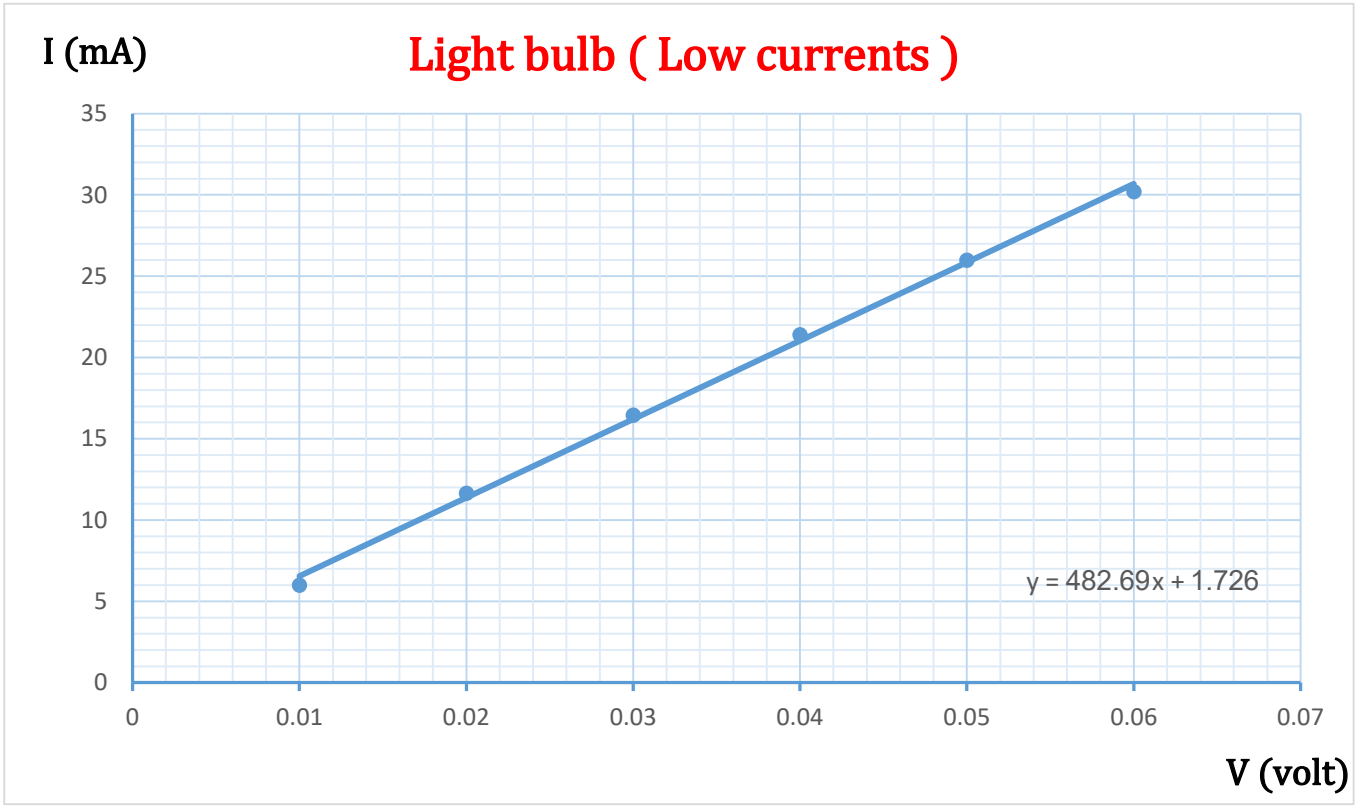


Graph 3 : Light bulb with Low currents

V(volts)	I(mA)
0.01	6.01
0.02	11.65
0.03	16.46
0.04	21.40
0.05	26.0
0.06	30.2

We notice that the relation here is linear, we see a straight line between the points.

So, Light bulb is linear component when the current and voltage are low.

