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NORTH SOUTH UNIVERSITY

Department of Mathematics & Physics

Experimental Physics

PHY-108L

Name of the Experiment: Ohm's Law

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Experiment Name: Verify OHM's Law

Objective:

- To confirm Ohm's law by studying the relationship of voltage, current and resistance.
- To make voltage and current measurements using a DMM in a resistive circuit to verify Ohm's law.
- Usage of DMM and Power supply and making a simple circuit in a breadboard.

Apparatus:

- Three resistors $2.2k\Omega$, $4.7k\Omega$ and $10k\Omega$.
- Breadboard
- Wires
- DMM
- Digital Power Supply.

Theory:

According to Ohm's law, electrical current in a resistive circuit is directly proportional to the applied voltage and inversely proportional to its resistance.

$$\therefore I = \frac{V}{R}$$

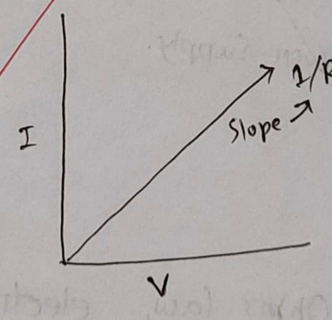
I is the current in Amperes (A).
V is the voltage in volts (V).
R is the resistance in ohms (Ω).

So, we need to prove that, the larger the applied voltage is, the larger the current becomes. The larger the resistance is, the smaller the current becomes.

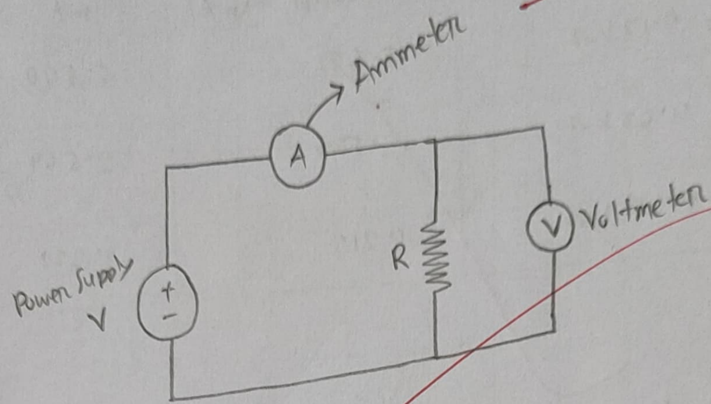
Conditions of Ohm's Law:

- A conducting device obeys Ohm's law when the resistance of the device is independent of the magnitude and polarity of the applied potential difference.
- Ohm's law is not applicable for unilateral electrical elements like diodes and transistors as they allow the current to ~~fast~~ flow through in one direction only.

Graphical Representation:



Circuit Diagram:



Data Table:

	R_1			R_2			R_3		
	Nominal R: 2.2k			Nominal R: 4.7k			Nominal R: 10k		
	Measured R: 2.17 k			Mesured R: 4.68k			Measured R: 9.83 k		
	Measured Values		I calculated mA	Mesured Values		I Calculated mA	Mesured Values		I Calculated mA
$V_{Nominal}$	V mesured	I measured mA		V measured	I measured mA		$V_{measured}$	I measured mA	
1 V	1.11	0.519	~~0.511~~ 0.455	1.13	0.241	~~0.242~~ 0.213	1.12	0.114	~~0.114~~ 0.100
2 V	2.13	0.984	~~0.982~~ 0.909	2.09	0.455	~~0.446~~ 0.426	2.10	0.216	~~0.214~~ 0.200
5 V	5.09	2.345	~~2.346~~ 2.273	5.05	1.086	~~1.079~~ 1.064	5.06	0.517	~~0.515~~ 0.500
10 V	10.03	4.671	~~4.622~~ 4.545	10.07	2.156	~~2.151~~ 2.128	10.07	1.027	~~1.024~~ 1.000
15 V	15.03	7.014	~~6.926~~ 6.818	15.09	3.228	~~3.224~~ 3.191	15.09	1.537	~~1.535~~ 1.500
20 V	20.07	9.396	~~9.248~~ 9.091	20.09	4.301	~~4.292~~ 4.255	20.09	2.045	~~2.044~~ 2.000
25 V	25.01	11.778	~~11.525~~ 11.364	25.08	5.0406	~~5.358~~ 5.319	25.08	2.562	~~2.551~~ 2.500

