University of Baghdad

College of Science

Department of Physics

Electricity Laboratory (Practical Physics)

1nd Stage, 1st Semester

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Lecturer.Hiba Hussein Issa

2022-2023

Lecture(1). graph line

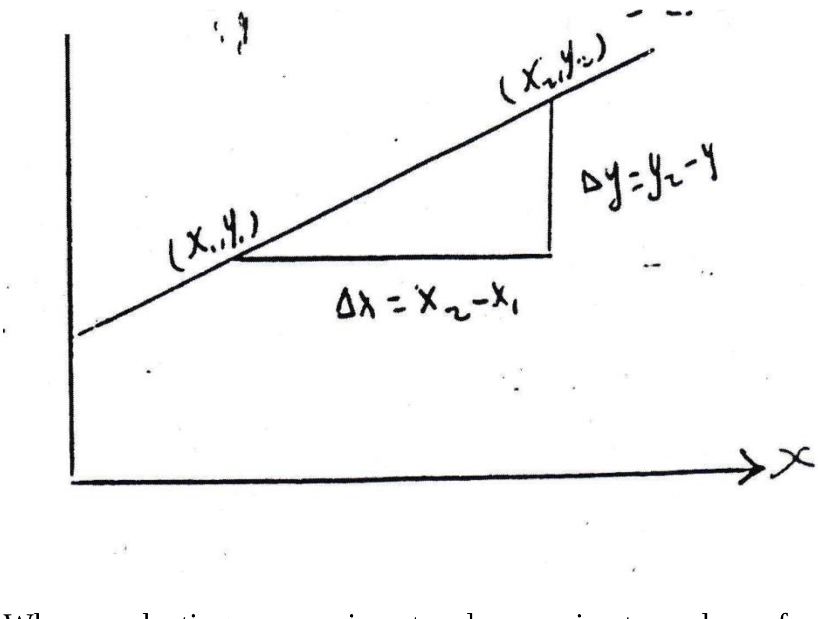
It is the curve that we get when drawing a variable Y, for example, as a function of another variable X, for example. In fact, drawing the graph of two variables represents a visual way to clarify and realize the relationship between them, and more and more, what we will encounter in our experiments are the cases in which the graph is straight and that the straight line equation is:

$$Y=ax+b$$

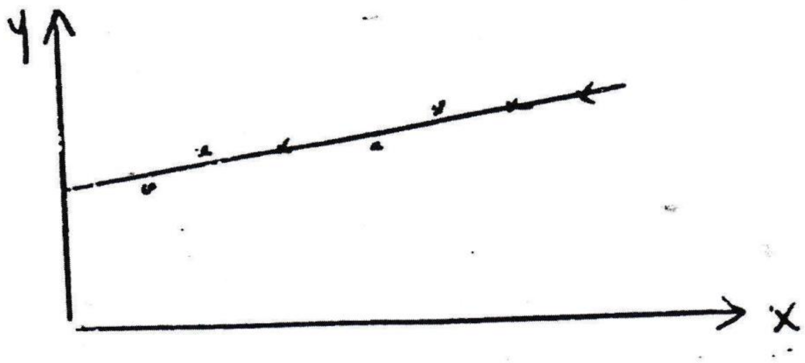
Where y is the function or variable dependent on the variable x, a: The slope of the straight line is equal to the change in y over the change in x, meaning that:

$$a = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

b represents the coordinates of the point of intersection of the line with the y axis, that is, it represents the value of y when the value of x becomes zero, as in the figure below:



When conducting an experiment and measuring ten values of x, for example, we will obtain, in return, ten values of y. Each pair of readings represents a point on the (x, y) level, as shown in the figure below:



Then we pass a graphic line between these points. And if the relationship is linear between x and y, then we pass a straight line between these points so that the sum of the squares of the deviations of these points from the straight line is the least possible. That is, the number of points below the line is equal to the number of points above the line, bearing in mind that the sum of the squares of the distances of the points below the line from the line is approximately equal to the sum of the squares of the distances of the points above the line from the line. Here are some notes for drawing such shapes, please commitment to them:

1- The y and x axes are 2 cm away from the edge of the paper.

2- Write on each axis the name of the variable, its symbol and its unit of measurement.

3- Write the number and title of each form directly below the form, as if we write:

Figure 1: Potential difference V as a function of current I.

4-Do not write anything on the data sheet other than what was mentioned above, with the exception of calculating the slope.

$$a = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

5- Remember that what the unit of length represents on the y-axis has nothing to do with what the unit of length represents on the x-axis, for example: 1 cm on the y-axis may represent 1 volt, while 1 cm on the x-axis may represent 0.001 ampere. In addition, it is possible to choose any suitable scale and obtain the same results.

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2022-2023

Lecture7: Measuring devices

In this lecture, we will learn about some of the important measuring devices in the laboratory to conduct the experiment

1- Galvanometer (G):

A device highly sensitive to electric current consisting of a coil arranged on an iron core fixed to a shaft and placed between the poles of a permanent magnetic bar.

When an electric current passes through the coil, a torque is generated, which causes the axis to twist, and accordingly the pointer connected to the axis moves according to the type of curved measurement. When no electric current is passed, it is clear that the return torque is proportional to the angle of rotation.

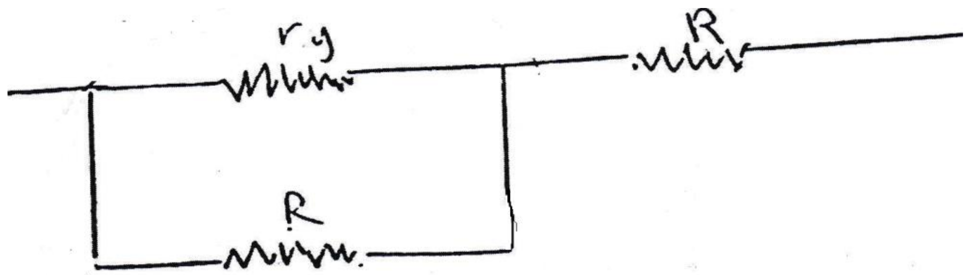
In fact, the angle of rotation or the magnitude of the deflection of the m}shar is directly proportional to the flowing current.

