

Experiment -01

Aim:- To determine the resistivity of given two / three wires by plotting a graph for potential difference versus current.

Apparatus/ Material Required:- Two/three resistance wires, a voltmeter (0-3) V and an ammeter (0-3) A , a battery/battery eliminator, a rheostat, a meter scale, one way key, connecting wires, a screw gauge.

Theory:- (i) According to the Ohm's law the current flowing through a conductor is directly proportional to the potential difference across its ends provided the physical conditions (temperature, dimensions, pressure) of the conductor remains the same. If I be the current flowing through a conductor and V be the potential difference across its ends, the according to Ohm's Law,
 $V \propto I$ or $V = RI$ where, R is the constant of proportionality. It is known as resistance of the conductor.

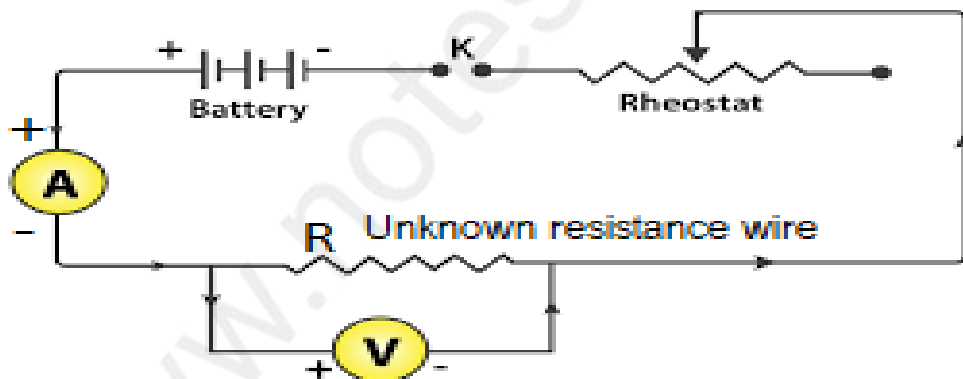
Or $\frac{V}{I} = R$ R depends upon the nature of material, temperature and dimensions of the conductor.

(ii) Specific resistance (ρ) of the material of the given material is given by

$$\rho = \frac{RA}{L} = \frac{R\pi r^2}{L} = \frac{R\pi D^2}{4L}$$

Where, L is the length and D is the diameter of the given wire.

Circuit Diagram:-



Procedure:-

- For Resistance :-**
1. Clean the ends of the connecting wire with the help of sandpaper to remove any insulating coating on them.
 2. Connect the resistance, rheostat, battery, key, voltmeter, and ammeter as shown in the figure.
 3. Make sure that the pointers in the voltmeter and ammeter coincide with the zero mark on the measuring scale. If not, adjust the pointer to coincide with the zero mark by adjusting the screw provided at the base using a screwdriver.
 4. Note the range and the least count of the given voltmeter and ammeter.
 5. Insert the key K and slide the rheostat to the end where the current flow is minimum.
 6. Note the voltmeter and the ammeter reading.
 7. Remove the key K and allow the wire to cool. Again insert the key and slightly increase the voltage by moving the rheostat. Note down the ammeter and voltmeter reading.
 8. Repeat step 7 for four different adjustments of the rheostat. Document the readings in a tabular column.

For Specific Resistance:- 9. Cut the resistance wire at the points where it leaves the terminals, stretch it and find its length by using a metre scale.

10. Measure the diameter of the wire at least at three places with the help of screw gauge.

11. Record your observations in table.

Repeat all steps from 1 to 11 for 2nd wire also.

Observations :-

Range of ammeter = 0 – 3 A

The Least count of ammeter = 0.05A

Range of voltmeter = 0 – 3 V

The Least count of voltmeter = 0.05V

The Least count of meter-scale = 0.1 cm

Least count of the screw gauge:-

Pitch of screw gauge= 1 mm

Total no. of divisions on the circular scale= 100

$$\therefore \text{L.C. of the given screw gauge} = \frac{\text{Pitch}}{\text{No. of divisions on the circular scale}}$$

$$= 0.01 \text{ mm} = 0.001 \text{ cm}$$

Zero error, e = 0 mm,

Zero correction, c = -e = 0 mm

For 1st wire:-

Length of the given wire, L= 15cm=0.15m

Observation table for Resistance:-

Sr. No.	Ammeter Reading I(Ampere)		Voltmeter Reading V(Volt)		$R = \frac{V}{I}$ (Ohm)
	Observed	Corrected	Observed	Corrected	
1.	6 x 0.05=0.30A	=0.30A	6 x 0.05=0.30V	=0.30V	$= \frac{0.30V}{0.30A} = 1.00 \Omega$
2.	10 x 0.05=0.50A	=0.50A	10 x 0.05=0.50V	=0.50V	= 1.00 Ω
3.	13 x 0.05=0.65A	=0.65A	14 x 0.05=0.70V	=0.70V	= 1.08 Ω
4.	17 x 0.05=0.85A	=0.85A	18 x 0.05=0.90V	=0.90V	= 1.06 Ω
5.	19 x 0.05=0.95A	=0.95A	20 x 0.05=1.00V	=1.00V	= 1.05 Ω

