Ministry of Higher Education and Scientific Research

Salahaddin University-Erbil

College of Education

Department of Physics

1st Stage

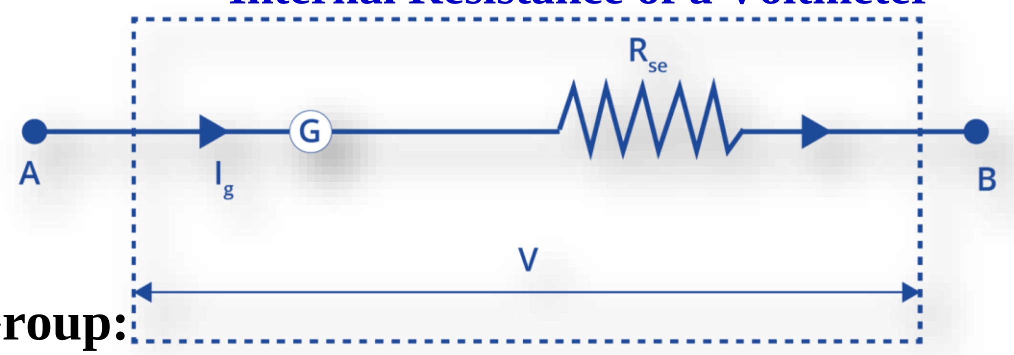
Laboratory of Electricity and Magnetism

Group (   )

Full Name:

Experiment Number: (3)

Name of Experiment: A Simple Graphical Method for Determining the Internal Resistance of a Voltmeter



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Experiment No (3)
A Simple Graphical Method for Determining the Internal Resistance of a Voltmeter

Aim of experiment:
Calculate the internal resistance of a voltmeter by using a simple graphical method.

Theory:
Let **E represents the total *e.m.f.*** of the circuit, ***R* represents the resistance box**, ***V* represents the voltmeter reading** and **R_v is the resistance of the voltmeter**.

$$E = IR + IR_V = I(R + R_V)$$

Then **the current I in the circuit is**

$$I = \frac{E}{R + R_V}$$

Assuming that the resistance of the accumulators in the circuit to be negligible. Hence, **the voltage across the voltmeter is**

$$V = IR_V = \frac{E\,R_V}{R + R_V}$$

Rearranging,

$$R + R_V = \frac{E\,R_V}{V} \rightarrow \quad R = E\,R_V \frac{1}{V} - R_V$$

Thus, from the graph of ***R*** (ordinates) against **1/V** represent a straight line which negative intercept on the ***R*** axis is represent the value of R_V as shown in figure 1.

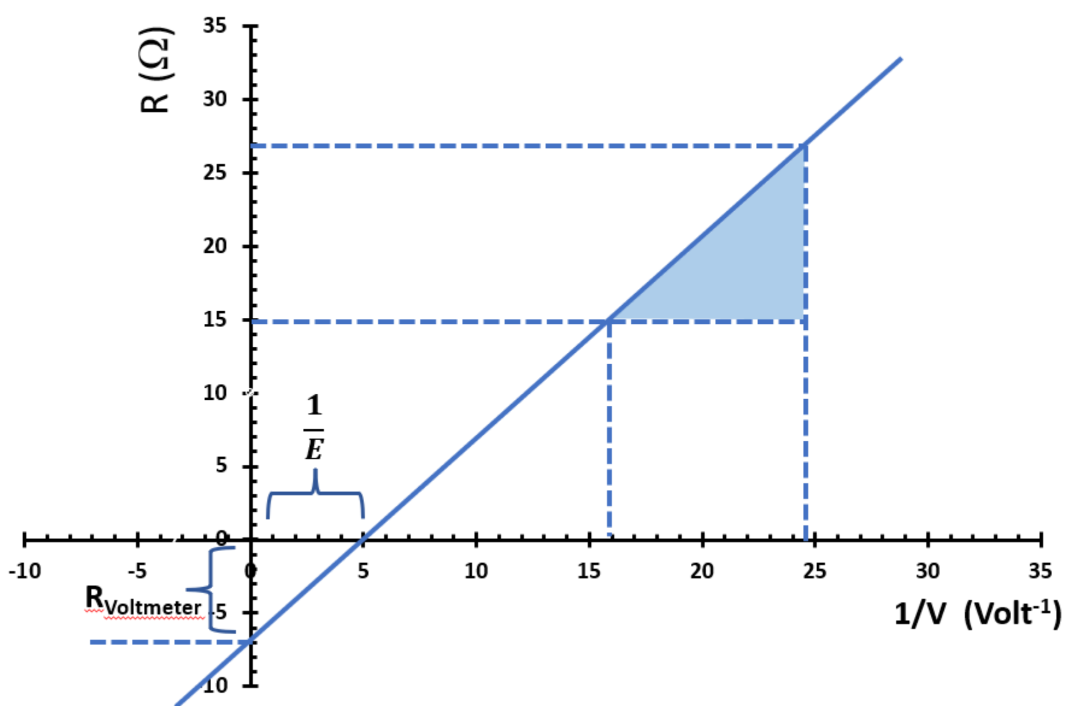


Figure 1: Graph between R and $1/V$ to find Voltmeter Resistance (R_v).