A galvanometer can be converted into an ammeter, a voltmeter, or an ohmmeter.

2- Ammeter (A):

A device used to measure ordinary electric currents. It is a galvanometer connected in parallel with a small resistance whose amount depends on the value of the current to be measured. If the ammeter is designed to measure fractions of ampere, then the resistance used is relatively large.

Since the ammeter is used to measure the current passing through a resistance, it must be connected in series with it, so that all current passes through it.



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Lecture8: Measuring devices

In this lecture, we will learn about some of the important measuring devices in the laboratory to conduct the experiment.

3- Voltmeter (V):

A device used to measure the potential difference between two points in an electric circuit, and for this reason it is connected in parallel with what is connected between those two points.

A voltmeter is a galvanometer with which a resistance is connected in series, the amount of which depends on the value of the potential difference to be measured.

If the potential difference is large, the resistance is very large, and if the potential difference is relatively small, the resistance is relatively small

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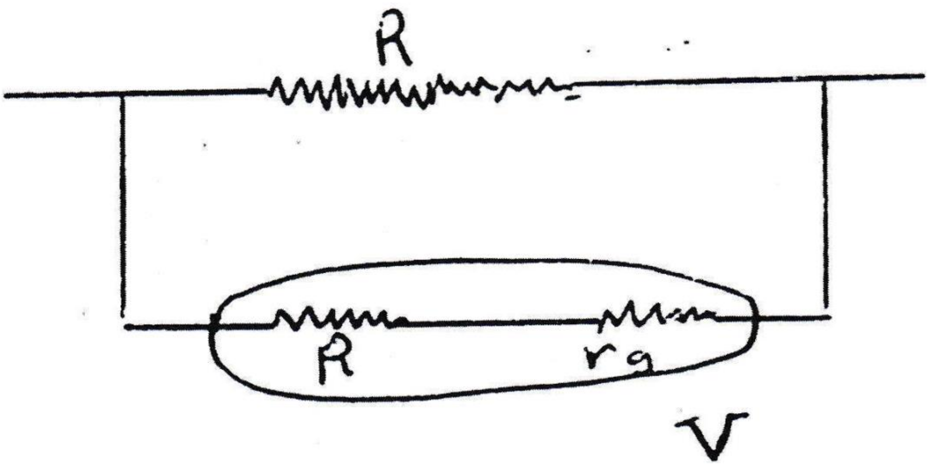
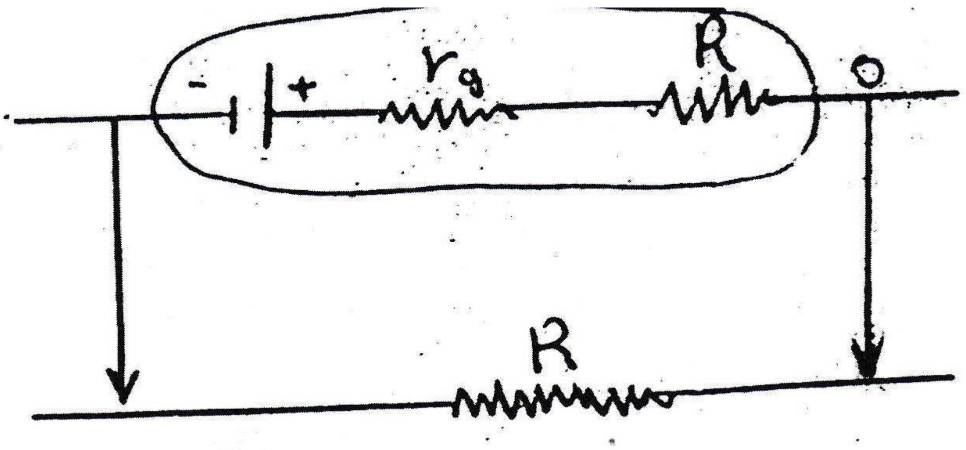


4- <u>Ohmmeter (O):</u>

A device used to measure resistors. It is a galvanometer with which a resistance and a battery are connected in a row so that if its ends are connected to each other, the pointer will deviate the greatest deviation, indicating that there is no external resistance.



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Lecture9: Measuring devices

In this lecture, we will learn about some of the important measuring devices in the laboratory to conduct the experiment.

5- Ohmmeter (AVO)

A device that can be used as an A-meter, a V-voltmeter, or an O-meter.

The AVO meter contains various electrical equipment and many resistors of varying value, and its use and purpose is determined by the use selection switch.

If this key is placed in front of the cutter letter A, then its use is determined as an ammeter, and a small resistance will be connected in parallel with the galvanometer.

Likewise for the ohmmeter, And by the way, by placing the reuse switch in the appropriate position, the AVO can be used to measure the current or the continuous or alternating voltage difference.