Mean value of resistance, $R = \frac{1.00+1.00+1.08+1.06+1.05}{5} = 1.04 \Omega$

Table for Diameter of wire:-

Sr. No.	Linear scale reading N(mm)	Circular scale readings		Observed Diameter $D_0=N+n \times (L.C.)$ mm	Corrected Diameter $D=D_0+c$	Mean corrected diameter mm
		No. of circular scale division on reference line (n)	Value [n×(L.C)] mm			
1.	0 mm	30	$30 \times 0.01 \text{ mm} = 0.30 \text{ mm}$	0.30 mm	0.30 mm	=0.30mm
2.	0 mm	31	$31 \times 0.01 \text{ mm} = 0.31 \text{ mm}$	0.31 mm	0.31 mm	
3.	0 mm	30	$30 \times 0.01 \text{ mm} = 0.30 \text{ mm}$	0.30 mm	0.30 mm	

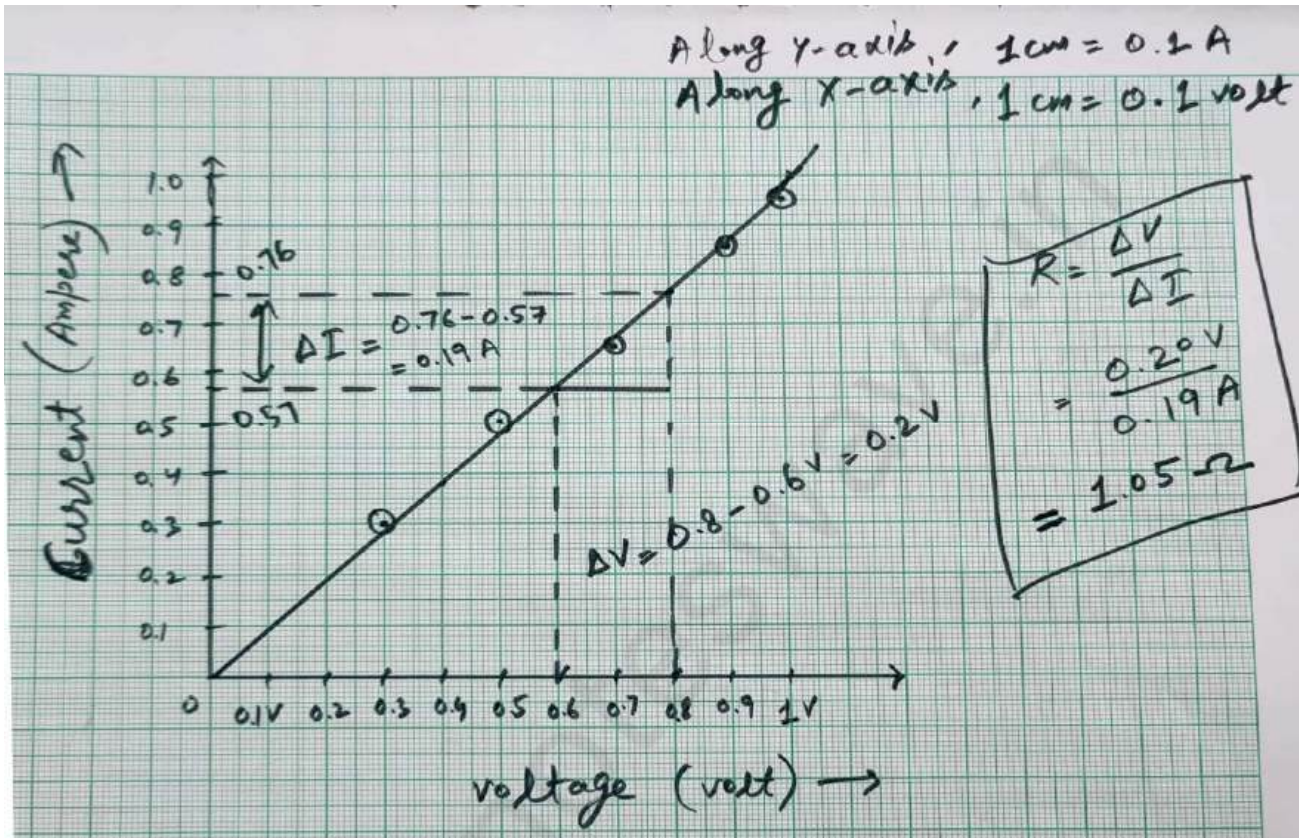
Calculations for Specific resistance:-

$$\rho = \frac{R\pi D^2}{4L} = \frac{1.04 \times 3.14 \times (3 \times 10^{-4})^2}{4 \times 0.15} \Omega\text{-m} = 48.98 \times 10^{-8} \Omega\text{-m}$$

Standard value of the specific resistance of the material (Constantan) of the given wire

$$\rho_0 = 49 \times 10^{-8} \Omega\text{-m}$$

$$\therefore \text{Percentage error} = \frac{\rho_0 - \rho}{\rho_0} \times 100\% = \frac{(49 - 48.98) \times 10^{-8}}{49 \times 10^{-8}} \% = 0.04\%$$



For 2nd wire:-

Length of the given wire, $L = 29 \text{ cm} = 0.29 \text{ m}$

Observation table for Resistance:-

Sr. No.	Ammeter Reading I (Ampere)		Voltmeter Reading V (Volt)		$R = \frac{V}{I}$ (Ohm)
