University of Salahaddin – Erbil
College of Science
Physics Department

Laboratory Manual
Electricity and Magnetism
1^{st} Course

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1Year – Physics
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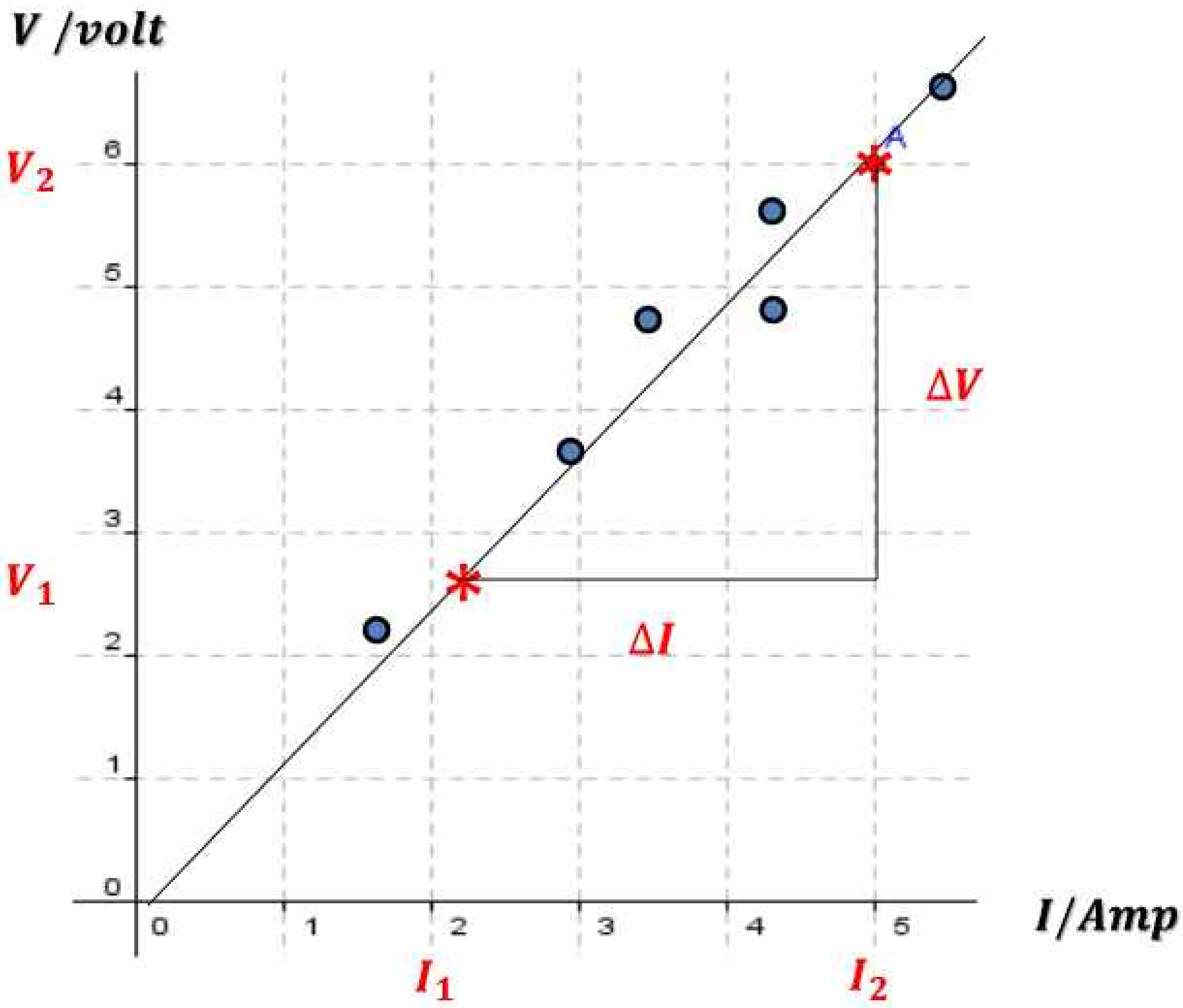
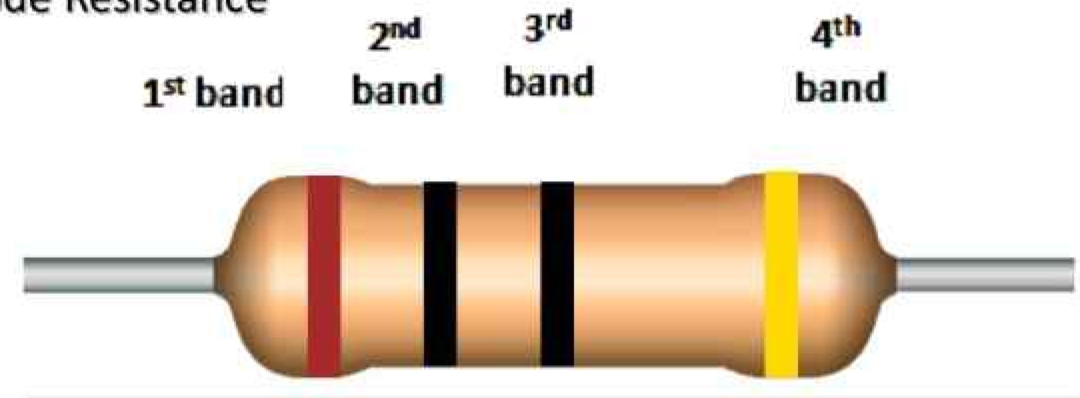
Experiment No. (1)
Ohm's law