And depending on the value of the resistance used, the range of the device for measurement is determined, and by range we mean the largest value that can be .measured

When placing the usage selection switch on the letter breaker A and opposite the range I, this means that the largest current that can be measured is one ampere, and if it is over a range of 10, then this means that the largest current that can be measured is ten amperes. The largest voltage that can be measured is 30 volts, and so on, and since the measuring plate on which the pointer moves is the same, then:

The correct reading of the device = (the reading of the indicator X the range) / (the largest reading on the measuring plate)

6- Resistors Box

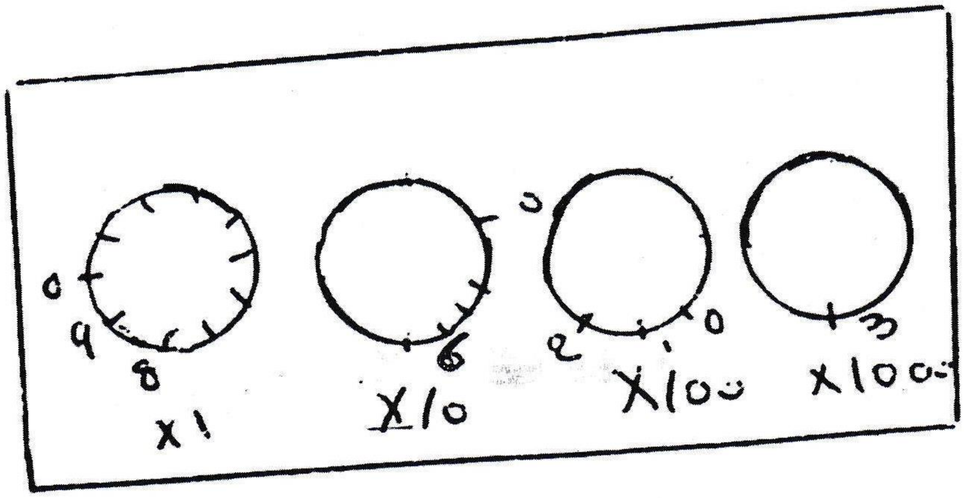
It is a group of resistors with double amounts that are all placed inside a box, and any of them can be connected to the other in a row to get a higher resistance according to what we want.

The resistors inside the box are usually classified into groups.

The first group are multiples of one, the second group are multiples of ten, the third group are multiples of hundreds, and there may be a fourth group for multiples of thousands.

There are several keys listed, each from 1-9, to choose the appropriate resistance, for example:

In the configuration shown in the drawing below, the resistance used is 3168 ohms.



$$R = 8x1 + 6x10 + 1x100 + 3x1000$$

$$= 8 + 60 + 100 + 3000$$

$$= 3168\ \Omega$$

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Lecture10: Measuring devices

In this lecture, we will learn about some of the important measuring devices in the laboratory to conduct the experiment.

7- Variable Resistance

Physically, it means the resistance shown by a conductor when an electric current passes through it.

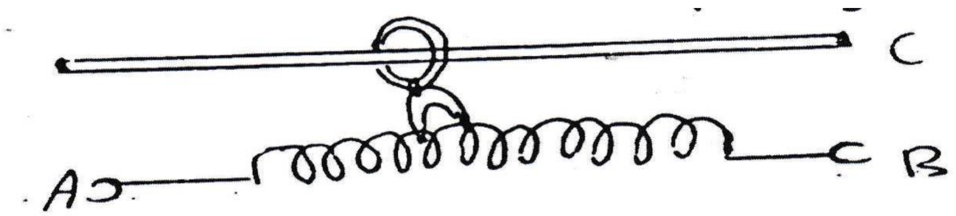
Static Resistance:

It is a constant resistance value due to the constant length of the wire.

Variable Resistance:

It is a wire coiled on an iron core and has two ends for connection A and B (black or white)

There is a piece of metal S that can slide on a metal rod, and its two ends are in permanent contact with the wire, and the rod ends at one end with a piece (usually colored).



Depending on how the variable resistor is connected, its use is determined:

1- If the two ends, A and B, are connected alone in the electrical circuit, then they will be used as a static resistance, in order to use the entire length of the wire.

2- If one of the two points A or B is connected with point C, then the part AS will be used, but if point B and point C are connected, then the part SBs will be used and the value of the resistance of the used part of the variable resistance. It depends on the location of S, and in such cases we have used the variable resistance to control the current.

3- The variable resistance is used as a voltage divider, that is, it is used to obtain a low voltage from a large voltage source, in the following way:

It connects the two ends of the voltage source to two points A and B, so we have applied all the potential difference to the entire length of the wire AB. Points C and A are connected to the other part of the electrical circuit. We have used the voltage part between S and A, and the sliding part S moves. We can control the voltage used.

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2022-2023

Department of Physics/College of Science/University of Baghdad
Practical Physics, Electricity Lab, 1^{st}year, 1^{st}semester
Exp.1 Ohm's law

Number of experiment: one
Name of experiment: Ohm's law investigation
The purpose of the experiment: 1. Ohm's law investigation
(Prove the linear relationship between the potential deference and the current passing through a linear metal resistance)
2. **Investigation of the law of connection of resistors in parallel and sires**
Devices used : 1.D.C electrical power source (battery), 2. Voltmeter, 3. Ammeter, 4. Resistors, 5.key, 6. Connecting wires
Theory:
Ohm's law: The potential difference V applied between two ends of a conductor is directly proportional to the current (I) passing through it if the conductor temperature is constant.

$$V \propto I \quad \text{or} \quad V = R \times I \qquad (1)$$

Where R is the constant of proportionality, and it is called the electrical resistance of the conductor.
If we divide the potential difference (V) by the unit of volts and the current (I) by the unit amperes, then the resistance is measured in ohms and this unit is denoted by the symbol (***Ω***).
The resistance of a conductor depends on :
1. The nature of its material.
2. Its length.
3. Its cross-sectional area.
4. and its temperature.

Electrical resistance: is an electrical property and represents physically the amount of resistance a conductor resists to the movement of the flow of electrons passing through it when the potential difference between its ends is applied.
It should be noted here that Ohm's law applies only to **linear resistors** (that is, fixed resistors that do not change regardless of the change in the voltage applied to them and the current passing through them.
In general, **metal conductors are linear resistances if they are at a constant temperature**.
It has been scientifically found that the resistance of the conductor R with an absolute degree T increases with increasing temperature according to the equation:

$$R=R_0\,(1+\alpha T+\beta T^2+\gamma T^3+\ldots\ldots) \quad (2)$$

Where R_0 is the resistance of the conductor with a degree of absolute zero and α, β, γ is the coefficient of thermal resistance to change the resistance.

