LAB REPORT FOR EXPERIMENT 5

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

Name:- **Partner's Name**

Registration N **Registration No:---**

Physics Section:-- **Instructor's Name:-**

PHYSICS LAB EXPERIMENT 5: THE WHEATSTONE BRIDGE

1. PURPOSE

We use the Bridge to determine the value of an unknown resistance The wheatstone bridge used for the quick and accurate comparison of resistances.

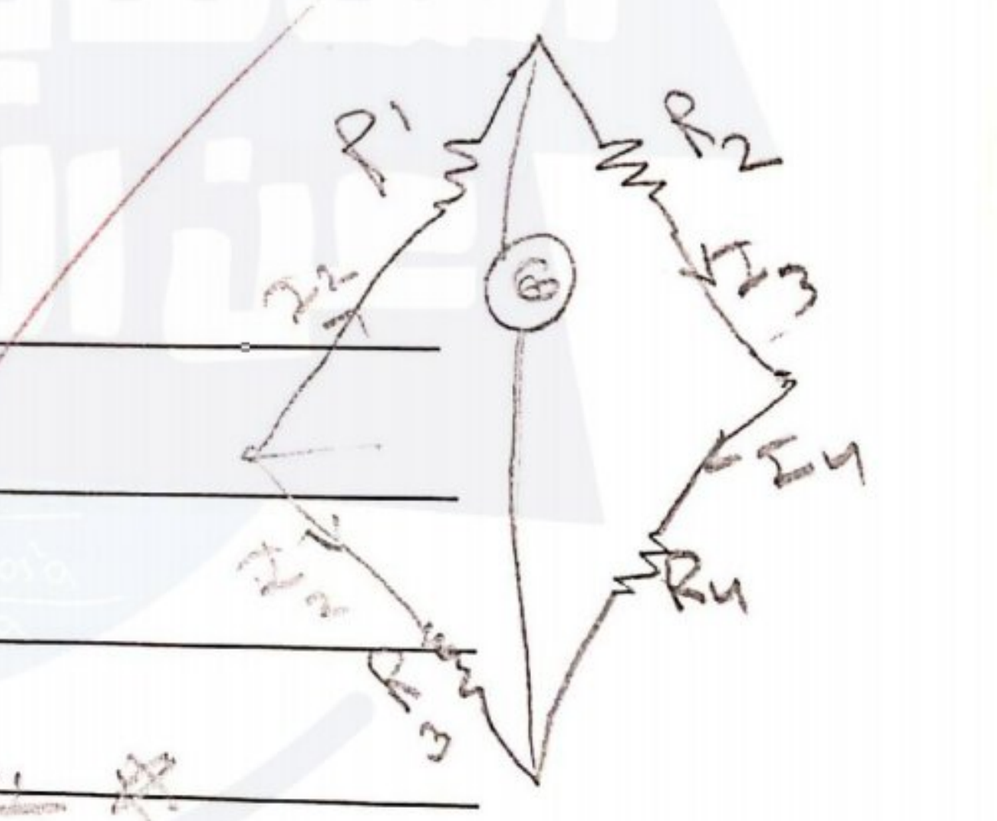
II. DATA AND DATA ANALYSIS :