	Observed	Corrected	Observed	Corrected	
1.	$5 \times 0.05 = 0.25 \text{ A}$	$= 0.25 \text{ A}$	$10 \times 0.05 = 0.50 \text{ V}$	$= 0.50 \text{ V}$	$= \frac{0.50 \text{ V}}{0.25 \text{ A}} = 2.00 \Omega$
2.	$10 \times 0.05 = 0.50 \text{ A}$	$= 0.50 \text{ A}$	$20 \times 0.05 = 1.00 \text{ V}$	$= 1.00 \text{ V}$	$= 2.00 \Omega$
3.	$15 \times 0.05 = 0.75 \text{ A}$	$= 0.75 \text{ A}$	$30 \times 0.05 = 1.50 \text{ V}$	$= 1.50 \text{ V}$	$= 2.00 \Omega$
4.	$19 \times 0.05 = 0.95 \text{ A}$	$= 0.95 \text{ A}$	$40 \times 0.05 = 2.00 \text{ V}$	$= 2.00 \text{ V}$	$= 2.11 \Omega$
5.	$23 \times 0.05 = 1.15 \text{ A}$	$= 1.15 \text{ A}$	$50 \times 0.05 = 2.50 \text{ V}$	$= 2.50 \text{ V}$	$= 2.17 \Omega$

$$\text{Mean value of resistance, } R = \frac{2.00 + 2.00 + 2.00 + 2.11 + 2.17}{5} = 2.06 \Omega$$

Table for Diameter of wire:-

Sr. No.	Linear scale reading N(mm)	Circular scale readings		Observed Diameter $D_0 = N + n \times (L.C.)$ mm	Corrected Diameter $D = D_0 + c$	Mean corrected diameter mm
		No. of circular scale division on reference line (n)	Value $[n \times (L.C)]$ mm			
1.	0 mm	30	$30 \times 0.01 \text{ mm} = 0.30 \text{ mm}$	0.30 mm	0.30 mm	=0.30mm
2.	0 mm	31	$31 \times 0.01 \text{ mm} = 0.31 \text{ mm}$	0.31 mm	0.31 mm	
3.	0 mm	30	$30 \times 0.01 \text{ mm} = 0.30 \text{ mm}$	0.30 mm	0.30 mm	