The method of work

Part one (single resistance)

1. Connect the electrical circuit as in **Figure (1)**, leaving the key (K) open, and ask one of the laboratory officials to check the connection
2. Close the circuit switch and note the amount of current passing through the circuit. The variable resistance can be used to control the amount of voltage and current passing through the circuit.
3. Make the value of the potential difference (0.2 volts) and read the value of the current corresponding to this potential difference and record it in the readings table
4. Increase the value of V in steps (0.1 V) and record the values of each of the current and the potential difference until the value of V becomes equal to (1) volts
5. Draw the graph between the values of (V) and the value of (I) so that the voltage difference is on the vertical axis and the current is on the horizontal axis and the figure should be a straight line.

Part two: series

6. Connect the electrical circuit shown in **Figure (2)** and repeat the previous steps (2-5). Practically find the value of the equivalent resistance (R) in the graph, and compare it with the theoretical value that is extracted from the following law:

$$R=R_1+R_2+R_3 \qquad (3)$$

Part three: parallel

7. Connect the electrical circuit in **Figure (3)** and repeat the previous steps (2-5), then find the practically equivalent resistance value from the graph and compare it with the theoretical value from the following law:

Note:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \qquad (4)$$

Cut the circuit when the readings are not taken so that the battery does not go down and the resistance does not heat up, which may affect the validity of the result

Questions:

1. The value of the resistance depends on its length and area, and in light of this, how you measure the results obtained from steps 5 and 6.
2. How do we connect the ammeter and voltmeter in the electrical circuit? And why?
What should be the values of each resistor to get good results?
3. Derive equations (3) and (4).

Figure (1): single resistance

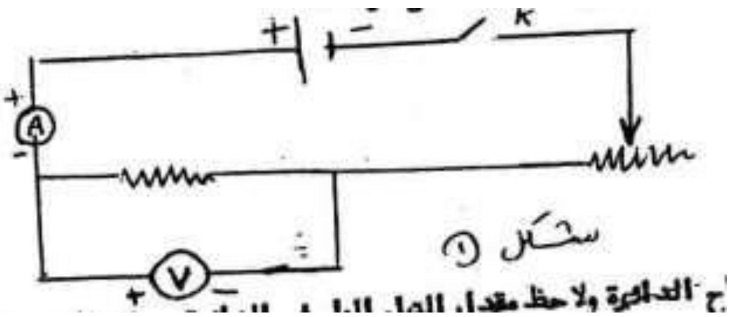


Figure (2) series connection

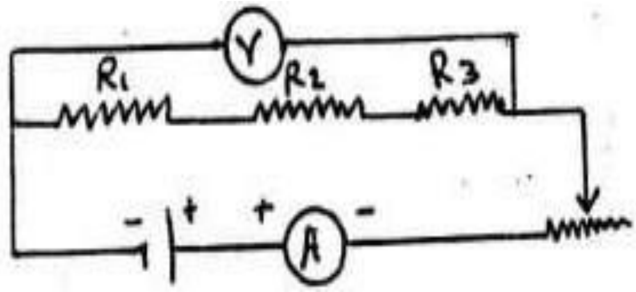
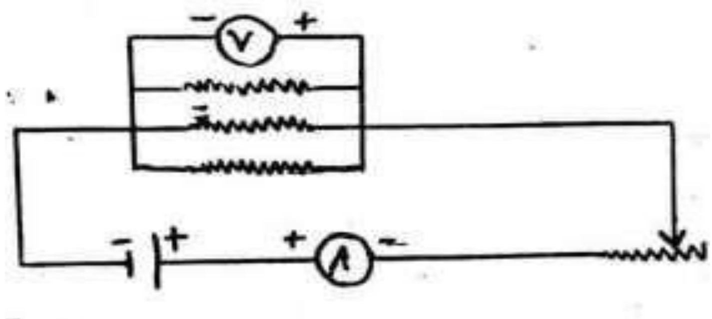


Figure (3): parallel connection



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Exp.2.Non-linear relation between the potential deference's and the current for heat resistance

Number of experiment: Two

Name of experiment: The nonlinear relationship between voltage and current for a hot resistance

The purpose of the experiment: Finding the empirical relationship between the current passing through the tungsten filament and the potential difference applied to its ends

Devices used : 1. Battery 2. Variable resistance 3. Ammeter 4. Voltmeter 5. Tungsten filament bulb 7. Switch

Theory:

In the previous experiment, we have shown that the resistance R of a wire of length P and area of cross-section A is given according to the following equation (1), provided that the temperature of the wire t is kept constant.

$$\mathbf{R} = \boldsymbol{\rho} \times \frac{P}{A} \qquad \mathbf{(1)}$$

Where $\boldsymbol{\rho}$ represents the dependence of the resistance of the wire R on the nature of its material, and it is called the **specific resistance** of the wire with unit ohm. meter **(Ω.m)**

On the other hand, when the geometric dimensions of the resistance are fixed (that is, when P and A are held constant), its value will depend on the temperature according to the equation.

$$\mathbf{R_t = R_0\,(1+\alpha t+\beta t^2+\gamma t^3+\ldots..)} \qquad \mathbf{(2)}$$

Where $\mathbf{R_t}$ is the value of the resistance which is t C^0 And $\mathbf{R_0}$ is the resistance value at zero degrees Celsius And **α, β** and **γ** represent the thermal resistance coefficients

The above equation indicates that the resistance increases with increasing temperature, and accordingly, the relationship between the current **I** passing through it and the potential difference **V** on its two ends is not linear, but rather like the curve shown in **Figure (1)**. Such resistors are called non-linear resistors or non-ohmic resistors.

