LABORATORY REPORT

Calculus Physics 2

PH422 / C3

Spring 2021

EXPERIMENT # 08

EXP. TITLE: Ohm's Law Study and Wheatstone Bridge

EXP. DATE: 03 /24 /2021

REPORT SUBMISSION DATE: 04 / 06 /2021

STUDENT NAME (Last / First) : Mahfujur Rahman

PARTNERS NAMES:
1. N/A
2. N/A
3. N/A

Number of pages (including cover page): 12

GRADE % : ____

Ohm's Law

1. Introduction

Title.

Audience: instructor,
To inform the knowledge of particular Topic.

Ohm's law basically is used to validate the relationship between voltage, current, and resistance in electrical circuits. Ohm's Law states that the total current in a circuit (I) is equal to the total impressed voltage (E)divided by the total series resistance (R). Then we will use an ammeter to measure the current, I, through the resistance and a voltmeter to measure the potential difference, V, across the resistance. In this particular experiment, the voltage would be checked within the series resistor and parallel resistor.

Objective:

To study Ohm's Law with resistors connected together

introduction

2. Theory:

Theoretical Background:

A voltage V applied to a resistor with a resistance value R would generate an electric current I through that resistor. Ohm's Law states that V = I *R. Voltage is the cause with the generated current as the effect. The R values are in Ohms when V the voltage is in Volts and I the current is in Ampere. Note that a resistance value can come from several resistors connected together.

Equations used in the experiment**:**

I=VR, where I is the total circuit current in amperes,V is the total impressed voltage in volts, R is the total resistance in ohms;

$R_{series} = \sum_{i=1}^{N} R_i$

$\frac{1}{R_{parallel}} = \sum_{i=1}^{N} \frac{1}{R_i}$

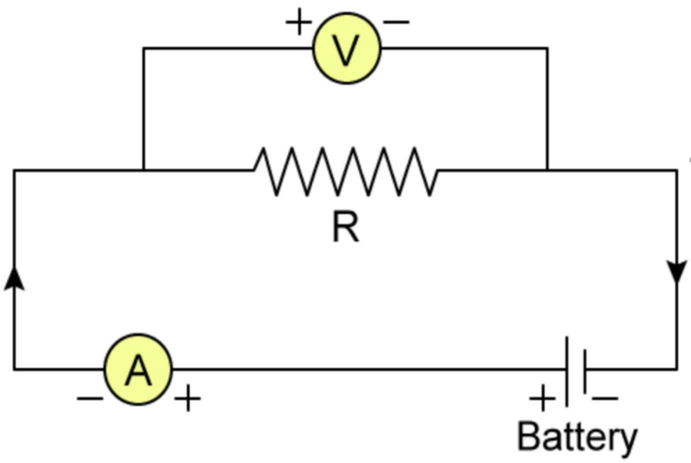
Slope $= \frac{Y_2 - Y_1}{X_2 - X_1}$

% difference $= \frac{|voltmeter\ reading - average\ IR|}{voltmeter\ reading} \times 100\%$

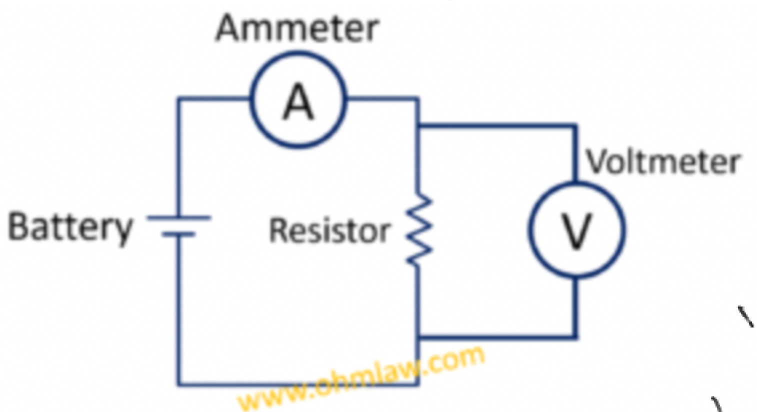
equation / metods

Diagrams:

Missing Abstract



illustration



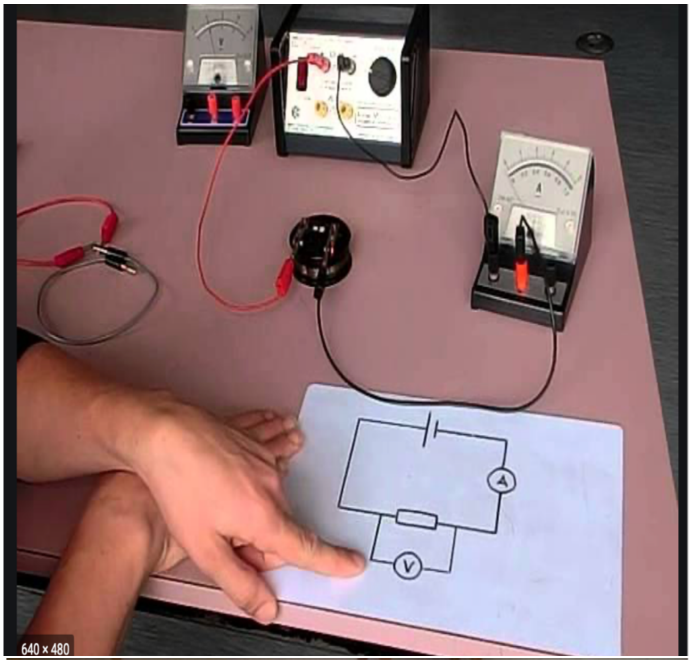
3. Experiment

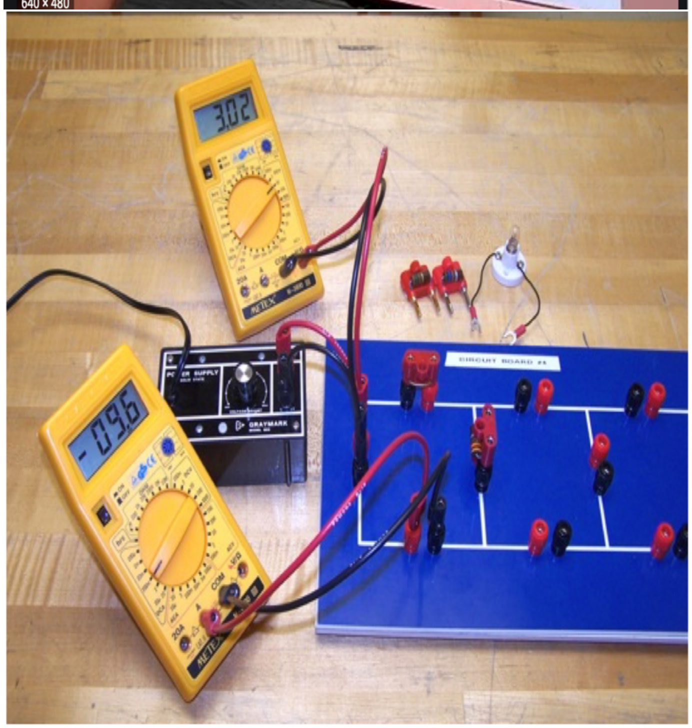
List of equipment:

- Two resistance decade boxes
- Ammeter
- Voltmeter
- power supply
- 12 wire leads

Details on what i use.

Experimental Diagrams:





Methods
Direction
To inform the reader on how The experiment was done.

Procedure:
Select resistance value on the resistance box so the resistance would not have zero resistance Make sure the power supply is off.

Part I Single variable resistor:
Set up a circuit with a power supply and a resistance decade box. Insert an ammeter in the current path to measure the electric current. Use the voltmeter to measure the power supply output voltage, connect the voltmeter in parallel. Select the lowest on the power supply would do. Turn on the power supply.

Part II Two resistors connected in Series:

Connect two resistance boxes together in a series configuration.