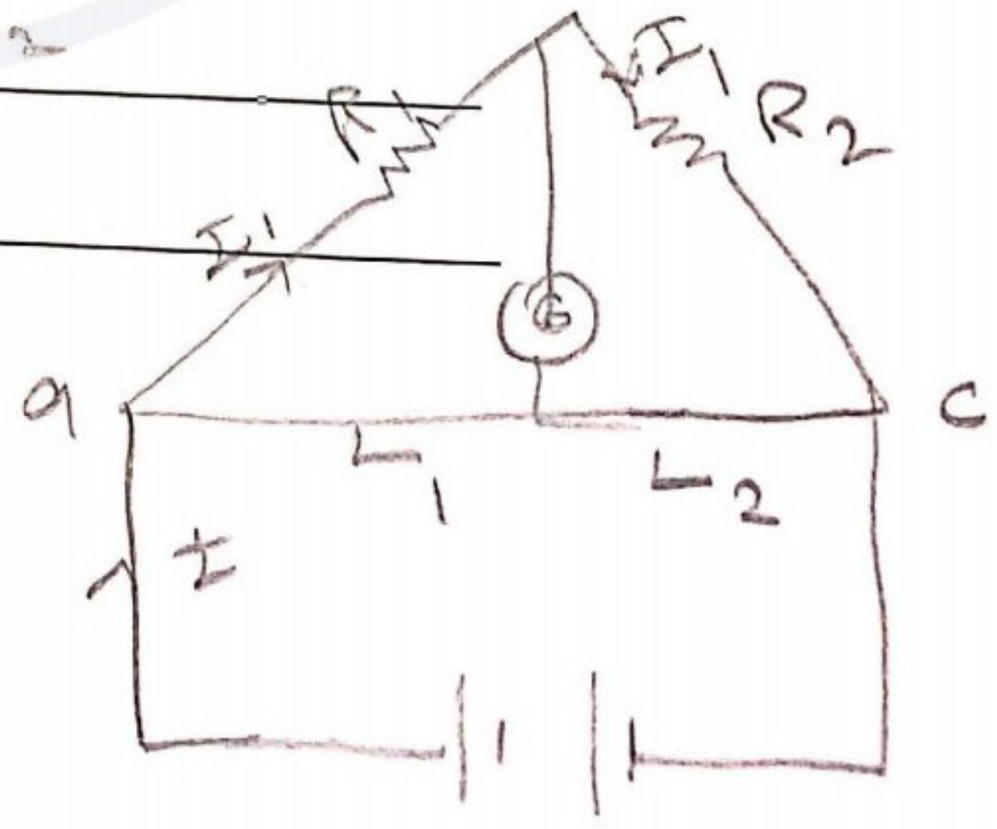
1. Show that $\frac{Rs}{R_x} = \frac{L_1}{L_2}$

$V_{bd} = V_{ad} \Rightarrow I_1 R_1 = I_2 R_3$

$V_{bc} = V_{cd} \Rightarrow I_1 R_2 = I_2 R_4$

$\frac{R_1}{R_2} = \frac{\rho L_1 / A}{\rho L_2 / A} \Rightarrow \frac{R_1}{R_2} = \frac{L_1}{L_2}$ *





$$\frac{R_s}{R_x} = \frac{L_1}{L_2}$$

ecord your data in Table (5.1) below:

Table 5.1

Reading	R_1 (Ω)	L_1 (cm)	L_2 (cm)	R_x (Ω)	$\Delta R_x / R_x$
1	10	16	84	52.5	1.0
2	20	27	73	54.07	0.97
3	30	36.5	63.5	52.14	1.01
4	40	43	57	53	0.99
5	50	48	52	54.16	0.97
6	60	53	47	53.2	0.99
7	70	57	43	52.8	1.0
8	80	60	40	53.3	0.99
9	90	63.5	36.5	51.7	1.02
10	100	66	34	51.5	1.02
$\overline{R}_x = 52.843\ \Omega$					

الخطأ عدم تطبيق القانون على يمين الورقة بشكل صحيح.

3. Using the equation derived in **(1)**, calculate the value of the unknown resistance R_x. Repeat for the different values of R_1 and enter your calculation in table 5.1 above .

Example for one calculation:

$R_{sc} = \frac{L_2}{L_1} R_s = \frac{84}{16} * 10$

$= 52.5\ \Omega$

4. Calculate the relative error $\Delta R_x / R_x$ for the different values of R_1 using the equation:

$$\frac{\Delta R_x}{R_x} = \left[\left(\frac{\Delta L_1}{L_1}\right)^2 + \left(\frac{\Delta L_2}{L_2}\right)^2\right]^{\frac{1}{2}}$$

$\Delta L = .05$

$= \sqrt{\left(\frac{0.05}{16}\right)^2 + \left(\frac{0.05}{84}\right)}$

Example for one calculation:

