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**Course Code :** CSE209

**Course Title :** Engineering Chemistry-1

**Submitted To**

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**Objectives:**

1. To get familiar with circuit variables (voltage and current) and circuit elements (voltage

source and resistance).

2. To learn how to measure dc voltage across a circuit element using a voltmeter.

3. To learn how to measure dc current through a circuit element using an ammeter.

4. To learn how to measure resistance of a resistor using a multimeter.

5. To verify Ohm’s Law.

**Theory:**

There are two types of elements in an electric circuit – active elements and passive

elements. An active element supplies energy. A voltage source or a battery is an active

element. The emf of a battery is measured using the unit volt (V). A passive element absorbs

energy. A resistor is a passive element. The resistance of a resistor is measured using the unit

Ohm (Ω).

There are two fundamental circuit variables – current through a circuit element and

voltage across a circuit element. The current through a circuit element is measured using the

unit Ampere (A) and the voltage across a circuit element is measure using the unit Volt (V).

A simple electric circuit is shown in Figure 1. The emf of the battery is E Volt and the

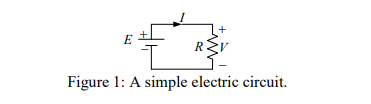
resistance of the resistor is R . The current drawn from the battery and the current passing

through the resistor are same and is I A. The voltage drop across the resistor is V Volt. The

voltage drop across the resistor is exactly equal to the emf of the battery, that is, E = V.

The Ohm’s Law states that V = IR. If we plot V vs. I (taking I as independent variable),

we have a straight line passing through the origin and the slop of the line is R.



An ammeter is used to measure current and a voltmeter is used to measure voltage. As

shown in Figure 2, an ammeter is connected in series with an element, current through which

is to be measured. A voltmeter is connected in parallel with an element, voltage across which

is to be measured. If you connect an ammeter in parallel with an element, the meter will be

damaged. If you connect a voltmeter in series with an element, it will not give you correct

result. So**, make sure that an ammeter is not connected in parallel and a voltmeter is not**

**connected in series.**

**A diagram of an electrical component

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**A diagram of a circuit

Description automatically generatedCircuit Diagram:**

**Pre-Lab Report Question:**

1. Theoretically calculate the values of I for the circuit of Figure 3 for E = 5, 6, 7, 8, 9, 10 V

and R = 1000Ω.

**Solution:**

Given,

R = 1000Ω.

E = 5, 6, 7, 8, 9, 10 V

From Ohm’s Law,

I=ER

 E= I/R

Now,

E = 5V; I = 5/1000 = 5 mA

E = 6V; I = 6/1000 = 6 mA

E = 7V; I = 7/1000 = 7 mA

E = 8V; I = 8/1000 = 8 mA

E = 9V; I = 9/1000 = 9 mA

E = 10V; I = 10/1000 = 10 mA

**Equipments and Components Needed:**

1. DC power supply

2. DC ammeter

3. DC voltmeter

4. Multimeter

5. Resistor 1000Ω

6. Breadboard

7. Connecting wires

**Lab Procedure:**

1. Measure the resistance of the resistor supplied using a multimeter and record it in Table 1.

2. Construct the circuit of Figure 3. Set the value of E at 5, 6, 7, 8, 9, and 10 volts and

measure the corresponding V and I and record them in Table 1.

3. Have the datasheet signed by your instructor.

Table 1. Experimental Datasheet.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Observation number | Set Value of *E* (V) | Measured Value of *V* (V) | Measured Value of *I* (mA) | Measured Value of *R* (Ω) |
| 1 | 5 | 4.8 | 4.5 | 1.08 |
| 2 | 6 | 5.85 | 6 |
| 3 | 7 | 6.86 | 7 |
| 4 | 8 | 7.85 | 8 |
| 5 | 9 | 8.8 | 9 |
| 6 | 10 | 9.78 | 10 |

**Post-Lab Report Questions:**

**1. Theoretically calculate the values of I using measured values of V and R. Compare the**

**theoretical values with the measured values and comment on any discrepancy.**

**Solution:**

To theoretically calculate the values of I using measured values of V and R, we can

use Ohm’s Law, which states that,

Itheoretical = V/R

Now,

Itheoretical = 4.8/1.08 = 4.4 mA

Itheoretical = 5.85/1.08 = 5.4 mA

Itheoretical = 6.86/1.08 = 6.3 mA

Itheoretical = 7.85/1.08 = 7.2 mA

Itheoretical = 8.8/1.08 = 8.1 mA

Itheoretical = 9.78/1.08 = 9.05 mA

Now, let's compare the theoretical and measured values:

|  |  |  |  |
| --- | --- | --- | --- |
| Observation Number | Measured value of I (mA) | Theoretical value of I (mA) | Discrepancy |
| 1 | 4.5 | 4.4 | 1.9% |
| 2 | 6 | 5.4 | 0.16% |
| 3 | 7 | 6.3 | 12% |
| 4 | 8 | 7.2 | 1.2% |
| 5 | 9 | 8.1 | 0.43% |
| 6 | 10 | 9.05 | 0.09% |

The measured and theoretical current values are generally extremely near, with a few minor and one substantial difference. These differences could be the result of things like minor measurement errors, temperature-related variations in the resistance values, or even computation problems. The divergence for the 7V scenario is greater—12%—and raises the possibility that there are other factors influencing the theoretical calculation's correctness for that particular data point. Overall, Ohm's Law holds true in this situation since the theoretical calculations roughly match the actual numbers.

