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DETERMINATION OF UNKNOWN RESISTANCE USING UITSON BRIDGE

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Abstract

In nature, there is a force that resists every force and it manifests itself in different forms. For example, there is a resistance force of the air acting on an object going up or down, whether it is horizontal or vertical, there is also a thermal resistance that prevents the thermal motion of the molecules of the objects from spreading, a part of the circuit is connected to the electric current There is also electrical resistance, a physical quantity that represents the feedback effect.[1] The purpose of this laboratory work is to determine the unknown electrical resistance using the Wheatstone bridge and to verify that the measurement of the unknown resistance does not depend on the current flowing through the resistance in the zero balance method. In 1833, Samuel Hunter Christie presented his "diamond" method, i.e., the Wheatstone bridge, in the form of the electrical properties of metals, as a method of comparing the resistance of wires of different thicknesses at the Royal Society's Baker Lecture.[2] However, this method was not recognized until 1843. Charles Wheatstone proposed it in another paper for the Royal Society to measure resistance in electrical circuits. Although Wheatstone introduced it as an invention of Samuel Hunter Christie, it is now associated with the method.

II.Material and metod

2.1 Experiment.

Method 1: Zero current by selecting l_1 and l_2.

A voltage of U=1V was applied to the resistors. Lengths l_1 and l_2 were set on the conductor wire in such a way that the ammeter showed I=0 A in its most sensitive range. Increased the value of ***R*** in the resistors deka.

Method 2: Bring the current to zero value by choosing R in the set of resistances. A switch was installed on the conductor wire to make the lengths l_1 and l_2 exactly 50 sm. A measurable resistance R_x with a value of 10 Ohm is connected according to the scheme and the corresponding R is set in a set of resistances.

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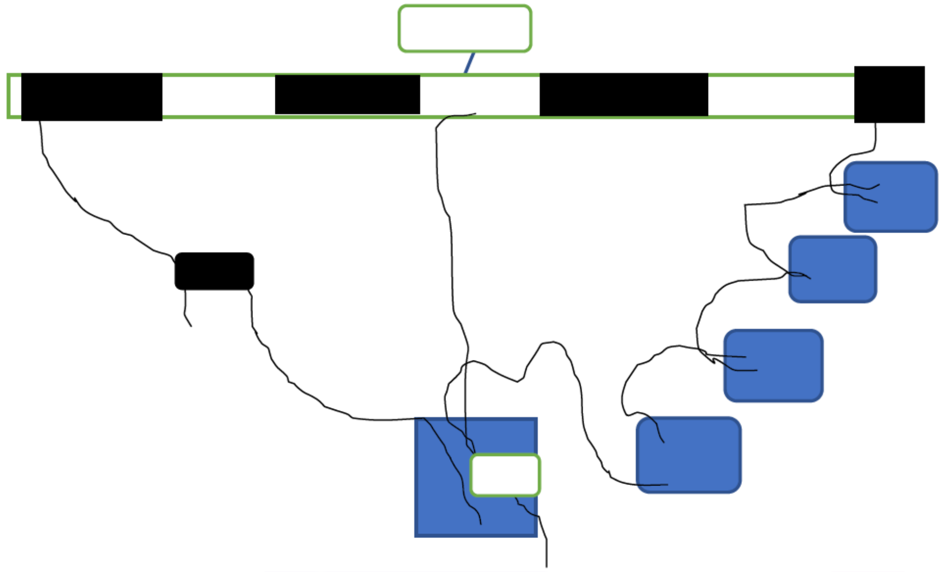
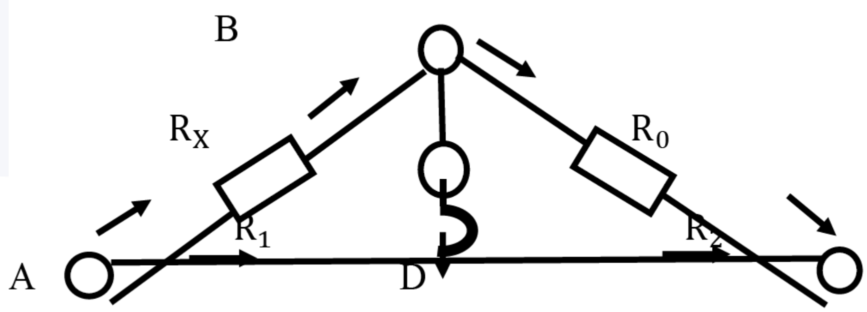


Picture1. Illustration of the experimental setup.

The voltage of the current source was brought to 1V. In the set of resistances, R was chosen so that the ammeter showed the smallest value I= 0 A. The device for the experiments was according to the schemes in pictures (1) and (2). A resistor with a value of 10 Ohm was installed as an unknown resistance. The voltage value of the current source should not be greater than 2V, and the current passing through the resistance set should not be greater than 250 mA. [4]

2.2 Nazariya.



Rasm2. Scheme of the experimental device.