Part III Two resistors connected in Parallel:
Connect two resistance boxes together in a parallel configuration.

Table to show Data

4) **Results**
Data Tables:

Part 1: Single variable resistor
I=V(1/R)

Table 1: V=3.3V

Resistance (Ohms)	1/R [s]	Current I=[mA]
100	0.01	28 mA
150	0.0067	18 mA
200	0.005	13 mA
250	0.004	10 mA
300	0.0033	8 mA

Table-2:

Resistance (Ohms)	Current , I		IR (V)
	mA	A	
100	28	0.028	2.8
150	18	0.018	2.7
200	13	0.013	2.6
250	10	0.01	2.5
300	8	0.008	2.4
		Average =	2.6

Calculation of 2nd row: V = IR

1) 0.018 A x 150 Ω = 2.7 volt
2) % difference = $\frac{|voltmeter\ reading - average\ IR|}{voltmeter\ reading} \times 100\%$

% difference = $\frac{|3.3\ V - 2.6\ V|}{3.3\ V} \times 100\%$= 21.2 %

Part-2: Two resistors connected in Series
Table-3:

Resistance (Ohms)	Current , I		R-total (Ohms)	IR-total (V)
	mA	A		
50 @ 60 in series	26	0.026	110	2.86

70 @ 80 in series	18	0.018	150	2.7
100 @ 110 in series	12	0.012	210	2.52
150 @ 180 in series	9	0.009	330	2.97
200 @ 250 in series	7	0.007	450	3.15
		Average	=	2.84

Calculation of 3rd row: $R_{series} = \sum_{i=1}^{N} R_i$

1. R-total = 100 Ω + 110 Ω = 210 Ω
2. V = IR = 0.012 A x 210 Ω = 2.52 volt
3. % difference = $\frac{|voltmeter\ reading - average\ IR|}{voltmeter\ reading} \times 100\%$

   % difference = $\frac{|3.3\ V - 2.84\ V|}{3.3\ V} \times 100\%$= 13.94%

Descriptive equation to show the calculation

Part-3:

Table-4: Two resistors connected in Parallel

Table 4:

Resistance (Ohms)	Current (Ampere)	R Total [Ω]	IR –total
50 @60 in parallel	0.14	27.3Ω	3.82 V
70 @30 in parallel	0.17	21Ω	3.57 V
100 @50 in parallel	0.10	33.3Ω	3.33 V
150 @100 in parallel	0.06	60Ω	3.60 V
200 @250 in parallel	0.02	111.1Ω	2.22 V
			Average =3.3087 V

Calculation of 1st row: 1/R-total = 1/R1 + 1/R2 or R-total = $\frac{R_1 R_2}{R_1 + R_2}$

1. R-total = $\frac{50\ x\ 60}{50\ +\ 60}$= 27.2727 Ω
2. IR-total = 0.14 A x 27.2727 Ω = 3.818 volt
3. % difference = $\frac{|voltmeter\ reading - average\ IR|}{voltmeter\ reading} \times 100\%$

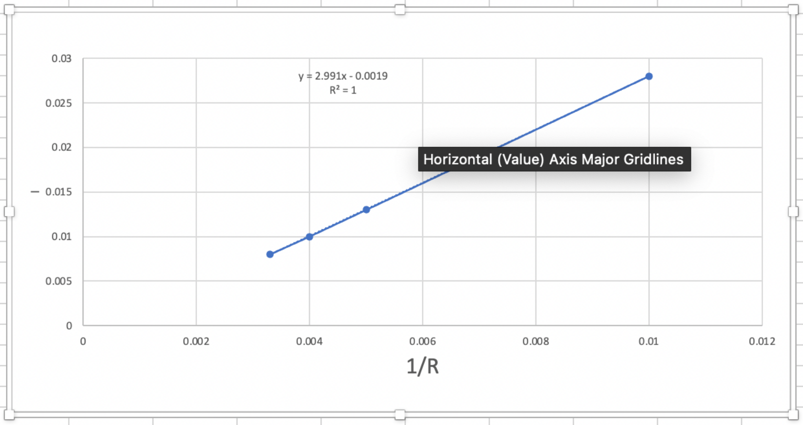
   % difference = $\frac{|3.3\ V - 3.31\ V|}{3.3\ V} \times 100\%$= 0.30 %