A// Ohm's law

$$slop = R = \frac{\Delta V}{\Delta I} = \frac{V_2 - V_1}{I_2 - I_1}$$



B// Color Code Resistance



1. color bands from nearest edge from the left to right and record them .
2. **band 1**// only number the color from **first columns**
3. **band 2** // only number the color from **second columns**
4. **band 3**// ten power number the color from **third columns**

   (multiplier by the first & second number)
5. **band 4**// only the **tolerance value color** from **last columns**

$$\_\_\_ \quad \_\_\_ \quad X\,10^{n} \mp n\%$$

n= mean the color

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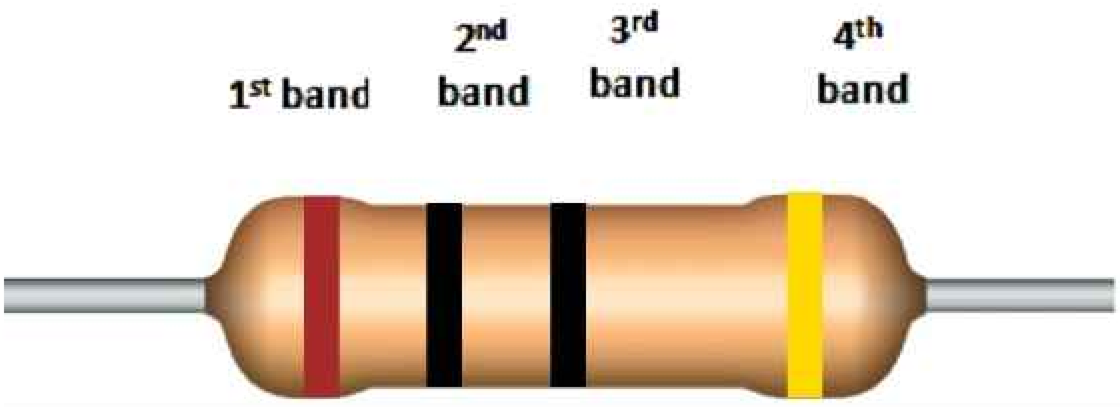