The unknown resistance R_x can be found using this circuit. For this, we look for the condition that the current passing through the galvanometer is zero. The relationship between R_x and R_o and the resistances of AC parts R_1 and R_2 is as follows:

$$\frac{R_x}{R_0} = \frac{R_1}{R_2}$$

from this

$$R_x = R_o \cdot \frac{R_1}{R_2} \qquad (1)$$

Found. If the resistances R_1 and R_2 are taken from the same conductor, the cross-sectional area does not change, so instead of the ratio of resistances, the ratio of the lengths of the wires can be obtained. Because the cross-sectional area of the conductors does not change when the resistance is directly proportional to the length of the conductor:

$$R_1 = \rho \cdot \frac{l_1}{s} \qquad R_2 = \rho \cdot \frac{l_2}{s} \qquad (2)$$

Where ρ- Resistivity of AC wire; S- AC-wire cross-sectional area; l_1- AD is the length of the segment; l_2- DC is the length of the part. (2) from Eqs

$$\frac{R_1}{R_2} = \frac{l_1}{l_2} \qquad (3)$$

If we put (3) in (1):

$$R_x = \frac{l_1}{l_2} \cdot R_0 \qquad (4)$$

The resistance of the conductor depends on its material, length, cross-sectional area and temperature:

$$R = \rho \frac{l}{s} \qquad (5)$$

Here S is the cross-sectional area of the conductor, l is the length,
ρ is the relative resistance of the conductor. As the temperature increases, the resistance of the conductor also increases. There is a linear relationship between resistance and temperature:

$$R_t = R_o(1+\alpha t) \qquad (6)$$

R_t and R_o are the resistances of the conductor at t° and 0°C, α -the thermal coefficient of resistance, which shows how many times the resistance changes when the temperature changes by one degree. The unit of resistance can be deduced from Ohm's law.

$$R = \frac{U}{I} = \frac{1\ V}{1\ A} = 1\ \Omega \qquad (7)$$

The unit of resistance is the resistance of a conductor through which a current of 1 Ampere passes when the voltage at its ends is 1 Volt. This unit of resistance is called 1 Ohm. [6] There are different ways to measure the resistance of a conductor. The first of them is measurement using an ammeter and a voltmeter. But the level of accuracy is not very high when measuring with this method.

Therefore, it is recommended to use the comparison method when measuring resistances. In this method, the value of current and voltage passing through the conductor is not measured. This method is implemented using a constant current bridge Wheatstone bridge.[7]

The value of the unknown resistance R_x can be measured with great accuracy by comparing it with the value of another known resistance R with very high accuracy. During the experiment, a voltage U is applied to a conducting wire with a length of 1 m and a constant cross-section. The ends of the wire are connected to an unknown resistance R_x and to a variable resistance R whose resistance is known with high accuracy and connected in series (Figure 2). A sliding contact mounted on the conductor wire divides the wire into two parts with lengths l_1 and l_2.

If the current passing through the ammeter, which serves as a zero indicator, is equal to zero

$$R_x = \frac{l_1}{l_2} \cdot R_0 \qquad \overline{R} = \frac{\sum_{n=1}^{10} R_n}{10} \qquad (8)$$

will be equal to.

Therefore, the zero-balance method of resistance measurement does not depend on the current flowing through the resistance and can be isolated using an unstabilized current source. For this experimental configuration, the best measurement accuracy can be achieved by symmetrical connection, that is, when the sliding contact conductor is located in the middle of the wire, and therefore, the parts l_1 and l_2 have the same length. Then R_x=R (2). Therefore, the value of the known resistance R should be measured as accurately as possible. Because the determined R_x resistance is equal to it. As an alternative to the above, in order to measure the unknown resistance directly by equation (5), the moving contact must first be placed at the center of the wire, and the value of the variable resistance R should be zeroed by the ammeter. it should be changed until it is done. In this case, the value of resistance R is directly equal to the value of the unknown resistance R_x, which is being sought.[8]

