LAB REPORT FOR EXPERIMENT 3

Name:----

Registration No:--

Physics Section:----

Date: ------------------------------

Partner's Name:---------------

Registration No:---------------

Instructor's Name:------------

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PHYSICS LAB EXPERIMENT 3: OHM'S LAW

1. PURPOSE

To determine the resistance when it connect in series or parallel and find the unkown resistance by normal resistor or carbonic resistor

II. DATA AND DATA ANALYSIS

1- Enter your data in Table 3.1

Table 3.1

R_1 Wire resistance		R_2 Carbon resistance		R_1 and R_2 in Series		R_1 and R_2 in Parallel	
V(Volt)	I(Amp.)	V(Volt)	I(Amp.)	V(Volt)	I(Amp.)	V(Volt)	I(Amp.)
5.9	0.84	4.6	1	5.8	0.52	2.8	1
5	0.71	3.9	0.86	5.2	0.46	2.4	0.88
4.4	0.62	3.2	0.7	4.2	0.38	2.2	0.8
3.6	0.52	2.2	0.5	3	0.26	2	0.74
2.8	0.4	2	0.44	2.2	0.2	1.6	0.6

lot graphs of voltage **V** as a dependent variable versus current **I** . y - intercept = 0

Determine the values of **R** for each **unknown resistance** as well as for the series and parallel combinations by calculating the **slopes** of your graphs.

R_1 = $\frac{1.8}{0.2} = 9$ Ω ------------------------

R_2 = $\frac{1.8}{0.36} = 5$ Ω ------------------------

R equivalent of R_1 and R_2 in series= $\frac{5.6}{0.5} = 11.2$ ------------------------

R equivalent of R_1 and R_2 in parallel= $\frac{2}{0.7} = 2.857$ ------------------------

4- From the graph of **V** versus **I** for R_1 , estimate the error ΔR_1.

Error =

5- Using the value of $\mathbf{R_1}$ obtained in (3) and the **length** and **diameter** of the wire used for R_1, calculate the resistivity of the wire ρ. L = 1m , D = 0.37 mm

$\rho = \frac{RA}{L} = \frac{9 \times (0.37 \times 10^{-3})^2 \pi \times}{}$

$= 3.37 \Omega$ (Ω.m)

