الجمهورية الجزائرية الديمقراطية الشعبية
PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
وزارة التعليم العالي والبحث العلمي
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
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Faculty of Technology
Socle Commun (ST)
First Year (ST-REE-ING), 2nd Semester
Physics practical work II

1st Practical Work
Resistance Measurement

Date:……..../…….../……..

Professor:…………………

First Name	Last Name	Group	Sub-Group	Prep Mark	Final Mark

Academic Year: 2023/2024

1-1 - Aim of the experiment

The overall aim of this experiment is to calculate the resistance within an electrical circuit. Measure the voltage at its terminals and the current passing through it using a multimeter. Calculate the resistance using Ohm's law. Assembly of simple and mixed electrical circuits. Determine the equivalent resistance of a mixed circuit. Highlight the use of the Wheatstone bridge and know metals from the measurement of resistivity. Resistance is measured in ohm (W).

2- Notions and preparatory work

2-1- Some laws of electrical circuits

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

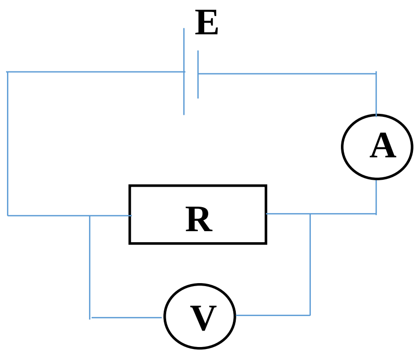

Figure. 1

The voltage ***V*** is measured using a multimeter, in the voltmeter position (*V*). A potential difference V arises between two terminals, the measurement is carried out in parallel with across the circuit element. The current ***I*** is measured using a multimeter in the ohmmeter position (***A***). It is a measurement carried out in series in a circuit. According to Ohm's law, measurements made against a resistor must satisfy the relationship: $V = R.I$. It describes the relationships between voltage, current, and resistance in electrical circuits.

The resistance R can be expressed as follows: $R = \rho \frac{l}{S}$

Where ρ indicates the resistivity, l the length, and S the cross-sectional area.

A groupe of resistors (R1, R2, …Rn) in series has an equivalent resistance given by Req=R1+R2+…+Rn, while 1/Req=1/R1+1/R2+…+1/Rn when these resistors are connected in parallel.

- Calculate the equivalent resistance for :

$R_1 = 100\ \Omega$, $R_2 = 150\ \Omega$, $R_3 = 200\ \Omega$.

2-1-a : R_1, R_2, R_3 are mounted in series ***Req = …….. Ω***.

2-1-b : R_1, R_2, R_3 are mounted in parallel ***Req = ……. Ω***.

2-1-c : R_1, R_2, R_3 are mounted in a mixed circuit according to the **figure.2**. ***Req = ……. Ω***.

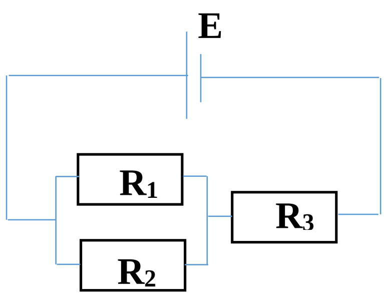

Figure. 2

2-1-d : R_1, R_2, R_3 are mounted in a mixed circuit according to the **figure.3**. ***Req = …….. Ω***.

- The law of nodes applies to connection points circuit elements. The law of knots states that the sum of currents entering a node is equal to the sum of the currents leaving the nodes. For the mixed circuit following the **figure-3** :

$I=I_1+I_2$

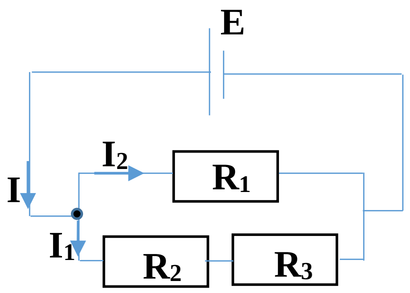

Figure. 3

- The law of meshes applies to loops in the circuit electric. The law of meshes states that the sum of the tension rises while crossing a loop is equal to the sum of the voltage drops (**figure. 4**).

Mesh N°1 traveled by the imaginary current I1 :

$$\mathbf{E = (I_1 - I_2)\, R_1}$$

Mesh N°2 traveled by the imaginary current I2 :

$$\mathbf{0 = (I_2 - I_1)\, R_1 + (I_2)\,(R_1 + R_2)}$$

Where E is the voltage across the generator.