Brown	Black	Black	Gold
1	0	10^0	$\mp 5\%$

$$R\ tolerance = 10\ X\ 10^{0}\ \mp 5\%\ \Omega$$

$$R\ Tolerance\ value = \frac{10*5}{100} = \mp 0.5\ \Omega$$

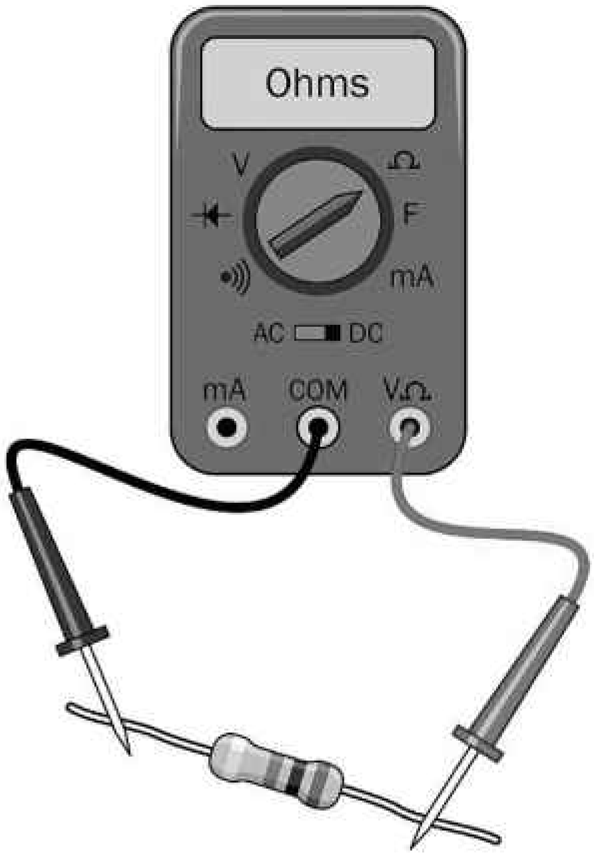
$$R\ tolerance = 10 \mp 0.5\ \Omega$$

$R\ tolerance(-) = 10 - 0.5 = 9.5\ \Omega$

$R\ tolerance(+) = 10 + 0.5 = 10.5\ \Omega$

$$R\ tolerance\ (9.5\ ,\ 10.5)\ \Omega$$

C// Using Digital Multimeter



✓ **by code**

R tolerance (9.5 , 10.5) Ω

✓ **by multi meter**

R= ?? Ω

$$\text{Error ratio (-)} = \left|\frac{\text{Rmulti} - \text{R tolerance}}{\text{Rmulti}}\right| \times 100\%$$

$$\text{Error ratio (+)} = \left|\frac{\text{Rmulti} - \text{R tolerance}}{\text{Rmulti}}\right| \times 100\%$$

Experiment No. (2)
Kirchhoff's law

Kirchhoff's law // (A) Parallel

- To build up a circuit with several resistors in **Parallel** .
- To measure the total current and the current through each resistor to verity **Kirchhoff first law** , the law of current **:** $(\mathbf{I} = \mathbf{I}_1 + \mathbf{I}_2 + \mathbf{I}_3)$ **or** $(\Sigma\mathbf{I} = 0)$
- To measure the total voltage are equal $(\mathbf{V}_{m1} = \mathbf{V}_{m2} = \mathbf{V}_{m3})$
- The total$\left(\frac{1}{R_T} = 1/R_1 + 1/R_2 + 1/R_3\right)$