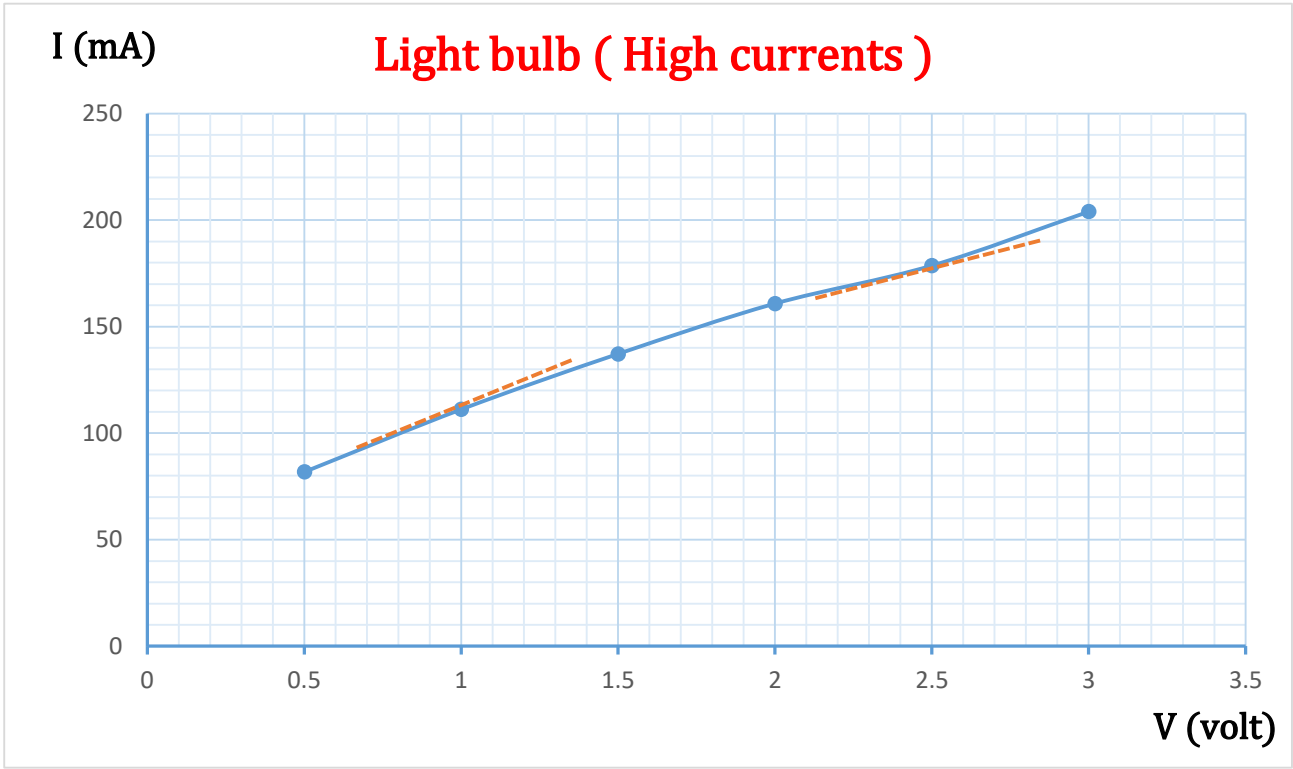


Graph 4 : Light bulb with High currents

V(volts)	I(mA)
0.5	81.8
1.0	111.2
1.5	137.2
2.0	160.8
2.5	178.6
3.0	204.0

We notice that the points (1, 111.2), (2.5, 178.6) have different tangent lines (in orange), this implies different values of resistance at the two points.

So, Light bulb becomes a non-linear component with high currents and voltage.



Results and conclusion:

The results shown previously illustrate that carbon resistor has a linear relation between I and V, and we find the value of Resistence from the graph. Also we find that the forwared biased diode is a non-linear component, it has a non-straight curve. which implies different values of Resistence. On the other hand, Light bulb has a complicated behavior, When the current and voltage are low, the relation between I and V is nearly linear. However, when the voltage and current are high, The relation between I and V becomes non-linear, and it has differen values of slop of tangent which results differen values of resistence.

The non-linear components affects by high tempreater, which generates the non-linear relation between I and V. So, in this experiment, we avoided to work in high tempreater and take measurments, because our results may change.