People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

Mohamed Boudiaf University of M'sila

Faculty of Sciences

Common Trunk of Matter Sciences

1st year - 2nd semester

Practical works - Physics 2

4th Practical Work

ResistanceMeasurement

Experiment date: ………/………/……………

Corrector professor : ……………………………………………

Report prepared by :

First name	Family name	Group	Sup-group	Preparation mark	Final mark
				/5,00	/20,00
				/5,00	/20,00
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				/5,00	/20,00
				/5,00	/20,00

Academic year : 2023/2024

1-The purpose of experiment

The purpose of this experiment is to measure current, voltage and resistance using a multimeter. Calculate Resistance using Ohm's law. Assemble the setup of simple and mixed electrical circuits. Determine the equivalent resistance of a mixed circuit. Check the law of junctions and the law of loops. Highlight the usefulness and use of the Wheatstone bridge and Knowledge of metals from the measurement of resistivity.

2-Notions and preparation work

2-1- Some laws of electrical circuits

Let a circuit consist of a generator (E) connected to a resistor R (expressed in Ohms) using the conductive wires (figure-1). Voltage is responsible for the movement of charges in an electrical circuit, the current is the flow of these charges, and resistance represents the tendency of a circuit element to oppose the flow of current.

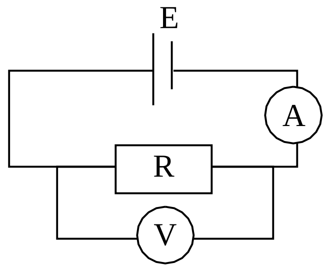

Figure-1

The voltage V (expressed in Volts) is measured using a voltmeter « V ». It is a parallel measurement with an element of the circuit.

The current I (expressed in Amps) is measured using an ammeter « A ». It is a series measurement in the circuit. According to Ohm's law, measurements made against a resistor must satisfy the relationship: $V = RI$,

A group of resistances $(R_1, R_2, \dots, R_n)$ in series has an equivalent resistance given by $R_{eq} = R_1 + R_2 + \dots + R_n$, while $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$ when these resistors are connected in parallel.

- Calculate the equivalent resistance for $R_1 = 100\Omega, R_2 = 150\Omega$, and $R_3 = 100\Omega$.

2-1-a-R_1, R_2 and R_3 are connected in series, $R_{eq} = \cdots\ \Omega$.

2-1-b-R_1, R_2 and R_3 are connected in parallel, $R_{eq} = \cdots\ \Omega$

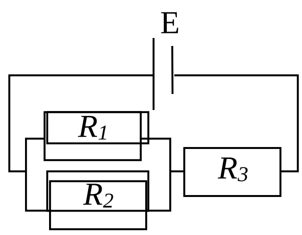

figure-2

2-1-c-R_1, R_2 and R_3 are connected in a mixed circuit according to figure-2; $R_{eq} = \cdots\ \Omega$.

Note: The equivalent resistance is calculated from the equivalent circuit where each branch is replaced by a resistance by first simplifying the series resistance groupings.

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2-1-d-R_1, R_2 and R_3 are mounted in a mixed circuit according to Figure-3; $R_{eq} = \cdots \quad \Omega$.

-The law of junctions applies to connection points of circuit elements. The law of junctions states that the The sum of the currents entering a junction is equal to The sum of the currents leaving the junction.

For the mixed circuit following figure-3; $I = I_1 + I_2$.

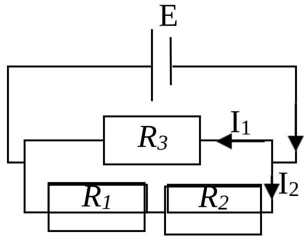

Figure-3

The law of meshes applies to loops in the electrical circuit. The law of meshes states that the sum of currents entering a node is equal to the sum of the currents leaving the node. (figure-4). For the previous circuit, we have

Mesh $N^0 1$ traveled by the current I_1:

$E = R_3 I_1 = R_3(I - I_2)$

Mesh $N^0 2$ traveled by the current I_2:

$0 = -R_3 I_1 + (R_1 + R_2) I_2 = R_3(I_2 - I) + (R_1 + R_2) I_2$

where E is the voltage across the generator.

