Laboratory Session 2

Experiment 1: Ohm's Law

OBJECTIVE:

The objective of this experiment is to investigate the relationship between voltage, current and resistance.

HYPOTHESIS:

The current flowing through a resistor is directly proportional to the voltage drop across that resistor as predicted by Ohm's law.

APPARATUS & INSTRUCTIONS:

- $100\ \Omega$ Resistor
- Prototype board
- Power supply
- Voltmeter
- Ammeter

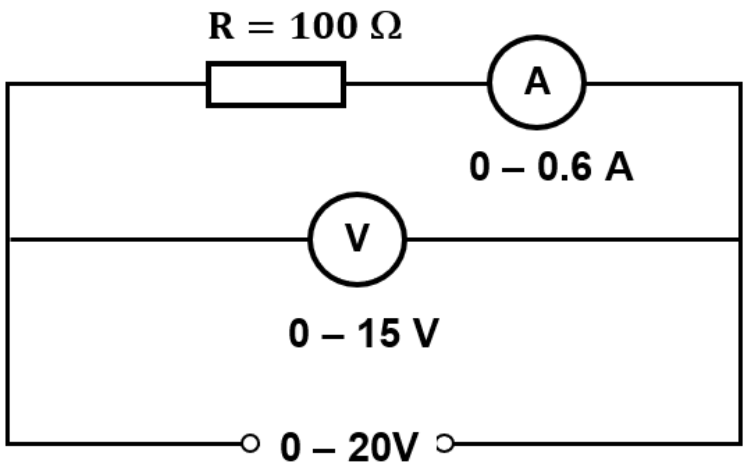

Figure 1. Basic Setup for the Ohm's Law Experiment

1. Assemble the circuit as shown in Figure 1.1, with R = 100 Ω. In electrical circuits, the red cable is usually for positive and the black for negative.
2. Make sure when connecting the voltmeter to the circuit you use the **0 - 15 V** range terminals and when connecting the ammeter you use **0 - 0.6 A** range.
3. Set the adjustable knob for the voltage to 0 Volts (the minimum side) and then turn on the power switch of the power supply.
4. Increase the voltage supply from 1 V to 12 V in steps of 1 V. **Use the value of the voltage from the voltmeter,** not value given by the power supply.
5. At each 1 V step measure the current using the **ANALOGUE** ammeter and tabulate your results from Step 3 in Table 1.1.
6. **Reduce the voltage to 0 V** and switch off the power after the experiment.

   N.B. The resistor can turn very hot over time, so be careful

MEASUREMENTS & CALCULATIONS:

Table 1.1 Voltage and Current Measurements

Measurement no	***Voltage*** V (V)	**Current** I_m (A)	I_p (A)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Table 1.2 Uncertainties associated with measured and predicted values.

Measurement no	δV (V)	δI_m (A)	δI_p (A)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Laboratory Session 2

Experiment 2: Resistors in Series, and in Parallel

OBJECTIVE:
The objective of this experiment is to investigate situations when resistors are connected in series/parallel.

HYPOTHESIS:

The effective resistance of resistors in series, and resistors in parallel, can be modelled using relevant equations and the current flowing in the circuit can be modelled using Ohm's law.

APPARATUS & PROCEDURE:

- $2 \times 100\ \Omega$ Resistors
- $2 \times 33\ \Omega$ Resistors
- Prototype board
- Voltmeter
- Ammeter
- Power supply

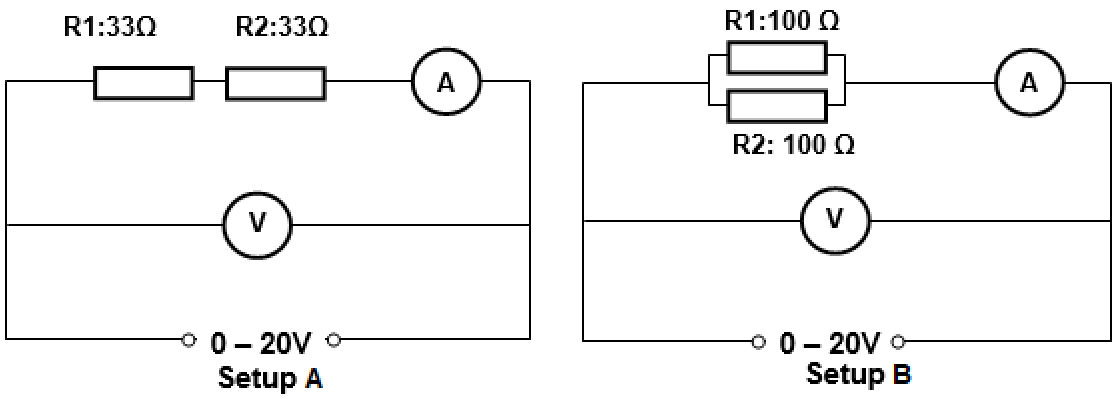

Figure 2.1 Setup for the Resistors-in-Series (A) Experiment, and the Resistors-in-Parallel (B) Experiment

1. Assemble the circuit as in Setup A in Figure 2.1, with the two resistors in series. Set the voltmeter to the **0 - 15 V** range and the ammeter to the **0 - 0.6 A** range. Make sure the adjustable knob for the voltage points at the minimum side, and switch on the power supply. Increase the voltage supply from 1 V - 10 V in steps of 1 V, measure the current using the ammeter and record your results in Table 1. **Now reduce the voltage to 0 V,** and switch off the power.
2. Assemble the circuit as in Setup B in Figure 2.1, and repeat the above procedure and record your results in Table 2.1. You will need to use some 'links' to construct the parallel connection. **After you finish this experiment, reduce the voltage to 0 V**.

