EXPERIMENT 1

Ohm’s Law, Serial and Parallel Connection of Resistors

Purpose:

- To prove experimentally Ohm's Law by examining the relationship between the voltage (V) applied between the ends of any resistor and the current (I) passing over this resistor.
- Based on the experimental data, to express the equivalent resistance in a circuit consisting of several resistors connected in series and in parallel.

Instruments for the Experiment:

- Electricity laboratory set
- Connection cable
- Resistors
- AVOmeter

Theoretical Information:

When we connect a conductor to a power source or a battery, the voltage between the ends of the conductor causes current to pass through the conductor. The magnitude of this current depends on the electrical properties of the conductor used. The most important measure of these electrical properties is the resistance of the conductor. There is generally a linear relationship between the voltage V applied to a conductor and the current I passing through the conductor;

$$V = I.R \tag{1.1}$$

where R is the resistance of the conductor. This relationship is called Ohm's Law. According to the SI unit system, the unit of V is Volt, the unit of I is Amper and the unit of R is Ohm (Ω).

When the circuit shown in Figure 1.1 is made and the current passing through the R resistance is plotted for different voltage values, a linear graph shown in Figure 1.2 is obtained. The slope of this graph gives the magnitude of the 1/R.

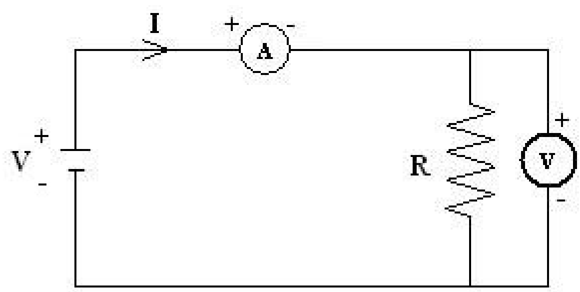

Figure 1.1 The circuit to be used to examine Ohm's law.

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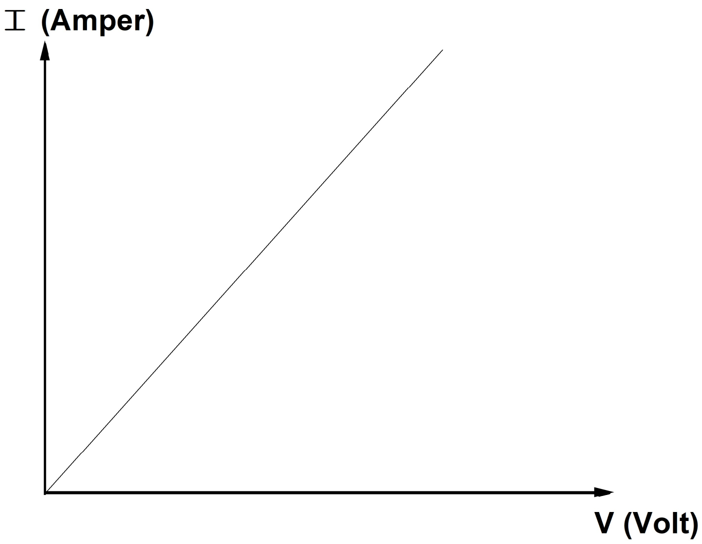

Figure 1.2 I-V graph obeying Ohm's law

If there is more than one resistor in a circuit, the circuit can be reduced to the equivalent circuit by determining the equivalent resistance according to the way the resistors are connected to each other (series, parallel). Thus, circuit analysis can be made easier. In Figure 1.3, a circuit containing more than one resistor is shown to be reduced to a circuit with single equivalent resistor.

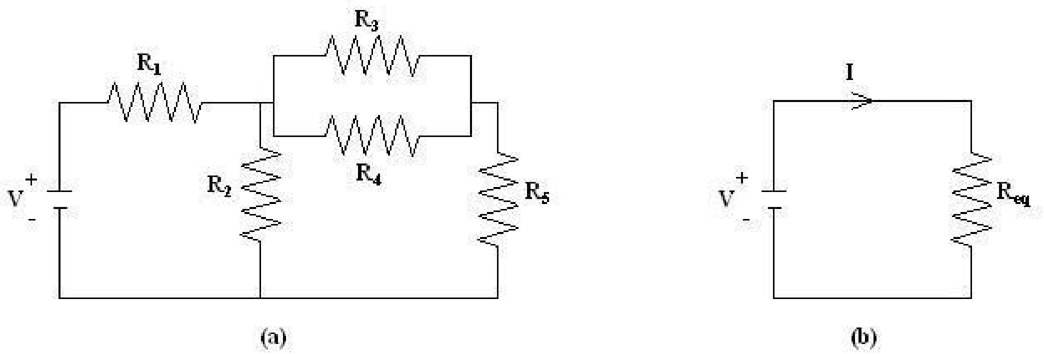

Figure 1.3 **(a)** A circuit consisting of five resistors and **(b)** equivalent circuit

In such a circuit, we find the magnitude of the current passing through the circuit from Ohm's Law;

$$I = \frac{V}{R_{eq}} \tag{1.2}$$

The resistors in the electrical circuits are connected to each other in series or in parallel. When two resistors are connected in series, the current passing through the resistors is equal, and when connected in parallel, the voltages between the ends of the resistors are equal (Figure 1.4).