$\mathbf{I}_T =$

$\mathbf{I}_1 =$

$\mathbf{I}_2 =$

$\mathbf{I}_3 =$

$\Sigma\mathbf{I} = 0$

$V_E =$

$V_{m1} =$

$V_{m2} =$

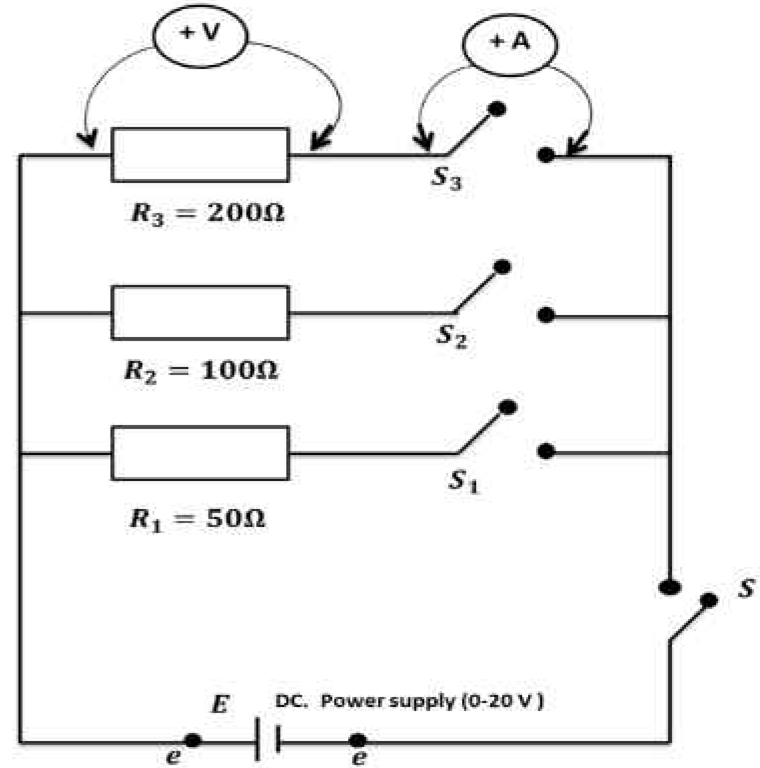
$V_{m3} =$

$V_T = \mathbf{I}_T R_T$

$V_1 = \mathbf{I}_1 R_1$

$V_2 = \mathbf{I}_2 R_2$

$V_3 = \mathbf{I}_3 R_3$



Kirchhoff's law // (A) Parallel

$I_T =$

$I_1 =$

$I_2 =$

$I_3 =$

$I_{123} =$

$\Sigma I = 0$

$V_{mT} =$

$V_{m1} =$

$V_{m2} =$

$V_{m3} =$

$V_T = I_T R_T$

$V_1 = I_1 R_1$

$V_2 = I_2 R_2$

$V_3 = I_3 R_3$

$$\text{Error ratio} = \left| \frac{I_T - I_{123}}{I_T} \right| \times 100\%$$

$$\text{Error ratio} = \left| \frac{V_1 - V_{m1}}{V_1} \right| \times 100\%$$

$$\text{Error ratio} = \left| \frac{V_2 - V_{m2}}{V_2} \right| \times 100\%$$

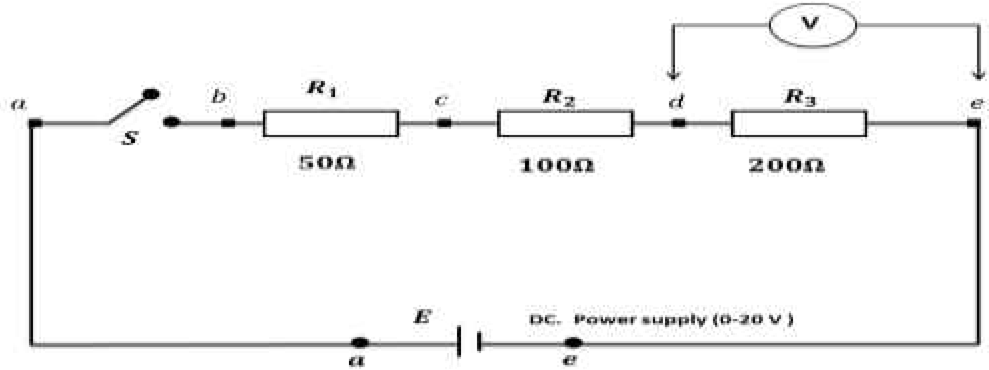
$$\text{Error ratio} = \left| \frac{V_3 - V_{m3}}{V_3} \right| \times 100\%$$

$$\text{Error ratio} = \left| \frac{V_T - V_{m123}}{V_T} \right| \times 100\%$$

Kirchhoff's law // (B) Series .

- To build up a circuit with several resistors in **Series .**
- To measure the total voltage and the voltage across each resistor so as to verity **Kirchhoff second law** , the law of current : **($V = V_1 + V_2 + V_3$) or ($\Sigma V = 0$)**
- To measure the total current are equal ($I_T = I_1 = I_2 = I_3$)
- The total ($R_T = R_1 + R_2 + R_3$)

$E_\circ$	E_L	V_{ab}	V_{bc}	V_{cd}	V_{de}	V_{bd}	V_{ce}	V_{be}	Calculated value	
									$V_{bc} + V_{cd} + V_{de}$	