$= 3.18 * 10^{-3}$

5. Is it essential that the battery supplies a constant current to the wire? Explain your answer.

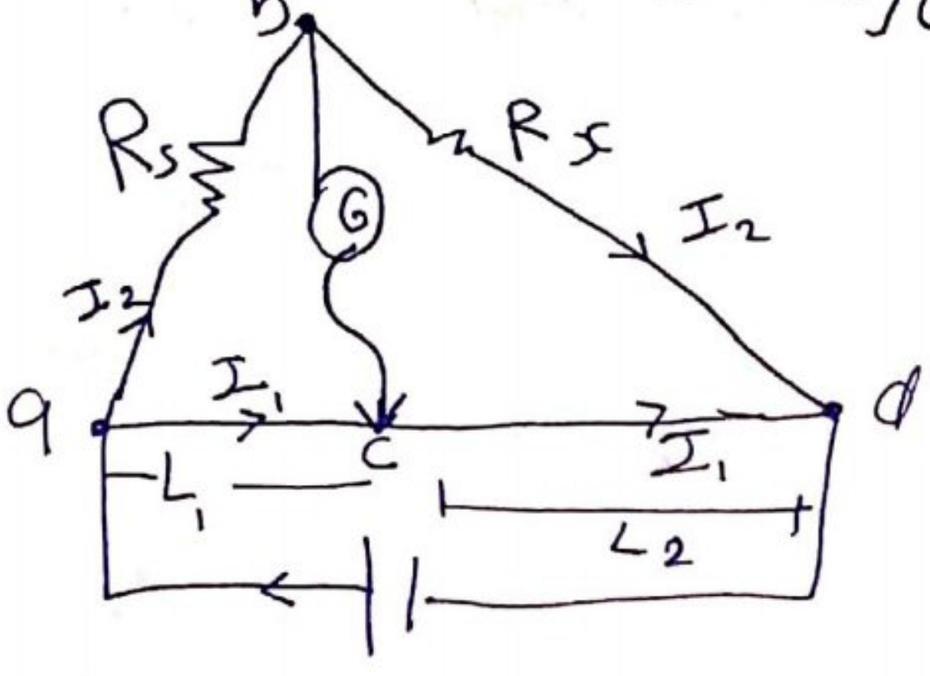
~~No, because we didn't use the current~~ in our calculation

6. From the table, determine the values of L_1 and L_2 for which the error $\Delta R_x / R_x$ is a **minimum.**

$L_1 =$ 48

$L_2 =$ 52

Stone Bridge



الـ (G) موصّل بين نقطة التقاء R_x و R_L

بدنا نخلّي نقطة الـ (G) = 0

وقتها الـ current في $R_s = R_x$

ماحد يروح جزء منه لـ (G)

$$I = I_1 + I_2$$

- السؤال هو: كيف نحسب المقاومة المجهولة R_x

بما إنو ماين current بين b و c معناها جهد c = جهد b

$$ab = ac$$

a نقطة مشتركة بينهم #

$$U_{ab} = -I_2 R_s$$
$$U_{ac} = -I_1 R_{ac}$$
$$-I_2 R_s = -I_1 R_{ac} \quad \text{—— 1}$$

$$L_1 + L_2 = 100cm$$

$$U_{bd} = U_{cd}$$

$$-I_2 R_x = -I_1 R_{cd} \quad \text{—— 2}$$

بقسمهم

$$-I_2 R_s = -I_1 R_{ac} \quad \text{—— 1}$$

$$\frac{R_x}{R_s} = \frac{R_{cd}}{R_{ac}} = \frac{\rho L_2 / A}{\rho L_1 / A} = \frac{L_2}{L_1}$$

$$\frac{R_x}{R_s} = \frac{L_2}{L_1}$$

$$\therefore R_x = \frac{L_2}{L_1} \cdot R_s \quad **$$

- بدي أجد النقطة اللي G = 0 عندها وأسجّلها

بأجد L_2, L_1 #

- رح نحسبها أكثر من مرة، بكل مرة حنغيّر R_s

$R_s(\Omega)$	$L_1(cm)$	$L_2(cm)$	$R_x(\Omega)$	$\frac{\Delta R_x}{R_s}$

* بعتمد عليها لو غيرت مو A ما تفرق لانو $\frac{L_2}{L_1}$

لو حسبنا R_x و R_s اطلعت $R_x = \frac{L_1}{R_2} R_s$

التوصيلات:

- ال + power supply مع ال zero لل wire بداية "الخشبة الخيرة"
- ال power مع نهاية ال wire عند ال 100 cm الشفافة
- بوصل المقاومة المجهولة مع الجهة اللي عند ال 100 cm مباشرة "فوقها" والجهة الثانية مع المقاومة المعلومة
- بوصل المقاومة المعلومة (عليها 0.456- أرقام) بوجه جهة مع ال zero فوقه اللي راح لل + power supply وجهة مع ال مجهولة
- الغلفانومتر سلك منه بطلع لنقطة التقاء ال 2 Resis. اللي هو فوقه السلك اللي بوصله مع المقاومة المعلومة اللي بجوه المجهولة داخل
- والسلك الثاني بالغلفانو مع ال pointer
- بمس المس ال pointer عند ال 100 cm بنحرف لليسار وعند ال 0 بنحرف لليمين
- بدور عن نقطة بين ال 0 وال 100 الغلفانومتر عندها 0