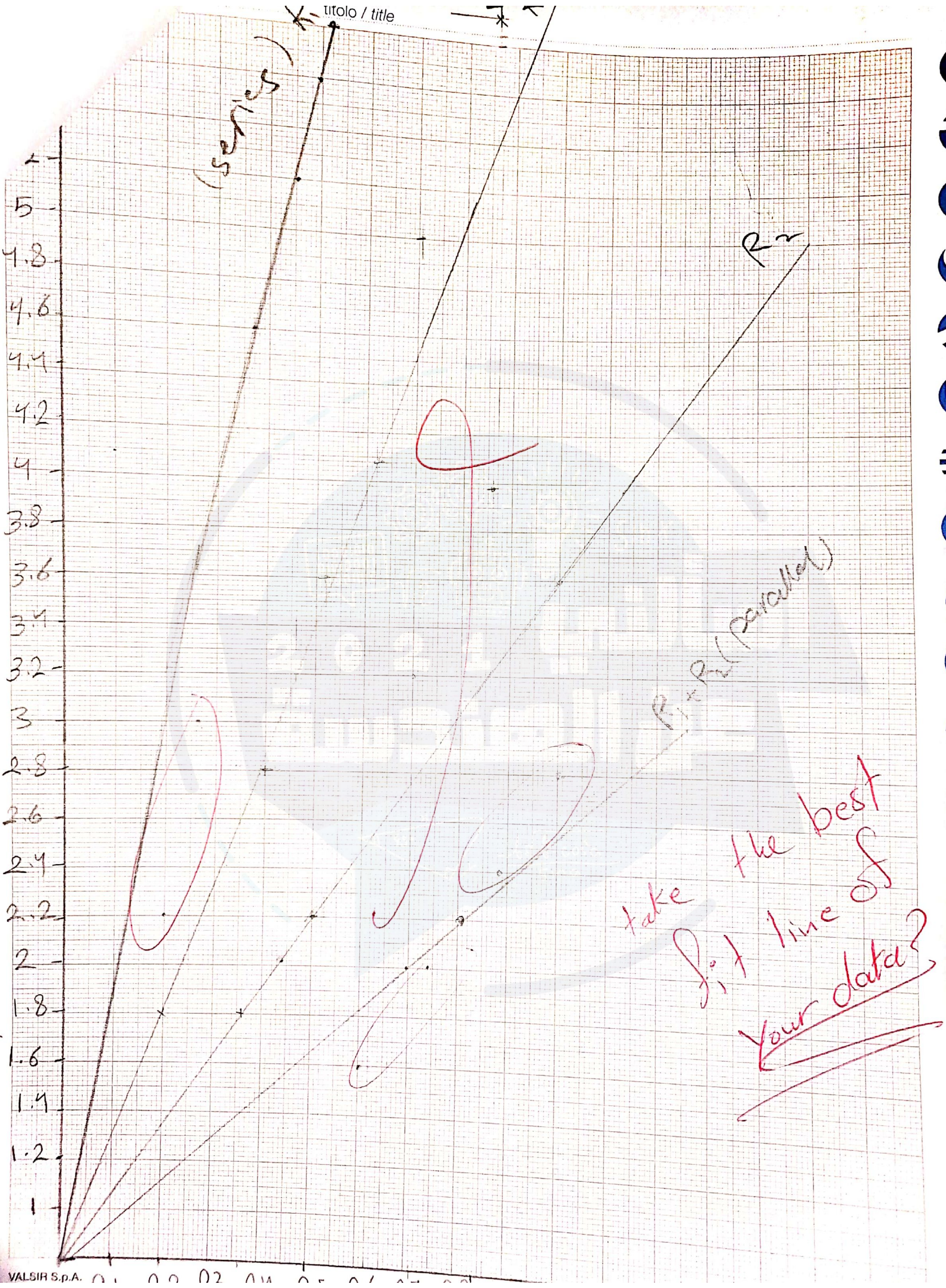
6- Compare the calculated values with the experimental values you obtained for:

Combination of resistances in series:

- experimental value: 11.2 Ω ------------------------
- calculated value: 14 Ω ------------------------

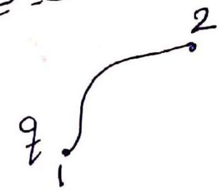
Combination of resistances in parallel:

- experimental value: 2.857 Ω ------------------------
- calculated value: 3.2 Ω ------------------------


titolo / title
(series)
R2
R1 + R2 (parallel)
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
VALSIR S.p.A.
take the best fit line of your data?

- علاقة تربط بين الـ current في الـ conductor وفرق الجهد .
وهي خطية

1 شو يعني فرق جهد ؟



شغل تبذله قوة كهربائية $W_{1\to2} = q\int_1^2 \vec{E}\cdot d\vec{s}$

$= -q\left(-\int_1^2 \vec{E}\cdot d\vec{s}\right)$

$= -q\,V_{1\to2}$

لو صار 2 ← 1 عكس المحتوى يعني حيجون $-\left(-\int_1^2 \vec{E}\cdot d\vec{s}\right)$

فرق الجهد يعتمد على الـ البداية والنهاية .

E.f ← التكامل لا يعتمد على المسار المهم نفس

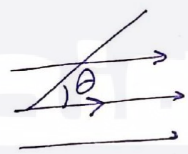
$$V_{1\to2} = -\int_1^2 \vec{E}\cdot d\vec{s} = \frac{-W_{1\to2}}{q}$$

↳ independent of the path from $1\to2$

units of $V = \frac{J}{C}$

*إذا الحركة مع الـ E (V negative)

Motion in the same directions of $\vec{E}$ ⟵ drop in ele. potential



" opposite to $\vec{E}$ ⟶ increase in elec. potential / V positive

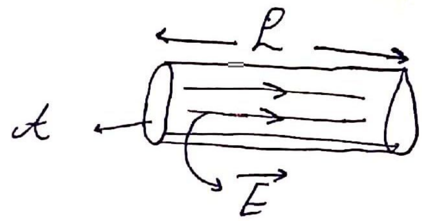
* In some Ohmic conductors it was found that there is a linear relation between $\vec{E}$ and the current density $\vec{J}$:

* Ohm's law $\vec{E} = \rho\vec{J}$ where ρ is resistivity / $\Omega.m$

If $\vec{E}$ is uniform inside a conductor of length L and cross sectional area A, the Above we can be written as:

$\frac{V}{L} = \frac{\rho L}{A} \rightsquigarrow V = \frac{\rho L}{A} I$ (constant: $\frac{\rho L}{A}$) Ohm's law

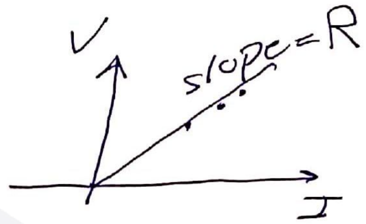
$\vec{E}$ نفس الاتجاه يتحرك مع + charges



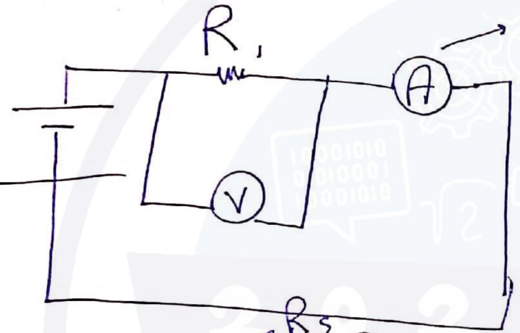
$V = EL \therefore E = \frac{V}{L}$

$R = \frac{V}{I}$ = volt/Ambere = Ohm's

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



الجزء العملي

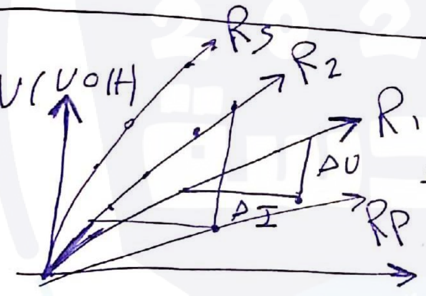


Voltmeter ← ع النقطتين اللي بدي أقيس بينهم

قياس current بوصله in series لازم

- بدنا نحسب R_1 عن طريق V/A

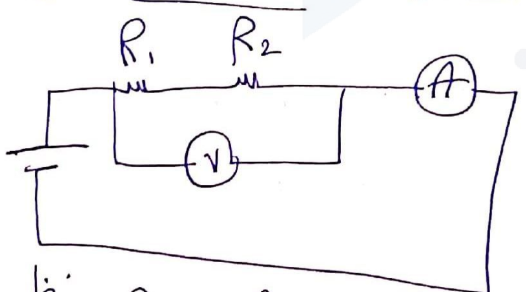
V (volt) | I (A)



$slope = \frac{\Delta V}{\Delta I}$

$V = RI$

- نفس السيركت برفع R_1 وبحط R_2 وبرسم مرة ثانية بالقراءات الثانية
- بعدها بدي أحسب المقاومة المكافئة لـ 2 Resistor → in series



- بقيس V و I بجدول

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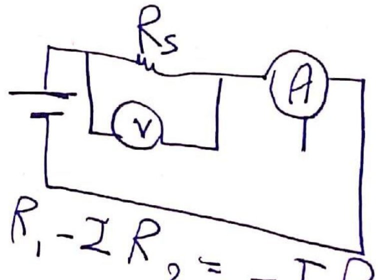
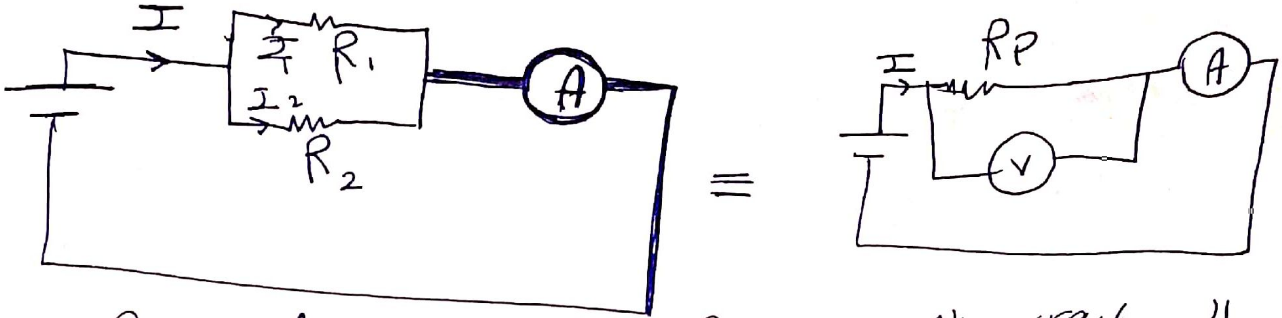