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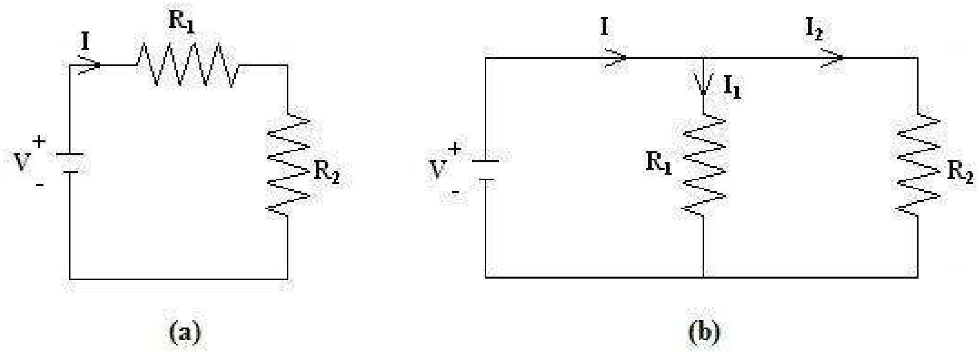

Figure 1.4 Circuits consisting of two resistors connected in **(a)** serial and **(b)** parallel

If there are V_1 and V_2 voltages between the ends of the R_1 and R_2 resistors connected in series as in Figure 1-4 (a), the total voltage is:

$$V = V_1 + V_2$$

$$\Rightarrow I.R_{eq} = I.R_1 + I.R_2 = I.(R_1 + R_2) \quad (1.3)$$

equations will be provided. So equivalent resistance of two resistors in series is:

$$R_{eq} = R_1 + R_2 \quad (1.4)$$

The current in Figure 1-4 (b) will be divided into two currents and similarly,

$$I = I_1 + I_2 \quad (1.5)$$

$$\Rightarrow \frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} = \left[\frac{1}{R_1} + \frac{1}{R_2}\right] V$$

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \quad (1.6)$$

or $$R_{eq} = \frac{R_1.R_2}{R_1 + R_2} \quad (1.7)$$

As can be seen from the above equations, when the two resistors are connected in series, the equivalent resistance is greater than each resistance of the resistor, while in the case where the two resistors are connected in parallel, the equivalent resistance is smaller than each resistance.

The resistors to be used in this experiment have fixed values as you see from the color codes. Other equipments used in this experiment, as voltmeter, ammeter and the connection cables, also have a little internal resistance.

EXPERIMENT 1

Ohm Law, Serial and Parallel Connection of Resistors

DATE :

GROUP ID :

Student ID	Name Surname	Signature

Experiment Expectation	

CALCULATIONS AND RESULTS:

Section 1: Ohm's Law

1. Make a circuit as shown in Figure 1-5 and keep the power supply off until the circuit is checked by the instructor. Once the circuit has been checked, switch on the power supply and change the level of the avometer to read the ammeter and voltmeter readings and record them in Table 1.1.

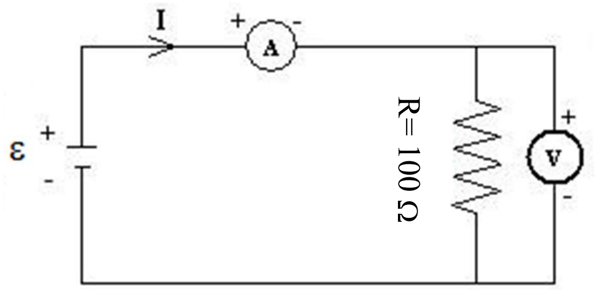

Figure 1.5. Circuit to be used to determine R resistance.

Table 1.1. Current and voltage values on the resistance R

Voltage to be Applied from the Power Supply (V)	Voltage (V)	Current (mA)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

2. Plot the I-V graph and determine the resistance. Record the values to Table 1.2.

Table 1.2 The value of R, experimental and from color code.

	experimental	from color code
R ( )		

Section 2: Series and Parallel Connection of Resistors

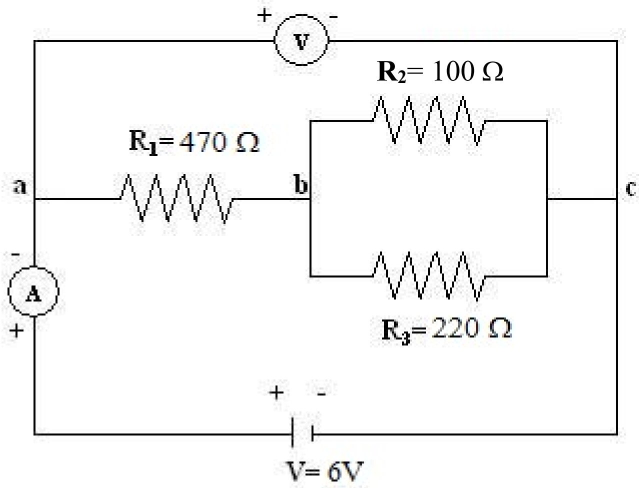

Figure 1.6 Serial and parallel connection of resistors

3. Make a circuit as shown in Figure 1.6 and keep the power supply off until the circuit is checked by the instructor. Measure the equivalent resistance of the circuit by using the ohmmeter first and write it down below.

   R_{eq}=……………………………..(experimental)

4. Use the formulas for parallel and serial connection of resistors to clearly calculate and write down the equivalent resistance.

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5. Once the circuit has been checked, switch on the power supply and measure the voltage across each resistor and the current through it and record them to the Table 1.3.

Table 1.3 Current and voltage values for each resistor.

R (Ω)	**V** (V)	**I** (A)
470		
100		
220		

6. Compare the measured results in Table 1.3 with your theoretically calculated results.

DISCUSSION AND COMMENTS:

1) Discuss the relationship between the voltage and the current for resistors.

2) Discuss the current values that have been found in Item 5.

3) Discuss the voltage values that have been found in Item 5.