**2. Theoretically calculate the values of R from the measured values of V and I using Ohm’s law. Compare the calculated and measure values of R and comment on any discrepancy.**

**Solution:**

To theoretically calculate the values of R using measured values of V and I, we can use Ohm’s Law, which states,

Rtheoretical=V/I

Now,

Rtheoretical=5.21/5.3=0.98 Ω

Rtheoretical=6.1/6.2=0.98 Ω

Rtheoretical=7/7.21=0.97 Ω

Rtheoretical=8/8.2=0.97 Ω

Rtheoretical=8.9/9.17=0.97 Ω

Rtheoretical=10/10.31=0.97 Ω

Ravg= (0.98+0.98+0.97+0.97+0.97+0.97)/6 = 0.97

Theoretically R =0.97 Ω

Measured R = 0.98 Ω

Discrepancy (%) = ∣ (Measured R - Calculated R)/ Measured R ∣ × 100 %

= |(0.98-0.97) / 0.98|× 100 %

=1.02%

The 1.02% deviation between theoretical and measured resistance values indicates a generally good agreement overall. This slight difference could arise from factors such as measurement inaccuracies, variations in circuit conditions, or tolerance levels in components. Despite this minor discrepancy, Ohm's Law remains a robust framework for comprehending the interplay among voltage, current, and resistance within the circuit.

**3. Compare the set value of E and the measured value of V and comment on any**

**discrepancy.**

**Solution:**

Given,

Set values of E = 5, 6, 7, 8, 9, 10 V

Measured values of V =5.1, 6.1, 7.2, 8, 9.1, 10 V

Now, absolute differences:

* + For E = 5V; |5V-5.21V|=0.21V
  + For E = 6V; |6V-6.1V|=0.1V
  + For E = 7V; |7V-7V|=0V
  + For E = 8V; |8V-8V|=0V
  + For E = 8V; |9V-8.9V|=0.1V
  + For E = 7V; |10V-10.V|=0.3V

Differences between the set and measured voltages happen because of mistakes in instruments, changes in the circuit, mistakes by people, differences in how components work, and outside signals affecting things. Knowing about these things helps make sure experiments give accurate results.

**4. Plot V vs. I (taking I as independent variable) and fit a straight-line passing through the**

**origin. From the plot determine the resistance of the supplied resistor using Ohm’s law.**

**Compare this value with the measured value and comment on any discrepancy.**

**Solution:**

A graph with a line

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From the plot the resistance of the supplied resistor using Ohm’s law is given below:

R1=5.21/5.3=0.98 Ω

R2=6.1/6.2=0.98 Ω

R3=7/7.21=0.97 Ω

R4=8/8.2=0.97 Ω

R5=8.9/9.17=0.97 Ω

R6=10/10.31=0.97 Ω

Ravg= (0.98+0.98+0.97+0.97+0.97+0.97)/6 = 0.97

Measured Resistance is R= 0.98

The measured resistance of 0.98 ohms exceeds the calculated average resistance of 0.97 ohms. This deviation could be due to several factors. Measurement errors, including inaccuracies in voltage and current readings or uncertainties in measurement instruments, might have contributed. Additionally, the resistor itself may have a tolerance specified by the manufacturer, accounting for some discrepancy. Non-ideal behavior such as temperature dependence or non-linear characteristics at high currents could also play a role. Environmental factors, such as fluctuations in temperature, might further influence the resistance measurement.

**5. Discuss how voltage or current is measured using a multi-range meter.**

**Solution:**

A multi-range meter is a versatile instrument used for measuring voltage, current, resistance, and sometimes other electrical parameters. These meters typically have multiple ranges to accommodate different levels of voltage or current. Here's how voltage and current are typically measured using a multi-range meter:

**Voltage Measurement:**

* Select the voltage range (AC or DC) on the meter.
* Connect the probes to the circuit/component.
* Read the voltage value on the screen.
* Adjust the range if needed for accuracy.

**Current Measurement:**

* Select the current range (AC or DC) on the meter.
* Connect the meter in series with the circuit.
* Close the circuit and allow current to flow.
* Read the current value on the screen.
* Adjust the range if needed for accuracy.

In both cases, it's crucial to select the correct range on the meter to ensure accurate measurements and prevent damage to the meter itself. Multi-range meters offer flexibility by allowing users to switch between different measurement ranges depending on the magnitude of the voltage or current being measured.