Parifa

For E = 12 V

Measured Resistance	Estimated current from Graph (mA)	Calculated Current mA	% of Error
$R_1 = 2.17\ k\Omega$	5.633	5.530	1.86%
$R_2 = 4.68\ k\Omega$	2.586	2.564	0.86%
$R_3 = 9.83\ k\Omega$	1.213	1.221	0.66%

Calculation:

For R_1:

$V_m = 1.11\ V$

$R_m = 2.17\ k\Omega$

$\therefore I_e = \frac{V_m}{R_m} = \frac{1.11}{2.17k} = 0.511\ mA$

$V_N = 1\ V$

$R_N = 2.2\ k\Omega$

$I_c = \frac{V_N}{R_N} = \frac{1}{2.2k} = 0.455\ mA$

For R_2:

$V_m = 1.13\ V$

$R_m = 4.68\ k\Omega$

$I_c = \frac{1.13}{4.68k} = 0.242\ mA$

$V_N = 1\ V$

$R_N = 4.7\ k\Omega$

$I_c = \frac{1}{4.7k} = 0.213\ mA$

For R_3:

$V_m = 1.12\ V$

$R_m = 9.83\ k\Omega$

$I_c = \frac{1.12}{9.83k} = 0.114\ mA$

$V_N = 1\ V$

$R_N = 10\ k\Omega$

$I_c = \frac{1}{10k} = 0.100\ mA$

For E = 12 V

Calculated current $I_1 = \frac{12V}{2.17k} = 5.530\ mA$

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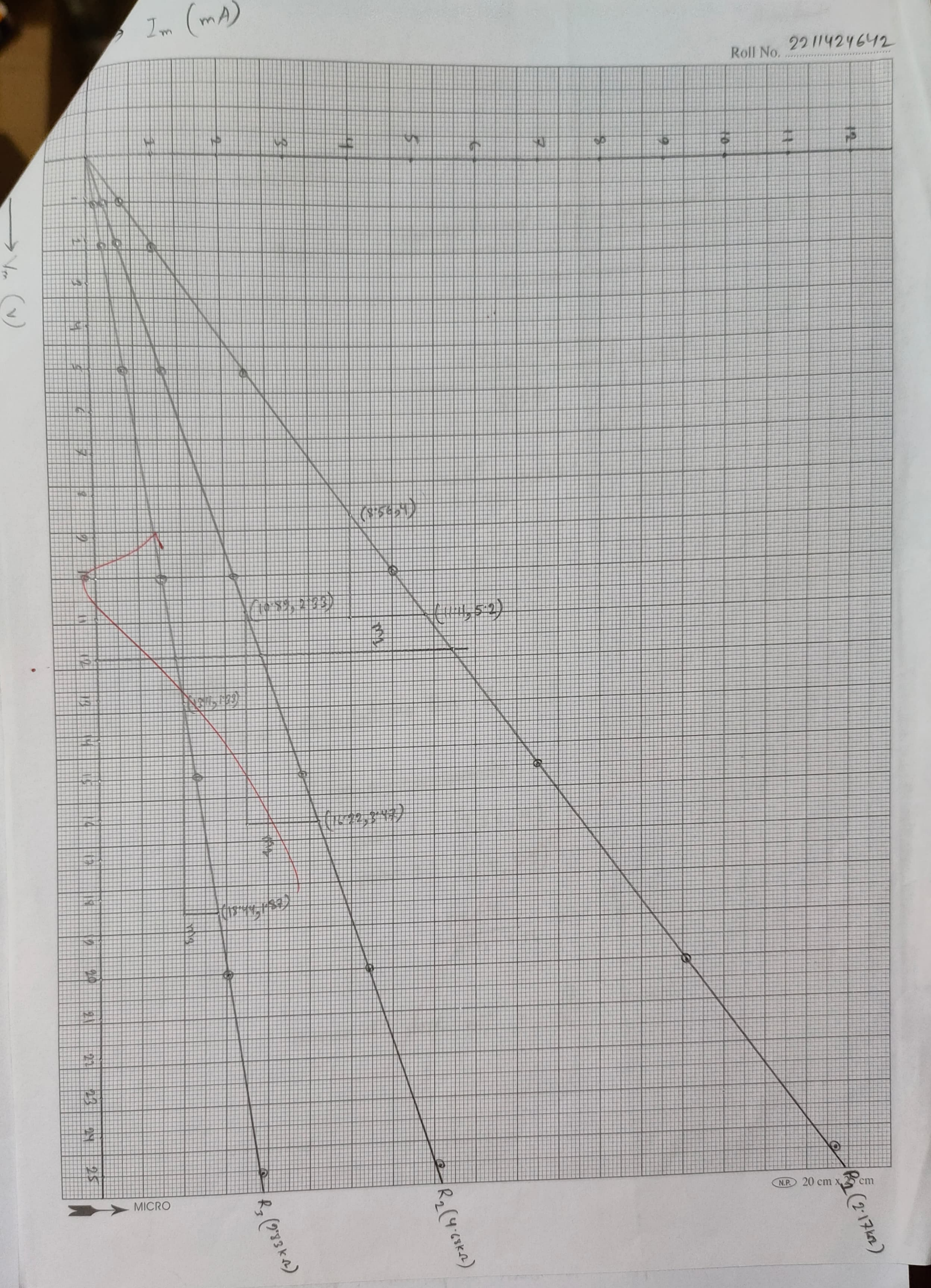

