

Student's name: _____

Grade: _____

Resistance and Resistivity Lab

Introduction:

Electrical resistance is a fundamental property of materials that opposes the flow of electric current. The resistance of a conductor depends on both its physical dimensions and the intrinsic property of the material called **resistivity**. This lab investigates the relationship between resistance and resistivity by measuring the resistance of copper and unknown wires, and using these measurements to calculate their resistivities and identify the unknown materials.

Theory:

1. Ohm's Law

The relationship between voltage V and current I in a conductor is given by:

$$V = IR$$

Where:

- V = voltage (V)
- I = current (A)
- R = resistance (Ω)

The resistance of the wire can be determined from the slope of the linear graph of V vs. I .

2. Resistance and Resistivity

The resistance of a uniform conductor is related to its resistivity ρ , length L , and cross-sectional area A by:

$$R = \rho \frac{L}{A}$$

Rearranging to solve for resistivity:

$$\rho = R \frac{A}{L}$$

Where:

$$A = \frac{\pi d^2}{4}$$

- ρ = resistivity ($\Omega \cdot \text{m}$)
- L = length of the wire (m)
- A = cross-sectional area of the wire (m^2), calculated as:

where d is the wire diameter.

Procedure:

Part 1 — Measuring Resistivity of a Copper Wire (diameter 0.101 cm)

1. Open the simulation: https://www.new3jcn.com/Phyc240/resistivity_lab.html
2. Change 'Right sphere position' slider and record current & voltage
3. Calculating Resistance column value

L (m)	I (mA)	V (mV)	R (Ω)
0.4			
0.45			
0.5			
0.6			
0.7			
0.8			
0.9			
1.0			

4. **Plot R vs. L.** The slope of the best-fit line gives the ratio R/L . Insert your graph here:

5. Calculate the cross-section area of the copper wire:

$$A = \frac{\pi d^2}{4} =$$

6. **Calculate resistivity ρ** using the formula:

$$\rho = R \frac{A}{L}$$

Show your work here:

7. The theoretical value of the copper wire's resistivity is $\rho = 1.68 \times 10^{-8} \Omega \cdot \text{m}$. Calculate the percentage error of the copper wire's resistivity.

Part 2 — Measuring resistivity of an Unknown Wire

1. Keep the unknown wire's length constant:
 - Unknown Wire : **diameter = 0.98 mm (0.00098 m); length = 0.8 m**
2. **Gradually increase the current** from 0 to **300 mA (0.300 A)**.
3. At each step, **record the voltage** across the wire corresponding to each current value.

I (mA)	V (mV)
0	
10	
20	
50	
100	
150	
200	
300	

4. **Plot V vs. I.** The slope of the best-fit line gives the resistance R. Insert your graph here:

5. **Calculate resistivity ρ** using the formula:

$$\rho = R \frac{A}{L}$$

Show your work here:

6. **Compare** the calculated resistivity values with standard resistivity tables (e.g., online or textbook values) to **identify the material** of the unknown wire.

Part 3 — Measuring cross-sectional area dependence

We will also measure the cross-sectional dependence of resistance for **brass** wires with the following diameters: (keep these brass wires' length constant at 0.8 m)

1. • 0.127 cm
2. • 0.101 cm
3. • 0.082 cm
4. • 0.051 cm
5. Measure V and I, plot V vs. I, determine R, and calculate ρ . Insert your table and graph here:

Diameter (m)	$1/A$ ($1/m^2$)	Current (mA)	Voltage (mV)	Resistance (Ω)
0.00051				
0.00082				
0.00101				
0.00127				

6. We know: $R = \rho L \frac{1}{A} = mx$ Plot R vs. $1/A$.

Determine the slope $m = \rho L$ of the linear line and calculate $\rho = m/L$. Insert your table and graph here

8. The theoretical value of the brass wire's resistivity is $\rho = 7.58 \times 10^{-8} \Omega m$. Calculate the percentage error of the brass wire's resistivity.

Conclusion:

- Verify the linearity of Ohm's Law for each wire.
- Compare experimental resistivity values to standard values.
- Identify the material of the unknown wires.
- Discuss possible sources of error such as measurement inaccuracies, temperature effects, and wire uniformity.