Tungsten is used in electric lamps because its melting point is 3380 °C and its specific temperature is low

It was found that the relationship between the current **I** and the potential difference **V** for such resistors is given according to the equation:

$$\mathbf{I \;\alpha\; V^n}$$

$$\mathbf{I = K\,V^n} \qquad \mathbf{(3)}$$

Where **n** and **K** are constants whose value depends on the nature of the resistive material and to find them we draw P**nI** as a function P**nV**

$$P\mathbf{nI = n}\,P\mathbf{nV} + P\mathbf{nIK}\ \mathbf{(4)}$$

This equation represents the equation of a straight line with slope **n** and its intersection with the P**nI** axis gives P**nK** and from it we get the value of the constant **K**. Note **figure (2)**.

By the way, there are resistors whose value remains constant and is equal to the ratio between the voltage difference V on its ends and the current passing through it (that is, $R = \frac{V}{I}$ always)

Therefore, such resistance is called ohmic resistance because Ohm's law applies to it, and it is also called linear resistance because the relationship between the voltage difference V on its ends and the current I passing through it is a linear relationship, i.e. it can be represented by a straight line

The method of work

1. Connect the electrical circuit as shown in **Figure (4)** below, leaving the circuit switch **K** open, and let us start with the readings before verifying the connection by one of the laboratory officials. Then leave the circuit closed until the completion of the experiment.

2. Start with the lowest appropriate reading of the voltage difference **V**, which causes an electric current **I** in the lamp and can be read in the ammeter. Record the value of **V** and **I** in a table as shown below

3. Increase the value of the potential difference **V** a little by an appropriate amount and record the values of **V** and **I** and record them in the table above

Exp.2.Non-linear relation between the potential deference's and the current for heat resistance

4. Continue gradually increasing the value of **V** until it reaches the largest suitable value for **V**, recordingeach time the values of **V** and **I**

5. Draw *P***nI** as a function *P***nV** to get a straight line as shown in **Figure (2)** and from it find the value of theconstants **K** and n as explained in the theorem

6. Draw **I** as a function of **V** to get a curve as shown in **Figure (1)**

Discussion questions

1. Using equation (1), try to define the specific resistance
2. Some resistors heat up when an electric current is passed through them, so the source of thermal energy(what does this cause and how?)
3. What is meant by non-ohmic or non-linear resistance?
4. Why is it preferred to use tungsten in light bulbs? Explain what you mean by your answer in more detail
5. Discuss the curve you get when plotting I as a function of V (hint: which gets faster, I or V at the beginning of the curve, and which gets faster at the end of the curve? How do you explain the observations?)

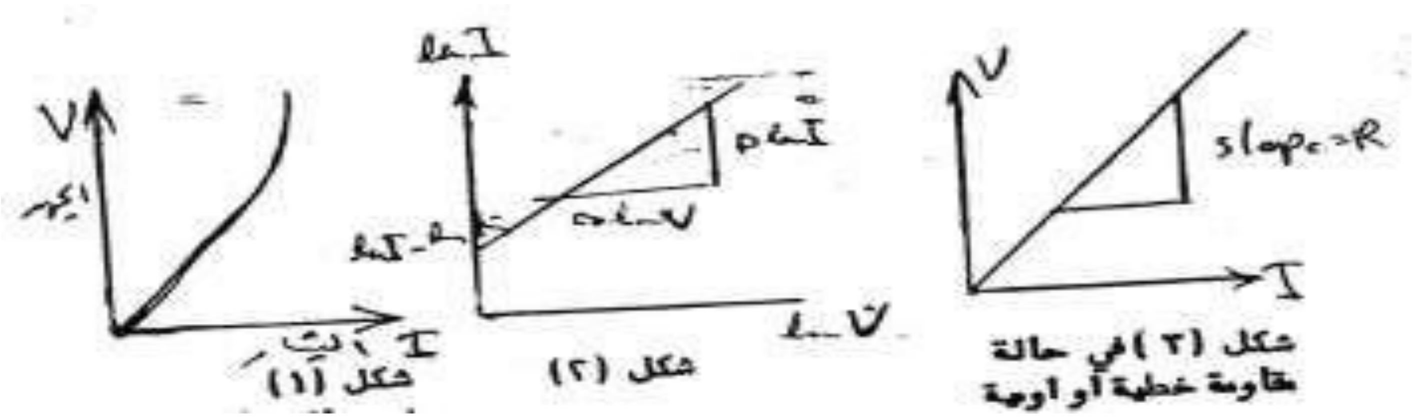

Figure (1) in the case of nonlinear or non ohmic resistanceFigure (3) in the case of linear or ohmic resistance

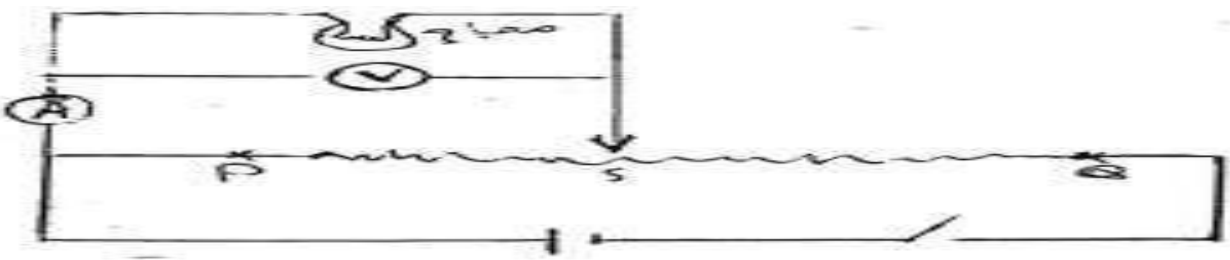

Figure (4)