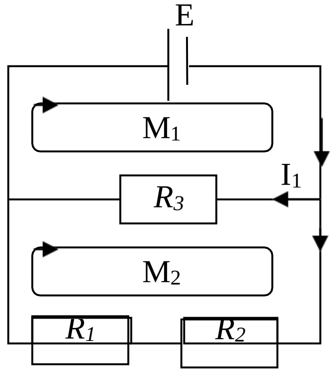

Figure-4

2-2- Wheatstone bridge

The Wheatstone bridge is used to convert a variation in resistance into a variation in voltage, which makes it a sensor in environments where measurement is difficult.

Consider the setup of figure-5.

2-2-a- Give the direction of U_{AM}, U_{BM}, U_{AB} in figure-5.

2-2-b- Express $U_{AM} = f(R_1, R_2, E)$

$U_{AM} = \cdots$

2-2-c- Express $U_{BM} = f(R_v, R_x, E)$

$U_{BM} = \cdots$

2-2-d- Deduce $U_{AB} = f(R_1, R_2, R_v, R_x, E)$

$U_{AB} = \cdots$

2-2-c-If $U_{AB} = 0$, the bridge is said to be equilibrated.

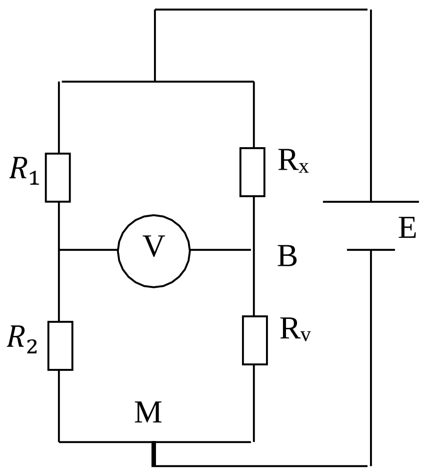

Figure-5

Show that the expression for R_x takes a form independent of the supply voltage.

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3- Practical work

3-1- Simple circuits

3-1-a- Resistors in series

Perform the setup where R_1, R_2 and R_3 are Connecting in series.

Powering your circuit with voltage $E = 5.0V$ and complete the opposite table.

	R1	*R2*	*R3*
I (mA)			
V(Volts)			
Resistance (Ω)			

3-1-b- Resistors in parallel

Perform the setup where R_1, R_2 and R_3 are Connecting in parallel.

Powering your circuit with voltage $E = 5.0V$ and complete the opposite table

	R1	*R2*	*R3*
I (mA)			
V(Volts)			
Resistance (Ω)			

3-2-Mixed circuits

Perform the setup where R_1, R_2 and R_3 are following figure-2.

Powering your circuit with voltage $E = 5.0V$ and complete the opposite table

	R1	*R2*	*R3*
I (mA)			
V(Volts)			
Resistance (Ω)			

Perform the setup where R_1, R_2 and R_3 are following figure-3.

Powering your circuit with voltage $E = 5.0V$ and complete the opposite table

	R1	*R2*	*R3*
I (mA)			
V(Volts)			
Resistance (Ω)			

3-3- Measuring the resistivity of a material

Perform the experimental setup in figure -5, where $R_1 = 1\ k\Omega$ and $R_2 = 100k\Omega$ and the resistant wire in place of R_x. Power the circuit with a voltage E=5.0V.

Vary the resistance "R_v" until the bridge is equilibrated (the galvanometer indicates zero voltage). For different section values, S, of resistant wire "$L = 1\ m$" long;

a)-Complete the table opposite.

b)-Deduce the type of the two metals; Use the displayed table of resistivity values.

Wire diameter *d* (*mm*)	1	0.5	0.7
R_v (Ω)			
Resistance R_x (Ω)			
Resistivity $\rho = \frac{RS}{L}$ (Ω.cm)			

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Electrical resistivity values of certain materials (at T=20°C)

Material	Resistivity ($\times 10^{-6}\ \Omega$ .cm)
Silver	1.63
Copper	1.69
Gold	2.2
Aluminum	2.67
Tungsten	5.4
Zinc	5.96
Brass (copper + zinc alloy)	6.2-7.8
Iron	10.1
Platinum	10.58
Lead	20.6
Constantan (Cu55/Ni45 alloy)	52
Carbon	3500
Germanium	46×10^{6}
Silicon	23×10^{6}
Glass	$10^{10} - 10^{14}$
Hard rubber	10^{13}
Suffer	10^{15}
Fused Quartz	76×10^{16}

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