Graphs:

Part-I: Plot I vs 1/R

a graph

I	1/R
0.01	0.028
0.00667	0.018
0.005	0.013
0.004	0.01
0.0033	0.008



Ohm's Law states that V = I *R. Since the relationship between current, I and 1/R is linear, this can be expressed as below:

$$I = V\left(\frac{1}{R}\right),$$

where V is the slope of that equation. Therefore, the slope of the above graph is 3 which is equivalent to V.

Calculation:

1. Slope determination:

$$V = \text{slope} = \frac{0.008 - 0.028}{0.0033333 - 0.01} = 2.99 \approx 3$$

Describing how can be improve

5. Discussion of results:

Possible source of errors: Some possible sources of errors include the wire leads not being completely attached to the other equipment, which may result in an incorrect result. Another error might be the multimeter's accuracy, or the use of some inaccurate instrument in the experiment, which would result in a loss. Another potential cause of error during the experiment is the use of a variable DC power supply. As a result, the measured results for the result method will be wrong. Explaining what he observe differently/expected observation

Observations:

In part-I, as the resistance value increases, the current decreases. Furthermore, the reciprocal of resistance and current has a linearly proportional relationship, with the voltage around the resistor acting as the slope. As the resistance inside the circuit increases, the voltage across the resistor decreases slightly. Part II connects the two resistors in a series configuration, effectively increasing the overall resistance value. As a consequence, R-total rises in a series within the electrical circuit. Also, the R-total, decreases as the resistors are connected in a parallel configuration. To put it differently, the R-total is less than the combined resistance of two resistors.

Suggestions for improved results: Bad formatting

Use Passive voice mostly

Conclusion

In order to improve the experiment's outcome, double-checking your setup and ensuring that the voltage is exactly on the appropriate value are some ways to boost your performance. The accuracy of the multimeter should be double-checked since low-quantity multimeters produce incorrect results and are therefore unsafe to use.

6. Conclusions:

In this experiment, we were able to determine the total current flowing through a series circuit and parallel circuit, the voltage across each resistors and the current flowing through a series circuit and parallel circuit, to investigate the relationship between the voltages across each resistor and the total voltage and the relationship between the current flowing through each resistor and the total current. We were able to determine the current and voltage through a series and parallel circuit by using Ohm's Law. The R values are in Ohms when V the voltage is in Volts and I the current is in Ampere.

Missing Abstract again and Report.

Wheatstone Bridge

1. Introduction:

Wheatstone bridge gives a precise method to measure resistance against a known standard. Within a Wheatstone bridge, a comparative device measures two additional relative resistances from two separate resistors. The relative resistance equals the lengths of a divided wire wound in a coil of ten-turns within a potentiometer, a device allowing the manipulation of this resistance ration. Thus, the Wheatstone bridge utilizes repetitive comparisons of potentials to find the equipotential settings. In this experiment, the unknown resistance will be measured by manipulating the paths of current can take through the Wheatstone bridge grid.

Good introduction

Objective:

To measure resistance by use of the slide wire Wheatstone Bridge and to measure resistances in combination.

Objective established.

2. **Theory**

Theoretical Background:

The various phenomena of current electricity are h many instances analogous to those of flowing water. The electric current corresponds to the rate of flow of water and the difference of potential in an electric circuit corresponds to a difference of hydraulic pressure. Whenever there is a difference of potential between two points connected by a conductor, a current will flow, If there is no flow of current between two points connected by a conductor, the two points must be at the same potential.

This could be intro and could make intro abstract.