Error calculation:

$$Error_1 = \left| \frac{\text{Calculated Current} - \text{Estimated Current}}{\text{Calculated Current}} \right| \times 100\%$$

$$= \left| \frac{5.530 - 5.633}{5.530} \right| \times 100\%$$

$$= \frac{103}{5530} \times 100\%$$

$$= 1.86\%$$

~~Results~~:

Slope Calculations for R_1

~~$m_1 =$~~

point-1 : $(8.56, 4)$

point-2 : $(11.11, 5.2)$

$$\therefore m_1 = \frac{5.2 - 4}{11.11 - 8.56} = \frac{8}{17}$$

inverse of slope, $m_1^{-1} = \frac{17}{8} = 2.125$

Result:

From the graph we found that, graph is a straight line and always increasing. That means, when voltage increase current also increase. Ohm's law also state that, when applied voltage is larger, current also becomes larger.

From here, we can say that, our experiment followed the Ohm's law.

Question & Answer:

1.

From the data table we see that, our measured current is greater than calculated current. It's a little bit error occurred for the resistor. As we take a 2·2 kΩ resistor but it provides 2·17 kΩ.

~~If the resistor~~

According to Ohm's law, current is inversely proportional to resistor. That means that, if resistor decrease, then current will be increase. And it happens to our experiment. Resistance decrease and current increase.

2. Graph attached.

3.

The inverse of the slope of our graph represent the resistance.

From R_1, slope is $m_1 = \frac{8}{17}$

then inverse of $m_1^{-1} = \frac{17}{8} = 2.125$

from the graph, resistance of R_1 is $2.125\ k\Omega$

Similarly,

$$m_2 = \frac{3.47 - 2.33}{16.22 - 10.89} = \frac{114}{533}$$

$$\therefore R_2 = m_2^{-1} = \frac{533}{114} = 4.68\ k\Omega$$

Again,

$$m_3 = \frac{1.87 - 1.33}{18.44 - 13.11} = \frac{54}{533}$$

$$\therefore R_3 = m_3^{-1} = \frac{533}{54} = 9.87\ k\Omega$$

4.

Attached ~~after~~ in Data Table Section.

Discussion:

First, we measured voltage for three resistance. We don't face ~~d~~ any difficulty. But, when we start to measured the current, DMM was not showing any data. Then we try to figure out and check circuit connection. Everything was okay but a little mistake we do that, we don't change the red wire ~~for~~ in DMM for measuring current. Then we change it to the Amperes point, then it was working perfectly. ~~The~~ In short, we learn how to use DMM and digital power supply. Also we can ~~check~~ make a circuit in a breadboard. Furthermore we also prove that, Ohm's law is correct.