Apparatus:

1. DC power supply
2. Set of wires.
3. Resistors box which its total resistance is not less than 1,000,000Ω (R).
4. Analog Voltmeter its scale 1, 3 or 10.

Experimental Method:

1. **Connect** down the circuit as shown in the figure 2. Take out a large resistance from the resistance box (R=0 to 1,000,000Ω), choose a scale for the Voltmeter (let it be 10), and put the value of the resistance box on 0 Ω and increase the voltage of the power supply till you get a full scale (V=10Volt)
2. Step by step**, increase *R*** and record **the resistance *R* with the reading of the voltmeter scale *V***. **tabulate** the values in the table.

***R* (*Ω*)**	***V* (*V*)**	***1/V* (V^{-1})**
0		
100,000		
200,000		

3. **Plot** a graph between the value of **(*R*) at Y-axis** and corresponding values of **(1/V) on X-axis**.
4. Calculate the slope [$\boldsymbol{Slope} = \frac{\boldsymbol{\Delta R}}{\boldsymbol{1/\Delta V}}$] of the straight line represents the value of the [$\boldsymbol{Slope} = \boldsymbol{ER_V}$]. Calculate the resistance of the voltmeter $\boldsymbol{R_V}$ by negative intercept on the R axis (Figure 1).
5. Compute the percent error between the measured and calculated value. Record this on the worksheet.

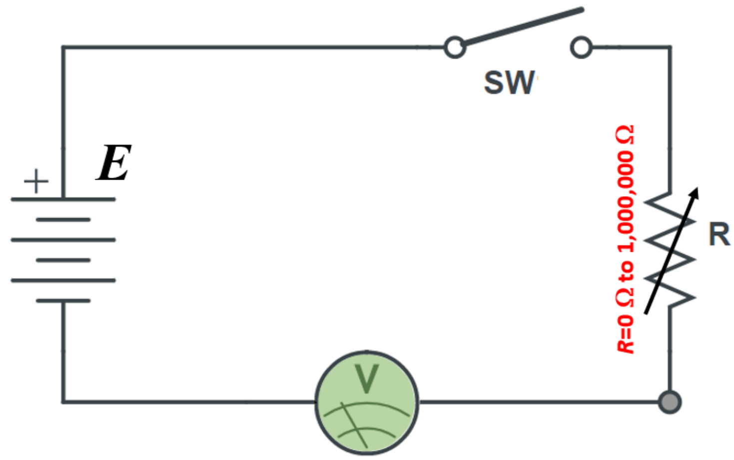
The **percentage change in an internal resistance (R_v)** as:

$$R_v = \frac{\left|R_{v\,Theoretic} - R_{v\,Experiment}\right|}{R_{v\,Theoretic}} \times 100\ \%$$

The **percentage change in electromagnetic force *E*** as:

$$E = \frac{\left|E_{Theoretic} - E_{Experiment}\right|}{E_{Theoretic}} \times 100\ \%$$