Equations used in the experiment:

I = E/R

$V_{AB} = V_{AD}$ and $V_{BC} = V_{DC}$

$\frac{I_1}{I_3} = \frac{R_3}{R_1}$

$\frac{I_2}{I_4} = \frac{R_4}{R_2}$

$\frac{R_3}{R_1} = \frac{R_4}{R_2}$

$R_{wire} = \rho \frac{L}{A}$

$X = R(\frac{L_1}{L_2})$,

where X is the unknown resistance.

Diagrams:

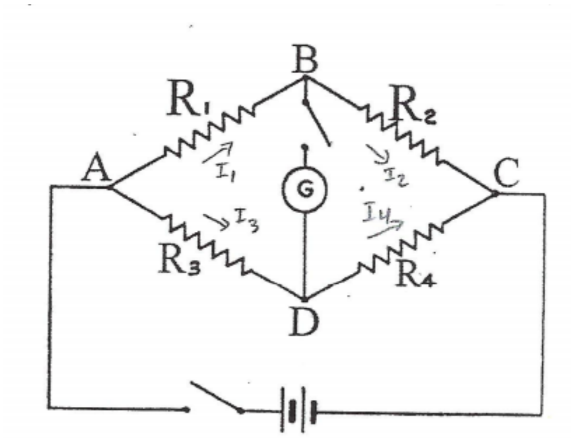


Figure-1

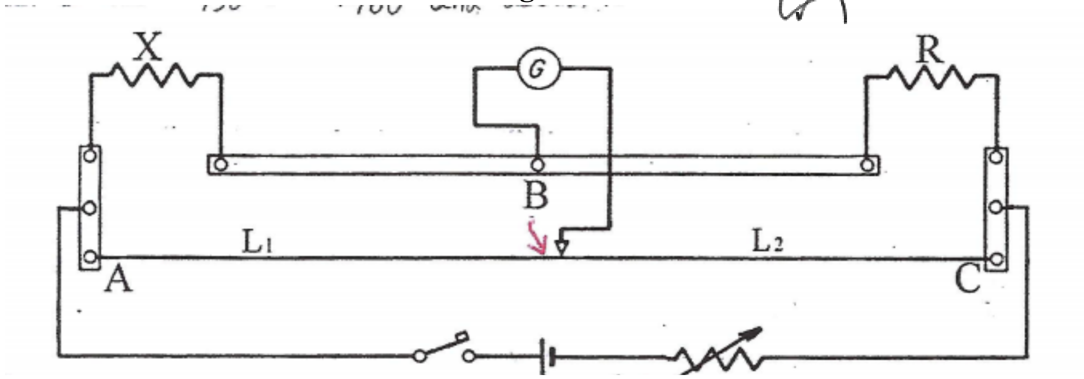


Figure-2

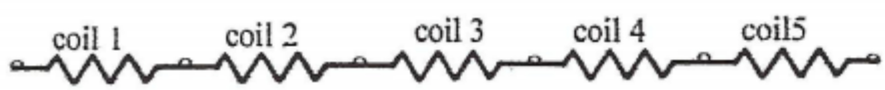


Figure-3

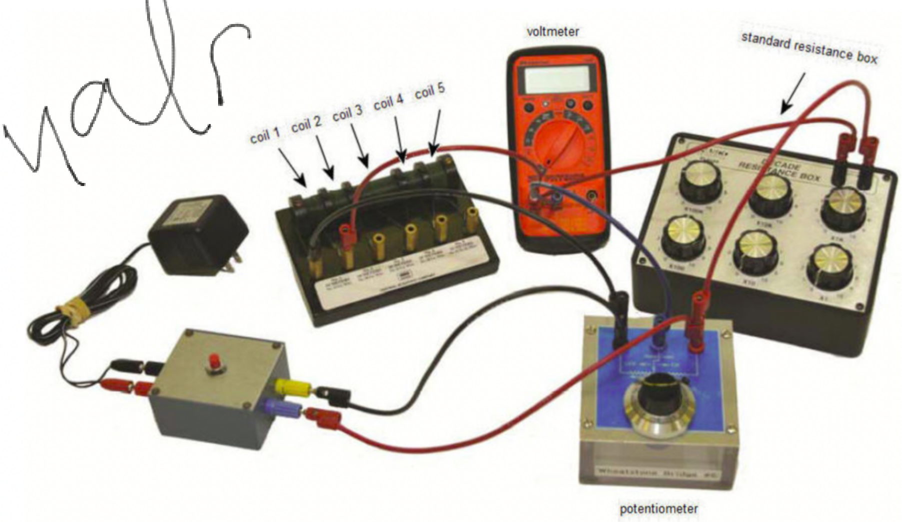
<u>3. Experiment</u>

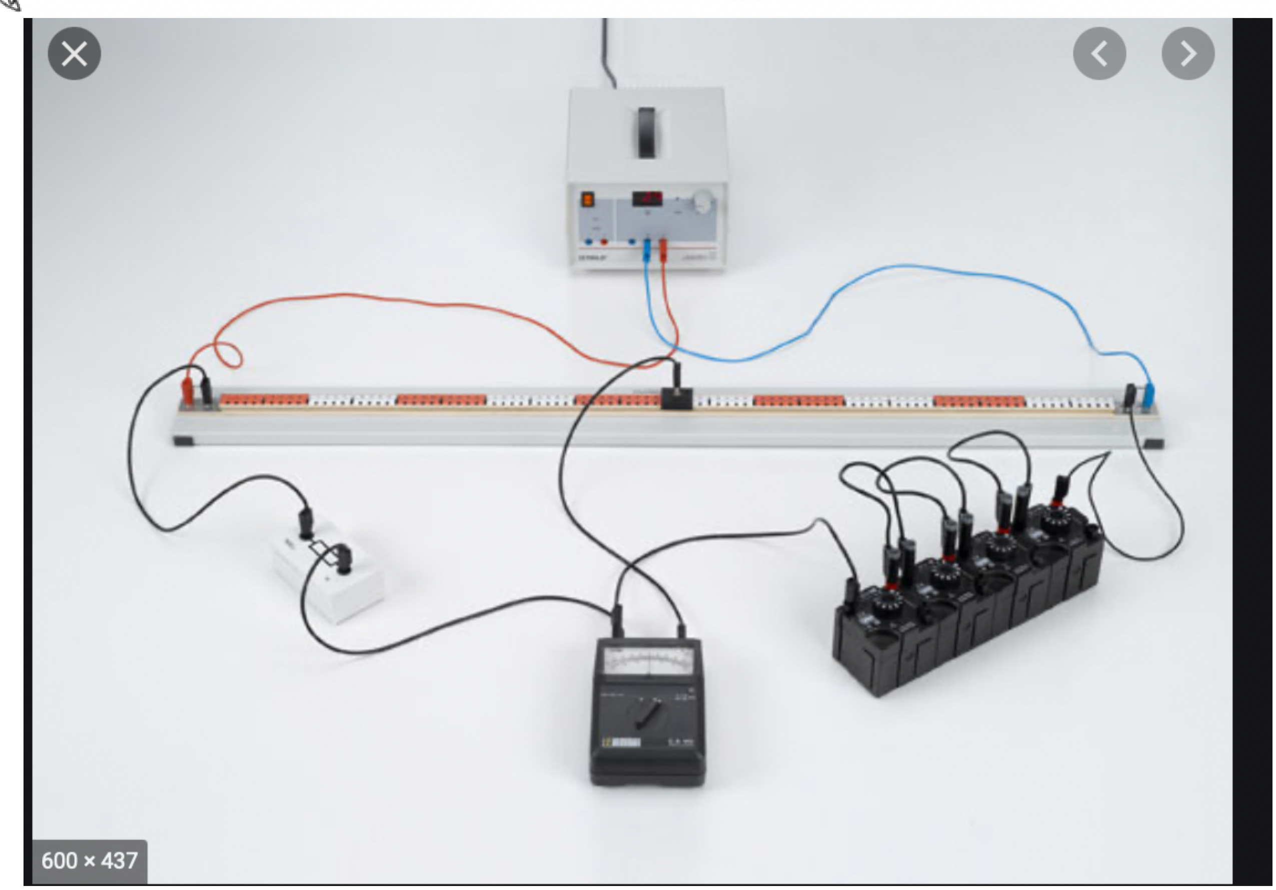
<u>List of equipment</u>:

- Wheatstone Bridge (slide wire form)
- Three-button galvanometer
- A resistance box
- A box battery
- An unknown resistance
- s.p.s.t switch
- 33-ohm rheostat
- Screw Gauge

Experimental Diagram(s):

Visuals





Procedure:

The slide wire was connected to the Wheatstone Bridge as shown in the figure-2. The resistance had been measured as the following sequences (by following figure-3):

a. Coils 1,2,3,4,5 individually. The coils are mounted on a common base so as to have common terminals.
b. In the series of coils 1,2 and 3.
c. In the series of coils 4 and 5.
d. In the series of coils 1, 2, 3, 4, and 5.
e. In parallel of coils 3 and 4.
f. In parallel of coils 4 and 5.

Methods

4. Results

Data tables:

Table-1:

Data.

Coil Number or Coil Combination	R (Ohms)	L_1(cm)	L_2(cm)	X (Ohms)
1	4	6	94	0.255
2	4	28	72	1.556
3	3	25	75	1
4	7	40	60	4.667
5	14	40	60	9.333
1, 2, 3 in series	4	40	60	2.667
4 and 5 in series	20	40	60	13.333
1, 2, 3, 4, 5 in series	23	40	60	15.333
3 and 4 in parallel	2	9	1	18
4 and 5 in parallel	3	40	60	2

Calculation of 8th row: $X = R(\frac{L_1}{L_2})$

$X = 23\ \Omega \times \frac{40\ cm}{60\ cm} = 15.33\ \Omega$

Table-2:

Coil Combination	Bridge Measurement X (Ohms)	Resistance Calculated Analytically	% Error
1, 2, 3 in series	0.53	3.72	28%
4 and 5 in series	2.13	14.36	7%
1, 2, 3, 4, 5 in series	1.06	18.08	15%
3 and 4 in parallel	4.26	3	83%
4 and 5 in parallel	10.10	3	33%

Calculation of 2nd row:

1. Resistance calculated analytically = $R_4 + R_5$= 4.26Ω+10.10Ω= 14.36Ω
2. % error = $\frac{|15.33-14.36|}{14.36} \times 100\%$= 7%

5. Discussion of results

Possible source of errors: One possible error is if the galvanometer is less sensitive, which would result in balance point inaccuracy. Another possible cause of error is self-heating. If self-heating happens during the process, the bridge's resistance can change. If there is a thermal electromotive power, the calculation would give lower resistance values, which could cause serious problems in the Wheatstone bridge. If the Wheatstone bridge is unbalanced, the experiment could be held open to other forms of errors. It will then give you incorrect readings. Furthermore, an error may be caused by the null detector's inefficiency. Outside of the bridge, contact or lead resistance may cause a visible error in the experiment.

Observations:

When doing this lab, some observations that came up were that in the second data table, we can see that the percentage error are high in the first coil, then at the third coil the percent error is the lowest, and it goes back up a high percent error at the fifth coil. The reason for this is because the balance point's center is probably at coil #3 making it the most accurate for the resistance.

Suggestions for improved results:

We need to reduce the amount of error that occurred during the experiment in order to boost the performance. To properly balance the Wheatstone bridge, unique specific reference resistances are needed. To reduce the uncertainty in the experiment, the highest quality galvanometer should be used. By calculating the resistance in a short period of time, the error caused by self-heating of resistance can be decreased. The thermal effect in the experiment could be minimized by connecting the reversing switch between the battery and the bridge.

6. Conclusions:

In conclusion, we were able to become familiar with Wheatstone bridge method of measuring resistance, to determine resistivity of metal conductor and to study the phenomenon that the resistance of a wire varies directly with its length and inversely with its cross-sectional area.

Audience - instructor Professor

Purpose - to inform the student knowledg on topic

Key things missing

Reference.