V	I	ln I	ln V

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Number of experiment: Three
Name of experiment: Two Kirchhoff's Law
The purpose of the experiment: 1. Two Kirchhoff law investigation
2. Law of potential difference between two points in an electric circuit Investigation

Devices used : 1.Electrical Power source (battery) 2. Three ammeters 3. Voltmeter 4. Resistors of different values 5. Switch 6. Connecting wires

Theory:

There are some complex electrical circuits connect that Ohm's law cannot be used to calculate the currents passing through their branches as shown in the two figures below [Figure (1) and Figure (2)]

To solve such circuits, i.e. to find the current in each branch of the circuit, we use Kirchhoff's law. Before explaining these two laws, we first clarify:

Branching point: It is the point where three or more conductors meet, such as points a and b in figure (1) and points a, f, c, and e in figure (2)

Closed path: any closed path such as fedcf, abcf in Figure (2)

Branch point law: The algebraic sum of the currents at any branch point is zero

$$\Sigma \mathbf{I} = 0 \qquad (1)$$

Considering the currents coming to the point are positive and the currents coming out of it negative or vice versa. Therefore, it can be said that:

$$\Sigma \mathbf{I}_{out} = \Sigma \mathbf{I}_{in} \qquad (2)$$

The sum of the incoming currents = the sum of the outgoing currents

This law confirms that the charges do not collect at the junction point.

Closed Path Law: The algebraic sum of the electromotive forces in any closed path is equal to the algebraic sum of the products of the current times the resistance **I × R** for that path

$$\Sigma \mathbf{E} = \Sigma \mathbf{I} \times \mathbf{R} \qquad (3)$$

This law is related to the law of conservation of energy, and we must remember that the potential difference between two points represents the amount of work required to transfer the unit of positive charges from one point to the other.

To apply equation (3), we must consider the currents and electromotive forces counterclockwise as positive, and those with the clockwise hand as negative (and vice versa), knowing that the direction of the electromotive force of a battery is always from the negative pole to the positive pole. As we should note, the closed path may contain currents in opposite directions. The current may be positive in one path, and the current may be negative in another path.

Finally, we must note that determining the currents signals when applying the branching point law has nothing to do with determining the currents signals when applying the closed path law.

Voltage difference **Vab**: To calculate the potential difference between two points in an electrical circuit, we use the following equation:

$$V_{ab} = \Sigma \mathcal{E} - \Sigma I \times R \qquad (4)$$

Where $\Sigma \mathcal{E}$ represents the algebraic sum of the electromotive forces of the batteries connected between points a and b, taking into account the electromotive force that reverses the movement from a to b is positive and that with the direction of movement from a to b is negative.

And $\Sigma I \times R$ represents the algebraic sum of the product of the currents in the resistors connected between points a and b, taking the current with movement from a to b to be negative and the current against the movement positive.

The method of work

1. Connect the circuit as in Figure (3) below, keeping the switch K open, and ask one of the laboratory officials to check its connection.

2. To investigation Kirchhoff's first law, close the switch K and quickly read and record the readings of the three ammeters A_1, A_2, and A_3.
3. Immediately after that, open the K switch to prevent the battery from falling and to avoid overheating and its values.
4. Apply equation (2) at point C and point g.
5. To achieve Kirchhoff's second law, inquire about the electromotive force of the battery and its internal resistance, r, using the values of i_1, i_2 and i_3 from the first step.
6. Apply equation (3) to closed paths: abcga , abcdega , gcdeg After you know the values of the resistors R_1, R_2, and R_3
7. To achieve the law of potential difference between two points in an electrical circuit, apply equation (4) to calculate the potential difference Vcg

a. Through resistance R_2 b. Through resistance R_3 c. Through the path gabc

Discussion questions

1. Mention the closed paths in Figure (1)
2. Mention only how many closed paths are shown in Figure (2). (Remember that you may ask about diagnosing these paths)
3. How does the resistance of a conductor change with its temperature? Explain your answer mathematically (see Experiment 1).
4. How do you explain the failure to achieve equation 3 and 4 very accurately with the results obtained?

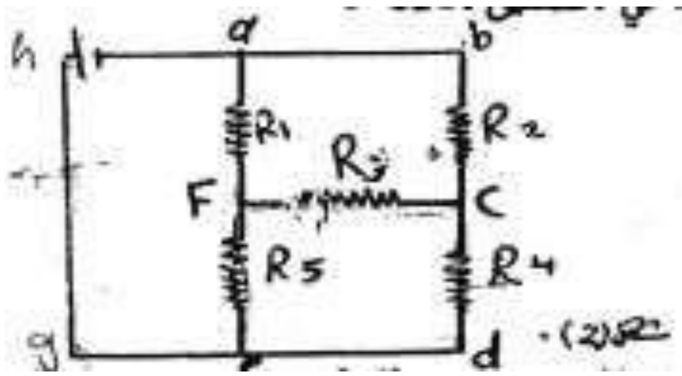

Figure (2)

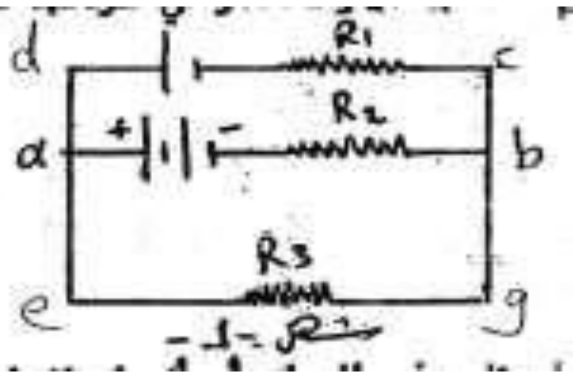

figure (1)