نظريا: $R_s = R_1 + R_2 \rightsquigarrow -IR_1 - IR_2 = -IR_s$

أثبتها / أفضل الجديد



الcurrent الي بيتوزع ع R_1 ، R_2 المكافئ اللي يدخل ع R_p

$$I = I_1 + I_2$$

$$\frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} \quad \therefore \quad \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

- بنوصل الدائرة وبناخد قيم V / I وبنرسم ← أقل slope

العملي

المكونات

1] Voltmeter 2] مصدر فرق جهد 3] Ameter

4] المقاومة [خشبة عليها أسلاك هامرة] ← فيه صورة للمكونات

- موجب الـ power supply مع + الـ Ameter
- سالب الأميتر مع الأيسر للـ Resistor
- من الـ Resistor الجهة التانية مع - الـ power supply

{ فيه صورة للتوصيلة

الـ Ameter in series with Resistance

+ الـ Voltmeter مع موجب الـ R

- الـ Voltmeter مع الـ R_p اللي موصولة مع - الـ power supply } كل التوازي

الجزء التاني: بيبدل R_1 ب R_2 ← [شناوة] لبس برجليهم

الأسلاك فوقها لنفس ماهم

* in series → R(الخشبة) بحط السلك الأول ع أول والثاني بخليه ع الشفافة، بعدها بجيب سلك بوصله بين ال 2R

3) in parallel بنوصل حدة مع ال Resistor جانو كاله
بعدها بوصل ال R الشفافة فوقه ال R خشبة
أحمر مع أحمر، أسود مع أسود (الأقطاب الأقطاب) فيه
بعدها بوصل voltmeter مع المقاومة الشفافة (فوقها)
مع أي R بعتبر

الشرح هنا صحيح لكن بالامتحان العملي لم يتم مطالبتنا بالحالتين.

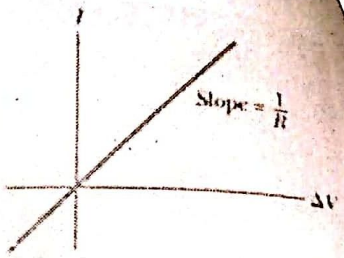
EXPERIMENT 3
OHM'S LAW

- **Ohm's Law** states that for many **Materials**, the ratio of the current density (J) to the electric field (E) is constant. This constant, σ (the electrical conductivity) is independent of the electric field producing the current.
- Previous statement of Ohm's Law is translated Mathematically into: $\mathbf{J} = \sigma\,\mathbf{E}$
- Ohm's Law is not a fundamental law of nature.
- It is an empirical relationship valid only for certain materials.
- In a conductor, the voltage applied (ΔV) across the ends of the conductor at constant temperature is proportional to the current (I) passing through the conductor.
- The proportionality constant is called the **Resistance** (R) of the conductor : $R = \frac{\Delta V}{I}$

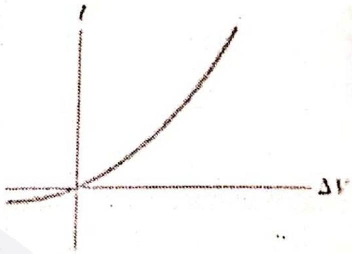
  this is another form or statement of Ohm's Law; Keep in mind that R does not depend on ΔV nor on I.
- **Electric circuits** usually use those **elements** called **Resistors**:
- **Main purpose** of using **Resistors** is to **control the current** level in parts of the circuit.
- **Resistors** can be ***wire-wound*** (R_1 : Wire Resistance) or ***composite*** (R_2 : Carbon Resistance).
- Most metals obey Ohm's Law. (almost 2/3 of the elements in the periodic table are metals).
- Hence, materials that obey Ohm's Law are said to be *Ohmic*.
- However, not all materials follow Ohm's Law.
- Materials that do not obey Ohm's Law are said to be *non-Ohmic*.