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اسمها Balance point

L_1 = الطول اللي طلع مني

$L_2 = 100 - L_1$

EXPERIMENT 5
THE WHEATSTONE BRIDGE

- In the **Wheatstone Bridge** experiment, the circuit configuration will allow for Quick and Accurate determination of the value of an **Unknown Resistance**. R_x

- This **Unknown Resistance,** termed R_X, will be compared to other Resistances of known values (Resistance Box $R_S = (10 - 100)\ \Omega$ and Meter Bridge Wire Resistance).

- During the experiment and at each value of R_S, the **Balance Point** will be **Checked** and **Located**. At the Balance Point, the **Galvanometer** will read **Zero.**

- The **Galvanometer** is a device that can **Register or Read** either the **Current** or the **Voltage** depending on the way it is connected to the circuit:
  - If connected in **Series**, it will read **Voltage**.
  - If connected in **Parralel**, it will read the **Current**.
  - Note that it is connected in **Opposite Manner** with respect to connection way of the **Ammeter** and **Voltmeter**.
  - In the Wheatstone Bridge experiment, it will read current.

- When the ciruit is closed, a **total current** I will flow from the power supply towards point a, and then part of it, I_1 , will flow through R_S and the other part, I_2, will flow through R_1: satisfying the **Junction Rule** of **Kirchhoff's Rules**:
  - **The Junction Rule**: At any junction, the sum of the currents must equal Zero

$$\sum_{Junction} I = 0$$

Hence, at **Junction** a, $I = I_1 + I_2$

- When the **Balance Point** is located for a particular value of R_S , the **Galvanometer** will read **Zero**, and both the **Junction and Loop Rules** of **Kirchhoff's Rules** will be satisfied:
  - **The Loop Rule**: The sum of the potential difference across all elements around any closed circuit loop must be Zero :

hkj

l

$$\sum_{Junction} \Delta V = 0$$

Where the closed loops could be loop *a*bc*a* and loop bdcb.

Hence, at that momoent:

- Same Current, I_1 , will pass through R_S and R_X, (Series combination).
- Same Current, I_2 , will pass through R_1 and R_2, (Series combination).
- Where at junctions:
  - $a : I = I_1 + I_2$, and at
  - $b : I_1 + I_2 = I$