Figure 2: Circuit diagram for determining a voltmeter internal resistance



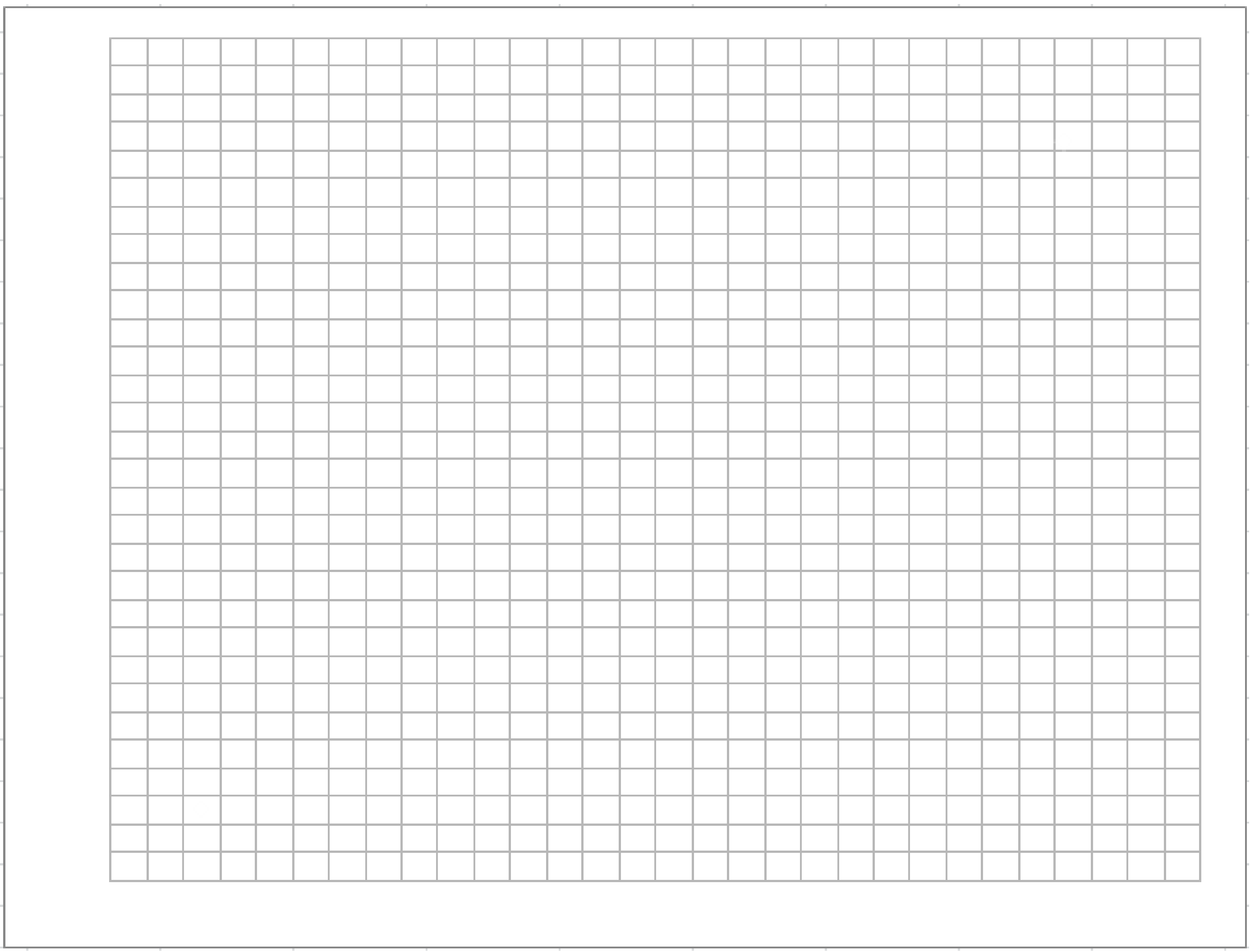
Data and Calculate:

Table 1:

$R\ (k\Omega)$	$V\ (Volt)$	$\frac{1}{V}\ (Volt^{-1})$
$R_v(Theoretic)$: **(By using ohmmeter)**	$R_v =$ …… ……	
$R_{experiment}$: **(By using graph)**	$R_v =$ …… ……	
$\varepsilon_{R_v}(Error_{R_v}) =$	$= \frac{\lvert R_{th} - R_{exp} \rvert}{R_{th}} \times 100\%$ $= \frac{\lvert \quad \rvert}{\quad} \times 100\%$ $=$	

$E(theoretic)$: **(By using voltmeter)**	$E = \dots\dots$
$\boldsymbol{R_{experiment}}$: **(By using slope)**	$E = \dots\dots$
$\varepsilon_{R_v}(Error_{R_v}) =$	$= \frac{\lvert E_{th} - E_{exp} \rvert}{E_{th}} \times 100\%$ $= \frac{\lvert \quad\quad \rvert}{\quad\quad} \times 100\%$ $=$

Graph 1:



$$\boldsymbol{Slope = \frac{\Delta R}{1/\Delta V}}$$

$\boldsymbol{Slope =}$ ____________________

$$Slope = \frac{}{}$$

$$Slope =$$

$$R_v =$$

$$ER_v = Slope$$

$$E = \frac{Slope}{R_v} =$$

Some questions:

1) Define a Voltmeter?
2) What is meant by an ideal Voltmeter?
3) Why the internal resistance of a voltmeter should be very high?
4) Voltmeter calibration can be done with a potentiometer, why?
5) How a galvanometer can be converted into a voltmeter?

Result and Discussion:

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