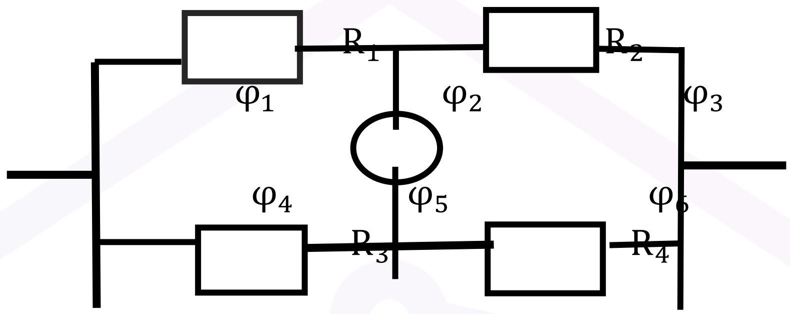
In the picture below, we see another view of the Wheatstone Bridge. The following expressions can be written for the scheme:

$$\begin{cases} \varphi_2 - \varphi_1 = R_1 \cdot I_1 \\ \varphi_3 - \varphi_2 = R_2 \cdot I_1 \\ \varphi_4 - \varphi_5 = R_3 \cdot I_2 \\ \varphi_6 - \varphi_5 = R_4 \cdot I_2 \end{cases} \qquad \begin{cases} \varphi_1 = \varphi_4 \\ \varphi_2 = \varphi_5 \\ \varphi_3 = \varphi_6 \end{cases} \qquad (9)$$

If we perform mathematical operations on the expressions,

$$\frac{R_1}{R_3} = \frac{R_2}{R_4} \qquad (10)$$

is formed. So, it can be seen that no current passes through the circuit.



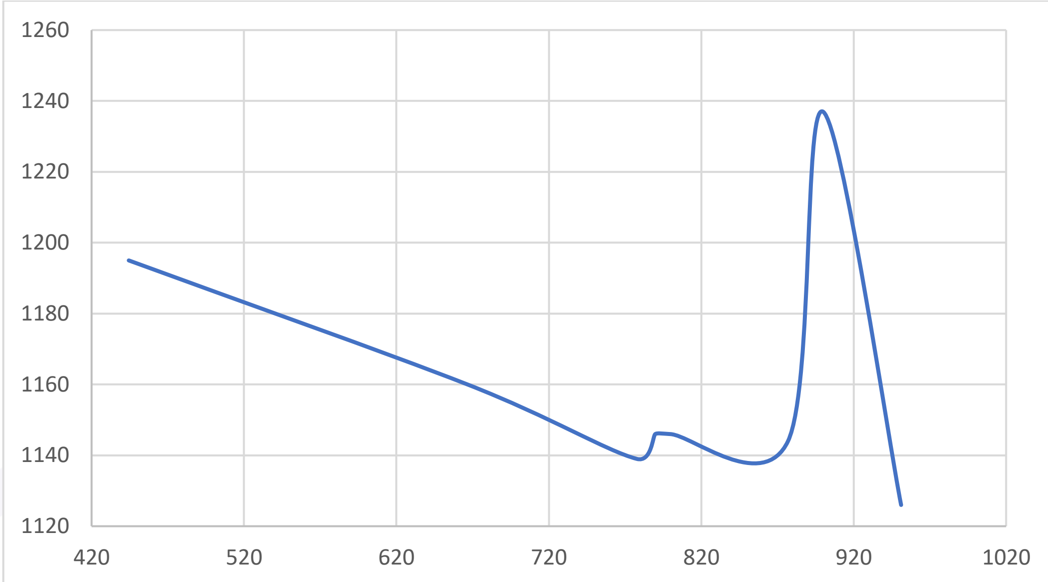
Picture 3.

III. Results

Due to the fact that the measuring instruments we use and our sense organs are not very well developed, the results of any measurement have only a certain level of accuracy. Therefore, the measurement results give us only the approximate value of the measured quantity, not the actual value. The absolute error ΔR=928.4, and the relative error ε=9.284% in determining the unknown resistance in the Wheatstone bridge in the 1st method. The reason for these values is external influence, room temperature, internal resistance of objects (cables).

And in the 2nd method, by selecting R in the set of resistances, when bringing the current to zero value, the ammeter shows I=0A at the given R=998Ω value, when the lengths l_1 and l_2 are taken from exactly 50cm.

№	R_x (Ω)	R(Ω)	l_1,(m)	l_2(m)	ΔR	ε	
1	1195,4524	444,4	0,729	0,271			
2	1159,70137	666,6	0,635	0,365			
3	1138,84324	777,7	0,596	0,404			
4	1145,98,431	789,8	0,592	0.408			
5	1146,04209	799,7	0,589	0,411			
6	1143,60691	876,9	0,566	0,434			
7	1237,49216	899,8	0,579	0,421			
8	1125,53755	951,1	0,542	0,458			
9	1129,70531	997,8	0,531	0,469			
Medium					928,4	9,2 %	



Graph 1. Graph of dependence of Rx on R.

In this experiment, we saw how to find the unknown resistance through the Wheatstone bridge. In the experiment, in method 1, the sliding contact acts as a zero indicator, so that no current passes through the ammeter, that is, I = 0, and in method 2, the sliding contact When the conductor is located in the middle of the wire, when l_1=l_2 is equal, the best measurement accuracy for the experimental configuration is R_x=R. As long as it does not depend on the current flowing through the resistance in the zero balance method of measurement.

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