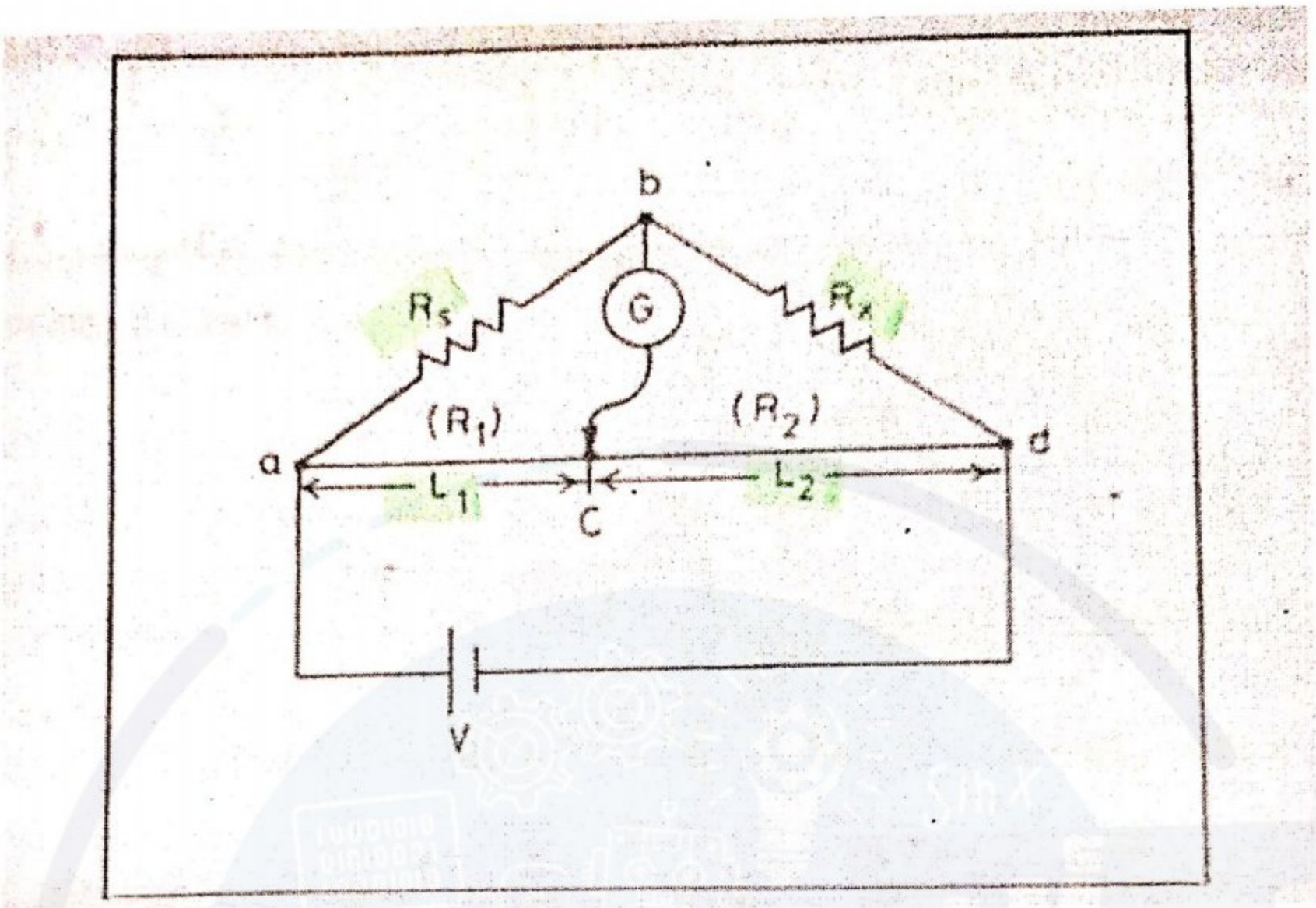
- $\Delta V_{ab} = \Delta V_{ac} \longrightarrow I_1 \times R_S = I_2 \times R_1$
  where $\Delta V_{ab} = I_1 \times R_S$ **(Ohm's Law)**
  and $\Delta V_{bd} = I_2 \times R_1 = I_2 \times (\frac{\rho}{A}) L_1$ **(Wire Resistance)**
  Hence, $I_1 \times R_S = I_2 \times (\frac{\rho}{A}) L_1$ **..... (equation I)**

  Also,

- $\Delta V_{bd} = \Delta V_{cd} \longrightarrow I_1 \times R_X = I_2 \times R_2$
  where $\Delta V_{bd} = I_1 \times R_X$ **(Ohm's Law)**
  and $\Delta V_{cd} = I_2 \times R_2 = I_2 \times (\frac{\rho}{A}) L_2$ **(Wire Resistance)**
  Hence, $I_1 \times R_X = I_2 \times (\frac{\rho}{A}) L_2$ **..... (equation II)**
- Now by dividing the two equations I and II by each other and canceling the common terms, one reaches to the following equation that can be used to determine the value of the unknown resistor, R_X:

  $$R_X = \frac{L_2}{L_1} R_S$$ **..... (equation III)**
- Using equation III, R_X can be determined per each value of R_X and the average value of $\overline{R_x}$ will easily be calculated.
- In order to solve for the relative error, remember that the error in reading the meter stick, ΔL is equivelant to ± ½ the smallest digit. (i.e. $\Delta L_1 = \Delta L_2 = \pm 0.5$ mm)

اسألي عنها



THE WHEATSTONE BRIDGE CONFIGURATION

equipment

- In today's experiment, we want to:
  - **Build up simple electric circuit** using different **circuit elements** including:
    1. **Electric wires** (considered as perfect conductors eventhough they tend to heat up during the experiment, hence, their power dessipation is ignored).
    2. **DC Power Supply** (3.0 Volts).
    3. **Three** different **Resistors:**
       - R_S: Resistance Box (1 – 100 Ω). ⟶ البوحس
       - Unknown resistance R_X. ⟶ الشفافة
       - Meter Bridge (wire resistance).
    - **Galvanometer** to be connected in parallel (in order to work as an Ammeter).
  - **Calculate** the average value of the unknown resistor R_X.
  - **Determine** the relative error in the $\Delta R_X / R_X$.