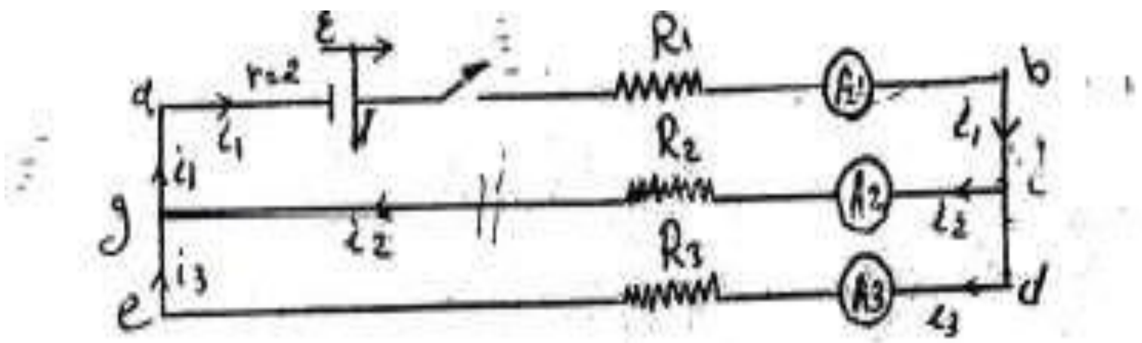

Figure (3)

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2022-2023

Number of experiment: Four

Name of experiment: Finding the value of an unknown "medium value" resistance by comparing it with a second resistance of known value

Part 1: connect the two resistors in series

Devices used: 1. D.C power supply 2. D.C voltmeter 3. Resistors box 4. Resistance of unknown value 5. Switch

The theory:

When two resistors are connected in series in an electrical circuit, the same DC current passes through the two resistors, while the potential difference on the two ends of these resistors is divided according to their value (note Figure 1) , Based on Ohm's law, = $\frac{R_S}{R_X} = \frac{V_S}{V_X}$ where R_S is the known resistance and R_X is the unknown resistance V_S is the potential difference on both ends of the known resistance and V_X is the potential difference on both ends of the unknown resistance , Since R_S is known resistance and by measuring the potential difference V_S and V_X, finding the value of the unknown resistance $R_X = R_S \frac{V_X}{V_S}$

The method of work

Connect the electrical circuit as shown in Figure (1).

1. Determine the value of the information R_S using the resistor box and record the reading of the voltmeter V_S and V_X and then calculate R_X

2. Change the known resistance in ascending values and each time record the readings of the voltmeter V_S and V_X as in Table No. 1 and extract the R_X rating

3. Plot $R_S V_X$ as a function of V_S from the slope Calculate the value of R_X and compare it with the previous value extracted from the table

Table (1)

R_S	V_X	V_S	$R_X=R_S\frac{V_X}{V_S}$	$R_S V_S$
			$R_{X(ave.)}$ =	

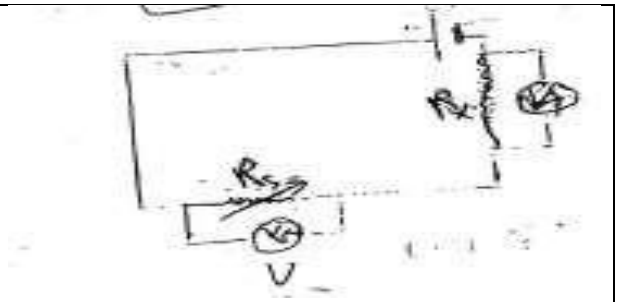


Figure (1)

Part two: connect the two resistors in parallel

Devices used: 1. D.C power supply, 2. D.C meter, 3. Resistors box, 4. Resistor of unknown value, 5. Switch

The theory:

In this case, the current will be divided according to the value of each resistance while the potential difference is constant on both ends of each resistance and equal to the source voltage difference (Fig. 2) and based on Ohm's law, $\frac{R_s}{R_X} = \frac{I_X}{I_S}$ where R_S is the known resistance, R_X is the unknown resistance, and I_X is the current The current passing through the unknown resistance I_S is the current passing through the known resistance.

The method of work

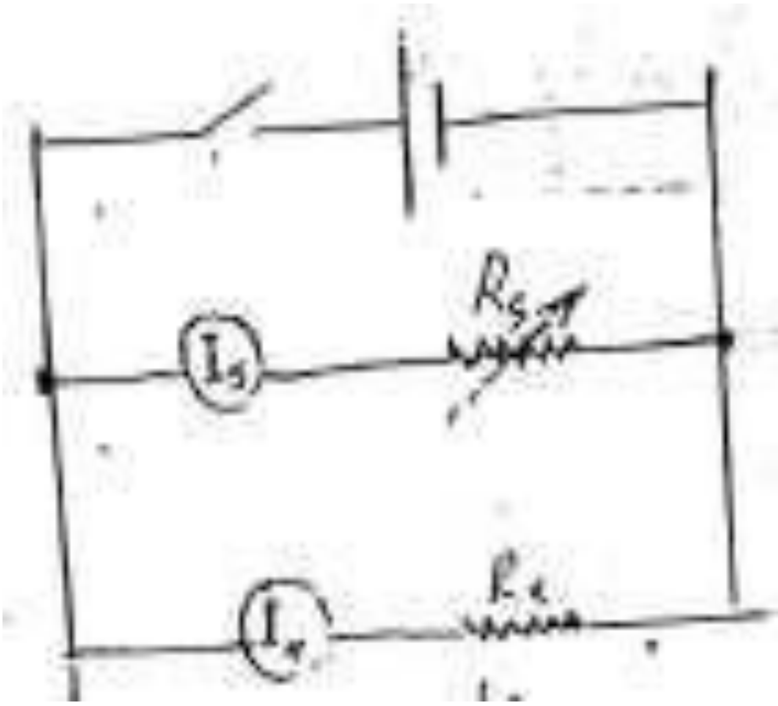
1. Connect the electrical circuit as shown in Figure (2).