Compare (Error ratio) :-

- ($E_\circ$) and with (V_{ab}) ,
- (E_L) with the sum of ($V_{bc} + V_{cd} + V_{de}$) .
- V_{be} with the sum ($V_{bc} + V_{ce}$) .
- V_{ce} with ($V_{cd} + V_{de}$) .

$$1.\ \textbf{Error ratio} = \left|\frac{E_\circ - V_{ab}}{E_\circ}\right| \times 100\%$$

$$2.\ \textbf{Error ratio} = \left|\frac{E_L - (V_{bc} + V_{cd} + V_{de})}{E_L}\right| \times 100\%$$

$$3.\ \textbf{Error ratio} = \left|\frac{V_{be} - (V_{bc} + V_{ce})}{V_{be}}\right| \times 100\%$$

$$4.\ \textbf{Error ratio} = \left|\frac{V_{ce} - (V_{cd} + V_{de})}{V_{ce}}\right| \times 100\%$$

Experiment No. (3)
The resistivity of the material of a wire using Wheatstone's bridge

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Kirchhoff's law (KVL)

1. Junction rule : at any junction , sum of the currents entering junction is equal to the sum of the current leaving the junction

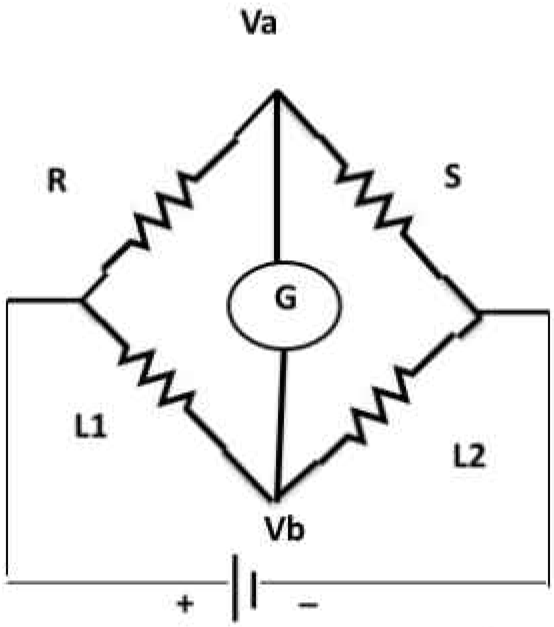
2. Loop rule : the algebraic sum of changes in the potential around any closed loop involving resistors or cells in the loop is zero .

Applying Kirchhoff's law Wheatstone's bridge :- (Proof)

$$V_a = V_b$$

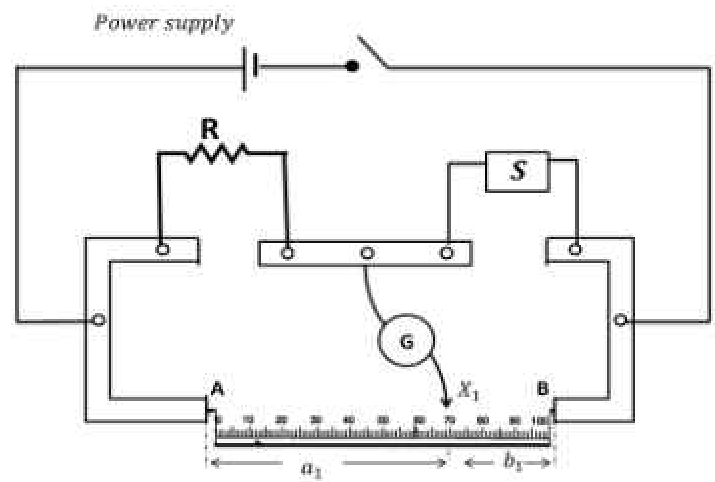
$$R = \frac{\rho . L}{A}$$

$$\frac{R}{S} = \frac{L_1}{L_2}$$



Experiment No. (3)

S Ω	L_1 cm	L_2 cm	$\frac{L2}{L1}$
100			
200			
300			
400			
500			
600			
700			
800			
900			