MEASUREMENTS & CALCULATIONS:

Table 2.1. Voltage and Current Measurements for Resistors in Series and Parallel

Measurement no	***Voltage V*** $(\mathbf{V})$	**Current - Series** I_m $(\mathbf{A})$	I_p $(\mathbf{A})$	**Current - Parallel** I_m $(\mathbf{A})$	I_p $(\mathbf{A})$
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Table 2.2. Uncertainties associated with measured and predicted values.

Measurement no	δV $(\mathbf{V})$	**Current - Series** δI_m $(\mathbf{A})$	δI_p $(\mathbf{A})$	**Current - Parallel** δI_m $(\mathbf{A})$	δI_p $(\mathbf{A})$
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Laboratory Session 2

Experiment 3: RC Circuits

OBJECTIVE:

The objective of this experiment is to examine how the voltage across a capacitor changes with time.

HYPOTHESIS:

The voltage across a discharging capacitor with respect to time can be accurately modelled with the following equation:

$$V_C = V_0 e^{-t/RC} \qquad \text{Eqn. 1}$$

where

V_C = the voltage across the capacitor (V)

V_0 = the voltage across the capacitor when $t = 0\ s$ (V)

t = time from the beginning of discharge (s)

R = resistance in the circuit (Ω)

C = capacitance of the capacitor (F)

APPARATUS & PROCEDURE:

- 10 kΩ Resistor
- 2200 μF Capacitor
- Prototype board
- Voltmeter
- Power supply

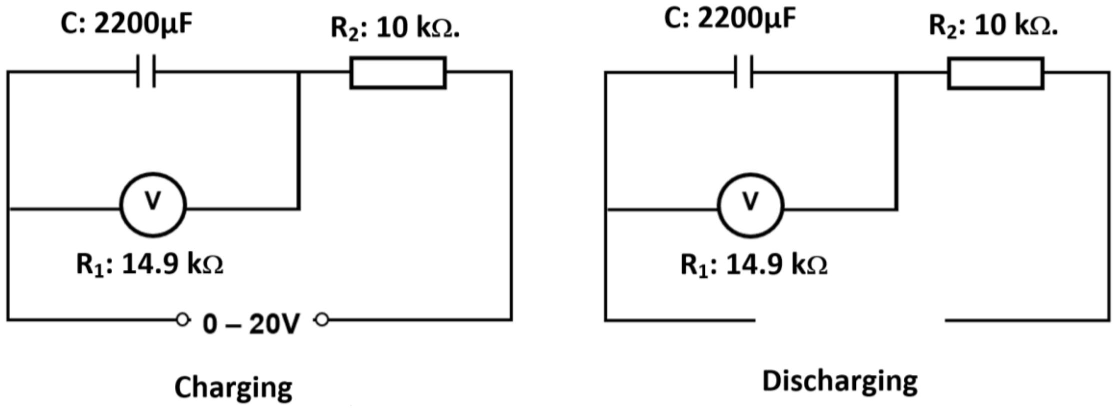

Figure 3.1 Setup for the experiment for both charging and discharging the capacitor

1. **First ensure that the adjustable knob for the voltage is set to 0 Volts and the power supply is switched off before starting the experiment.**
2. Set up the circuit as shown in the **charging** circuit diagram in Figure 3.1, with a resistor and a capacitor in series. Set the voltmeter to the **0 - 15 V** range. **You may need to use crocodile clips when connecting components.**
   N.B. The internal resistance of the voltmeter is **R_1: 14.9 kΩ**
3. Increase the voltage from the power supply to 15 V, and wait for the capacitor to charge-up, indicated by the voltmeter having a reading greater than 7.0 V.
4. Remove the power supply from the circuit as shown in the **discharging** circuit diagram in Figure 3.1 and use the stopwatch to record the time taken for the potential difference across the capacitor to drop to the voltage values listed in Table 3.1. You should start the

stopwatch when the voltage reaches 6.0 V (use this value as V_0). **N.B. The resistance of the circuit in this part is now 14.9 kΩ.**

5. Repeat the measurement three times, and again tabulate your results in Table 3.1.

MEASUREMENTS & CALCULATIONS:

Table 3.1 Time taken for the capacitor to discharge.

Measurement no	**Voltage V (V)**	**Time (s)**				
		t_1	t_2	t_3	**Average t_m**	**Predicted t_p**
1	6.0	0.00	0.00	0.00	0.00	0.00
2	5.5					
3	5.0					
4	4.5					
5	4.0					
6	3.5					
7	3.0					
8	2.5					
9	2.0					
10	1.5					
11	1.0					

Table 3.2 Uncertainties associated with measured and predicted values.

Measurement no	δV (V)	**Time (s)**	
		δt_m	δt_p
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			