Non-Ohmic Devices I - Light Bulb

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1 Theoretical Background

1.1 I-V Characteristic of a Bulb

Resistance of non-ohmic devices is not constant and it changes as a function of current. For example, a filament bulbs emits more light, if we increase the current and wire in the bulb gets hotter and hotter over time. If we draw current-voltage graphic of such devices, we observe a non-linear characteristic. Therefore we need to talk about the "dynamic resistance" which is a current-dependent resistance value for non-ohmic devices or AC circuits. Dynamic resistance value of a filament bulb is given by,

$$R_{dyn} = \frac{dV}{dI}. \quad (1)$$

In the experiment, we will have discrete current and voltage values. Thus we need to modify above equation as follows,

$$R_{dyn} = \frac{\Delta V}{\Delta I} \quad (2)$$

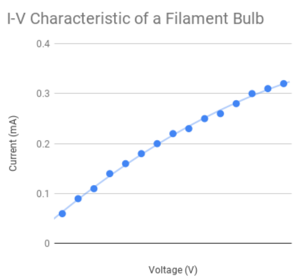

Figure 1: I-V characteristic of a light bulb.

An I-V characteristic for the filament bulb is given in Fig (1). In this figure you may observe that as voltage over the bulb increases the current creases as well but not with a slower speed. This means that even though we provide more electrical energy into the circuit, we can't observe it in the the circuit as the movement of electrons, i.e. the current. Where does this energy goes? It is spent in another form of energy, the light energy. As a matter of fact you will see this behaviour of the bulb getting shinier when supply voltage increases in the experiment.

2 Procedure

2.1 Experimental Procedure

CAUTION!!!

Perform this experiment in a short period of time and do not forget to turn off the electrical supply while you are writing your data and making calculations.

1. Set the circuit given in Fig (2) with a light bulb and 10Ω resistor.

2. By using the power supply, adapt the source voltage to the 1st source voltage value at Table (1).
3. By reading from multimeters, note the current, voltage over the bulb and voltage over the resistor; then write these values on Table (1).
4. Repeat the steps number 2 and 3 with other source values from Table (1).

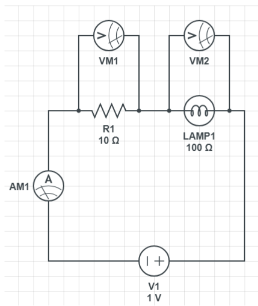

Figure 2: Circuit for the experiment.

2.1.1 Analysis Procedure

1. Using values on Table (1), plot the I-V graph for the bulb and the resistor separately.
2. Calculate the slope of the plot for the resistor. This should yield the resistance value of the resistor.
3. Using data on Table (1) fill the Table (2).
4. Write an exapmle calculation for Table (2) in Eqn (**??**).

3 Data & Analysis

Table 1: Table of voltage and current values for bulb and resistor.

i	V_s (V)	I (___)	V_R (V)	V_B (V)	i	V_s (V)	I (___)	V_R (V)	V_B (V)
1	1.0				11	10.5			
2	2.0				12	11.0			
3	3.0				13	11.5			
4	4.0				14	12.0			
5	5.0				15	12.5			
6	6.0				16	13.0			
7	7.0				17	13.5			
8	8.0				18	14.0			
9	9.0				19	14.5			
10	10.0				20	15.0			

Table 2: Table of resistance values for bulb.

i	V_B^i (V)	I^i (___)	$i+1$	V_B^{i+1} (V)	I^{i+1} (___)	ΔV_B (V)	ΔI (___)	R_B (Ω)
1			2					
2			3					
3			4					
4			5					
5			6					
6			7					
7			8					
8			9					
9			10					
10			11					
11			12					
12			13					
13			14					
14			15					
15			16					
16			17					
17			18					

18			19					
19			20					

- Example calculation for resistance of bulb:

- Experimental value of resistor:

- Theoretical value of resistor:

- Percentage error:

4 Conclusions

5 Notes