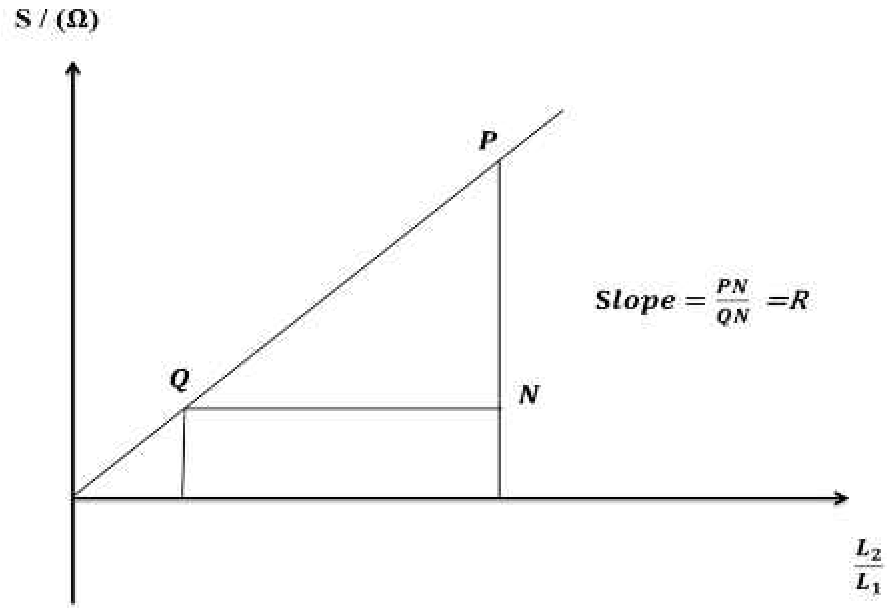
Experiment No. (3)

calculate R : –

$$R = \frac{L_1}{L_2} \times S$$

$$Slop = R = \frac{\Delta S}{\Delta(\frac{L_2}{L1})}$$

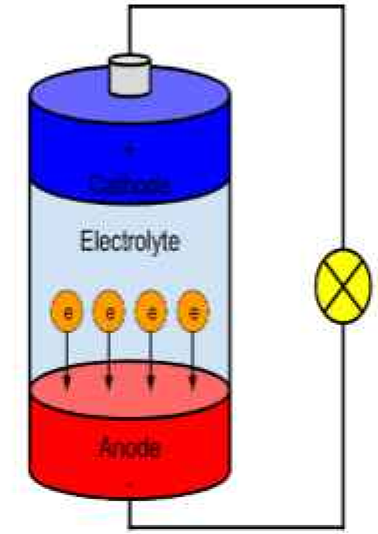
$$R = \frac{S_2 - S_1}{(\frac{L_2}{L1})_2 - (\frac{L_2}{L1})_1} = ?? \quad \Omega$$



$$\text{Error ratio (R)} = \left|\frac{R_{measured} - R_{calculate}}{R_{measured}}\right| \times 100\%$$

Experiment No. (4)
A simple graphical method for determine both the e.m.f and the internal resistance of a cell

What is Emf in electric circuits?

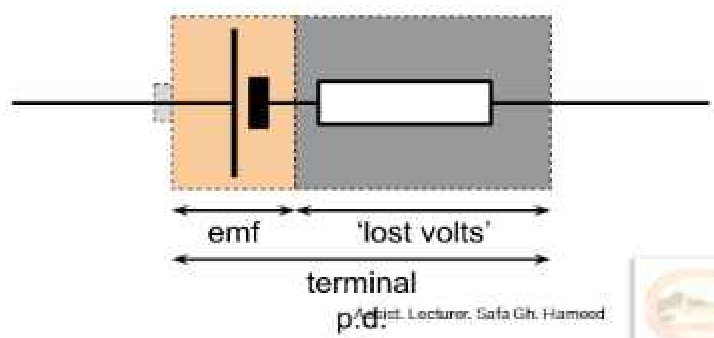


All voltage sources create a potential difference, providing current when connected to a circuit with resistance. This potential difference produces an electric field that acts on charges as a force, causing current to flow.

E.m.f is the potential difference of the source when there is no current flowing through it, and internal resistance is the resistance within the power source that resists current flow.