hkj

$\frac{V}{I} = R$



- For an ***Ohmic*** device (as in this experiment):
  - Resistance is constant over a wide range of voltages.
  - Relationship between current and voltage is linear.
  - Slope is related to the resistance



- For ***Non-Ohmic*** materials:
  - Resistance changes with voltage or current.
  - Current-Voltage relationship is nonlinear.
  - A diode is a common example of a *non-Ohmic* device.

- SI units of resistance are *Ohms* (**Ω**):
  - 1 Ω = 1 V / A

- Resistance in a circuit arises due to **collisions** between the electrons carrying the current with the fixed atoms inside the conductor.

- The inverse of the conductivity is the **resistivity**:
  - $\rho = 1/\sigma$

- **Resistivity** has SI units of Ohm-meters (**Ω · m**).

- **Resistance** is also related to **resistivity** through the following equation: $R = \rho \frac{L}{A}$
  - Note that R depends only on the specifics of the electric wire including the materials it is made of with the wire's dimensions including its length L and cross sectional area A.

- To a good approximation, the **resistivity** of a conductor **varies linearly with temperature** according to the following equation over a limited temperature range:

  $$\rho = \rho_0[1 + \alpha(T - T_0)]$$

  Where :
  resistivity ρ_0 is taken at some reference temperature ($T_0 \sim 20°$ C) and
  α is the **temperature coefficient of resistivity** with SI units = $°C^{-1}$

- Considering the resistance of a conductor with uniform cross sectional area is proportional to the resistivity, then the effect of temperature on resistance

  $$R = R_0[1 + \alpha(T - T_0)]$$

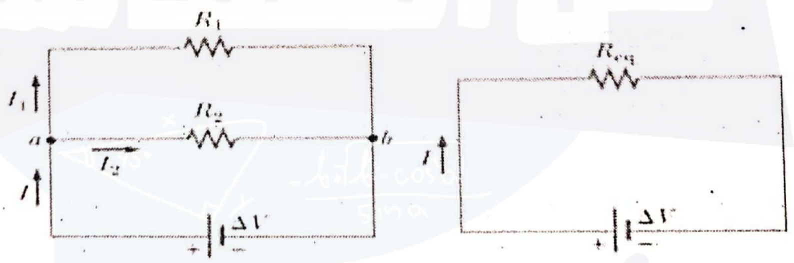
  Hint: Knowing that R changes with T, data must be taken at constant temperature if possible.

- When two resistors or more are connected end-to-end, they are said to be connected **in *series*.**

- For a **series combination** of resistors:
  - **Currents** are the **same** in all resistors
  - **Potential difference** will **divide** among the resistors such that the sum of the potential differences across the resistors is equal to the total potential difference across the combination.
  - **Equivalent Resistance** of a series combination of resistors is the algebraic sum of the individual resistances and is always **greater than any individual resistance:** $R_{eq,s} = R_1 + R_2 + R_3 + \ldots$

- For a **parallel combination** of resistors:
  - **Potential difference** is the **same** in all resistors
  - **Current** which enters a point must be equal to the total current leaving that point: $I = I_1 + I_2$
  - **Equivalent Resistance** of a parallel combination of resistors is always **less than the smallest resistor in the group**:

$$\frac{1}{R_{eq,p}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$



- In today's first experiment, we will learn how to:
  - **Build up simple electric ciruit** using different **circuit elements** including:
    - **Electric wires**.(considered as perfect conductors eventhough they tend to heat up during the experiment).
    - **Power Supply** to supply electric power to the electrical load or ciruit.
    - **Two** unknown different **Resistors** (The wire resistance R_1 and the Carbon resistance R_2).
    - **Voltmeter** to register the potential drop across the resistances, which is usually connected in parallel to the resistance.
    - **Ammeter** to register the current passing through the ciruit, which is usually connected in series with the resistances.