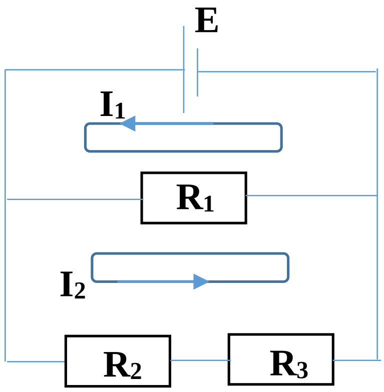

Figure. 4

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 measurements are difficult.

See the assembly of figure-5.

2-2-a : Give the meaning of U_{AM} ; U_{BM} ; U_{AB} on the figure. 5 ?

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

2-2-c : Express U_{BM} =f (R_3, R_x, E) ? ***U_{BM} =***

2-2-d : Deduct U_{AB} =f (R_1, R_2, R_3, R_x, E) ? ***U_{AB} =***

2-2-e : If ***U_{AB} =0***, the bridge is said to be balanced.

Show that the expression for Rx takes a form independent of the supply voltage ?

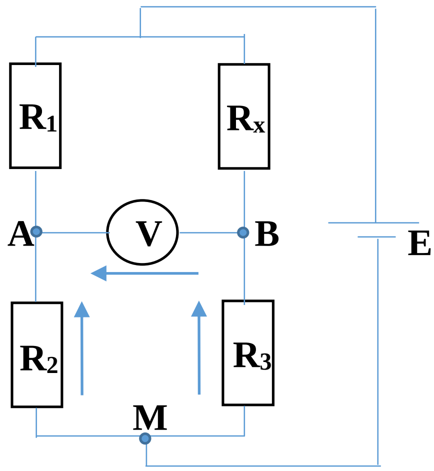

Figure. 5

3-Manipulations

3-1- Simple circuits

3-1-a- Series resistors

- Carry out the assembly where R1, R2, R3 Serial climbs.

- Powering your circuit with voltage E=4. and complete the table opposite.

	R_1	R_2	R_3
I (mA)			
V (Volts)			
Résistance (Ω)			

3-1-b- Parallel resistors

- Carry out the assembly where R1, R2, R3 Parallel climbs.

- Powering your circuit with voltage E=4. and complete the table opposite.

	R_1	R_2	R_3
I (mA)			
V (Volts)			
Résistance (Ω)			

3-2- Mixed Circuits

3-2-a- Carry out the assembly where R1, R2, R3 are according to the **figure. 2**.

- Powering your circuit with volt E=4.5V and complete the table opposite.

	R_1	R_2	R_3
I (mA)			
V (Volts)			
Résistance (Ω)			

3-2-b- Carry out the assembly where R1, R2, R3 are according to the **figure. 3**.

- Powering your circuit with volt E=4.5V and complete the table opposite.

	R_1	R_2	R_3
I (mA)			
V (Volts)			
Résistance (Ω)			

3-3- Measuring the resistivity of a material

Carry out the assembly in figure-5 or R_1 = 1 kΩ, R_2 = 100 kΩ, and the resistor wire in place of Rx, power your circuit with a voltage E = 4,5V.

Vary resistance R3 until the bridge is balanced (the galvanometer indicates zero voltage). For different values of the section S of the wire the length is ***l=1m***.

a) complete the table opposite

b) Deduce the type of the two metals; use displayed table of resistivity values ?

Diamètre du fil *(mm)*	*1*	*0.7*	*0.5*
R_3 *(Ω)*			
Résistance R_x *(Ω)*			
Résistivité $\boldsymbol{\rho = R_x * S/l}$ *(Ω . cm)*			

جدول يمثل قيم المقاومة النوعية لبعض المعادن
Electrical resistivity for T=20°C

Material	Resistivity **(Ω .cm . 10^{-6})**	Thermal coefficient **Coefficient thermique (K^{-1})**
Argent / Silver	1.63	0.0041
Cuivre / Copper	1.69	0.00430
Or / Gold	2.2	0.0040
Aluminium / Alumium	2.67	0.0045
Tungstène / Tungten	5.4	0.0048
Zinc	5.96	0.0042
Laiton / Brass	6.2-7.8	0.0016-0.0017
Fer / Iron	10.1	0.0065
Platine / Platium	10.58	0.00392
Plomb / lead	20.6	0.0042
Constantan (Alliage Cu55/Ni45)	52 -72	+/-0.0002
Carbone / Cardon	1375	$-0.2\ 10^{-3}$
Germanium	$46\ 10^{6}$	$-48\ 10^{-3}$
Silicium / Silicon	$23\ 10^{6}$	$-75\ 10^{-3}$
Verre/Glass	$10^{10}\ 10^{14}$	
Caoutchouc dur / Rubber	10^{13}	
Soufre / Sulphur	10^{15}	
Quartz fondu	$76\ 10^{16}$	