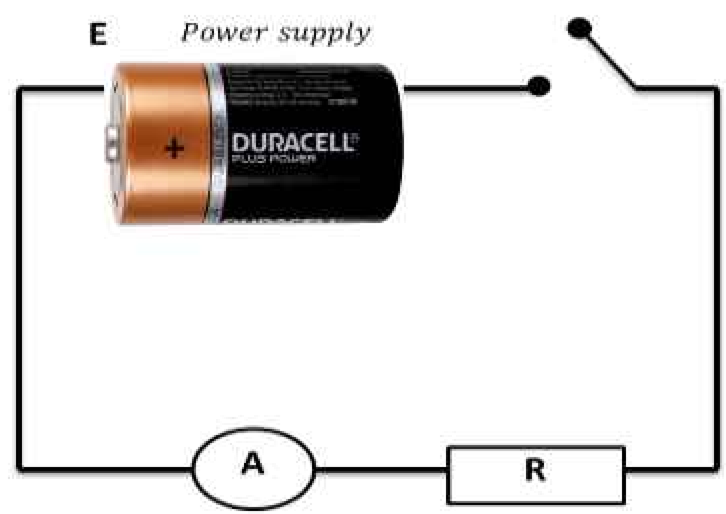
internal resistance is the resistance within the power source that resists current flow. It usually causes the power source to generate heat.

emf = terminal p.d. + lost volts



Experiment No. (4)

R Ω	$I/A \times 10^{-3}$	$\frac{1}{I}/A^{-1}$
10		
20		
30		
40		
50		
60		
70		
80		
90		

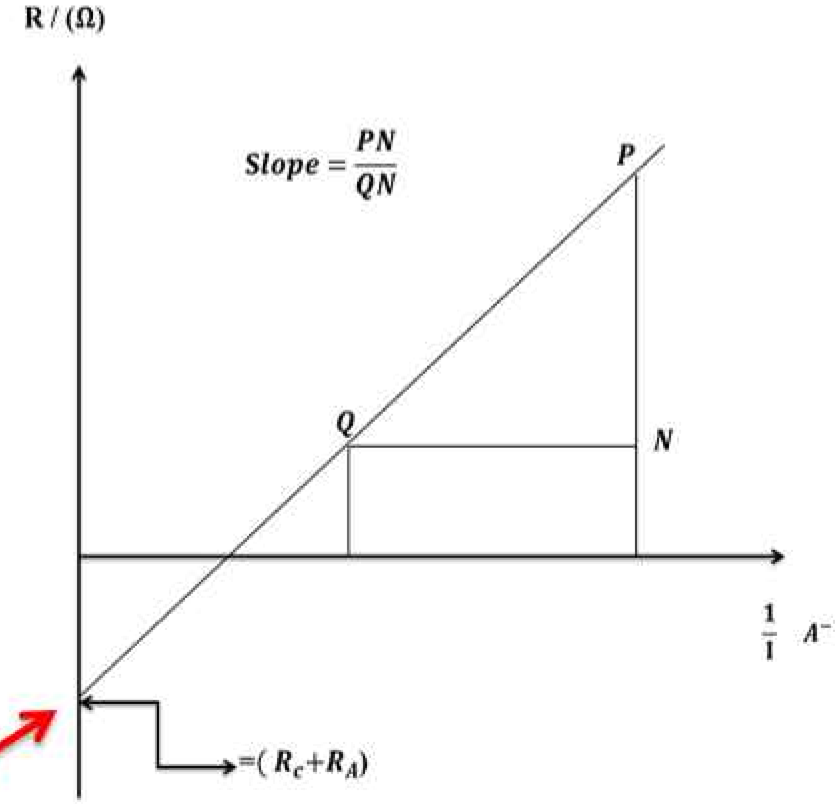


Experiment No. (4)

$$R = E(e.m.f) \times \frac{1}{I}$$

$$Slop = E(e.m.f) = \frac{\Delta R}{\Delta(\frac{1}{I})}$$

$$E(e.m.f) = \frac{R_2 - R_1}{(\frac{1}{I})_2 - (\frac{1}{I})_1} = ?? \quad volt$$



$R_c + R_A$= ?? (from graph)

R_A =? (**by millimeter**)

Find R_c (r) =??

$$difference_{\ calculation} = \left| \frac{E.measured - E.calculated}{E.measured} \right| \times 100\%$$

The End