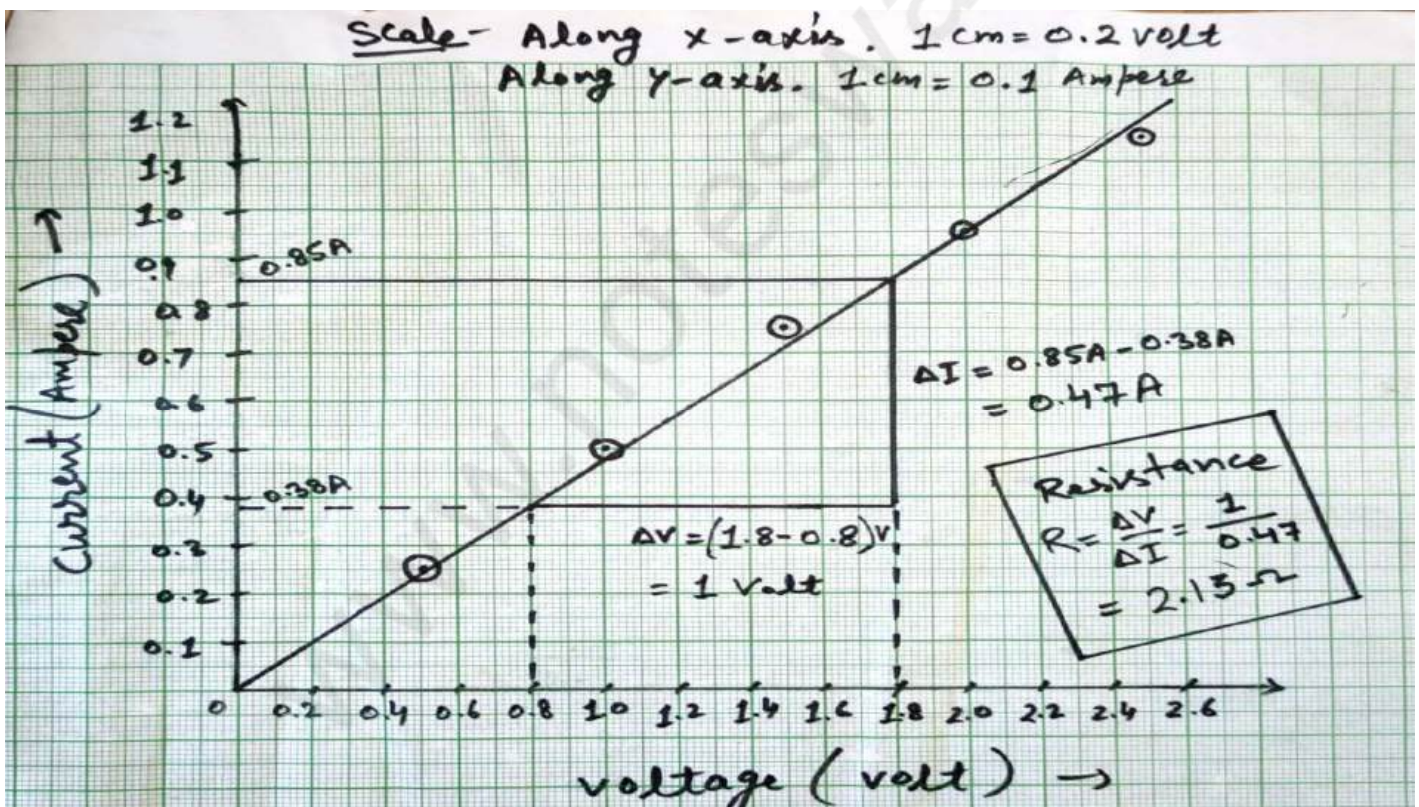
Calculations for Specific resistance:-

$$\rho = \frac{R\pi D^2}{4L} = \frac{2.06 \times 3.14 \times (3 \times 10^{-4})^2}{4 \times 0.29} \text{ ohm-m} = 50.19 \times 10^{-8} \Omega\text{-m}$$

Standard value of the specific resistance of the material (Constantan) of the given wire

$$\rho_0 = 49 \times 10^{-8} \Omega\text{-m}$$

$$\text{Percentage error} = \frac{\rho - \rho_0}{\rho_0} \times 100 \% = \frac{(50.19 - 49) \times 10^{-8}}{49 \times 10^{-8}} \% = 2.43\%$$



Result:-

- Resistance of 1st wire from table = 1.04 Ω and from graph = 1.05 Ω
- Resistivity of 1st wire = $49 \times 10^{-8} \Omega\text{-m}$
- Percentage error = 0.04%
- Resistance of 2nd wire from table = 2.06 Ω and from graph = 2.00 Ω
- Resistivity of 2nd wire = $50.19 \times 10^{-8} \Omega\text{-m}$
- Percentage error = 2.43%

Precautions:-

1. The connections should be neat, clean and tight.
2. Thick connection wires should be used for the connections.
3. Voltmeter and ammeter should be of proper range.
4. A low resistance rheostat should be used .
5. The key should be inserted only while taking observations to avoid heating of resistance.
6. At one place, diameter of wire should be measured in two mutually perpendicular directions.
7. The wire should not make a loop.

Sources of Error:-

1. The instrument screw may be loose.
2. Thick connection wires may not be available.
3. Rheostat may have high resistance.
4. The wire may not have uniform thickness.
5. The screw gauge may have faults like back lash error and wrong pitch.

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