2. Determine the known resistance R_S by means of the resistors box and record the reading of I_S and I_X and then calculate R_X

3. Repeat step 2 for several unknown resistors

Discussion

1. **Derive the relationship in the case of series and parallel**
2. **On what does the accuracy of measuring the unknown resistance depend in this experiment?**
3. **Number (how many) of ways to measure resistors**



Figure(2)

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1^{nd} Stage, 1^{st} Semester

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2022-2023

Name of experiment: The internal resistance of the voltmeter

Devices used: 1. Battery 2. Resistance box 3. Switch 4. Voltmeter

The theory:

A voltmeter is a device for measuring the potential difference between two points in an electrical circuit (for example, at the ends of a resistance R). For this reason, it is connected in parallel with the resistance whose potential difference is to be measured, Fig. (1) and its reading, V, is equal to the product of resistance R by the current through it I, just as the resistance of the voltmeter R_V is equal to the current through which I is:

$$V = I \times R = I_V \times R_V \quad (1)$$

It is clear from all this that the resistance of the voltmeter must be high

To measure the internal resistance of a voltmeter, an electrical circuit as shown in Figure (2) can be used for this purpose.

For the purpose of measuring its resistance R_V, current is passed in the circuit by closing and opening the switch K

When the switch K is closed, current I passes in the circuit, and when the internal resistance of the battery (which is usually small) is neglected:

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

OR

$$E = I \times R + I \times R_V = I \times R + V$$

Substituting for I from equation (2),

$$E = \frac{ER}{R+R_V} + V \quad (3)$$

By modifying this equation, we can write:

$$\frac{I}{V} = \frac{R}{R_{VE}} + \frac{I}{E} \quad (4)$$

Assuming that both E and R_V are constant, the relationship between R and $\frac{I}{V}$ is linear

In other words, equation (4) R, $\frac{I}{V}$ is the equation of a straight line Y=mX+b

So, by plotting $\frac{I}{V}$ as a function of R, we will get a straight line as shown in Figure (3).

As shown in Figure (3), which can be deduced theoretically from equation (4), the point of intersection of the straight line with the $\frac{1}{V}$ axis represents $\frac{1}{E}$, meaning that

$$\left(\frac{1}{V}\right)_{R=0} = \frac{1}{E}$$

The point of its intersection with the R axis is RV

$$R_V = \left|(R)_{\frac{1}{V}=0}\right|$$

The method of work

1. Connect the circle as shown in Figure (2).

2. Use a suitable resistance from the resistance box, then close the switch and record the voltage reading, V

3. Repeat the previous step (8) more times. Increase the external resistance by (10,000) ohms each time. Arrange your results as in Table (1).

4. Draw a graph of the values of $\frac{1}{V}$ as a function of the values of R and from the figure extract the value of the internal resistance of the voltmeter R_V and the value of $\frac{1}{E}$ from it, calculate the electromotive force of the battery E

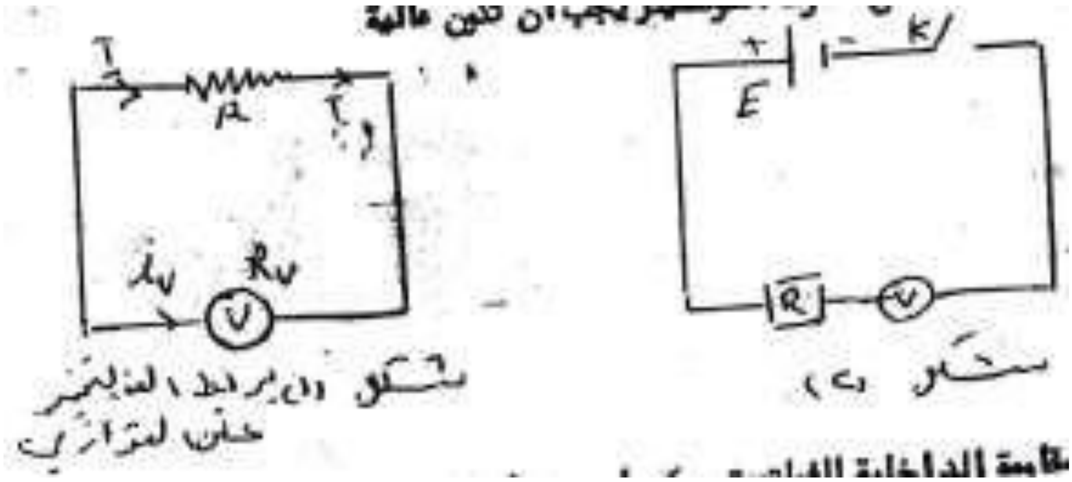
Discussion Questions

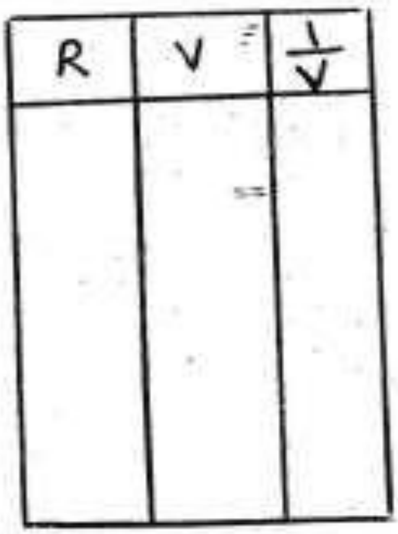
1. Why is a voltmeter connected in parallel? Why is the resistance so great?

2. Write equation (3) and then transform it to get equation (4).

3. What does your straight line represent? And what is its value? Use the values of $\frac{1}{E}$ and R_V you obtained from the force (4) to calculate their value in terms of each other using this slope value. Compare results **(2)**

4. What are the factors that may cause your calculations to be inaccurate?





R	V	$\frac{1}{V}$

جدول (1)