Faculty of Natural and Applied Sciences
Department of Physics

PHY 108
Electricity and Magnetism Experiment
Experiment 2: Wheatstone Bridge

STUDENT NAME:

STUDENT ID:

DEPARTMENT:

DATE OF EXPERIMENT:

GROUP:

OBJECTIVES:

1. Determination of the resistance of a wire as a function of its cross-section.
2. Determination of unknown resistances.
3. Determination of the total resistance of resistors in series, resistors in parallel.

NEEDED EQUIPMENT

PHYWE Power supply 0-12 V DC/ 6 V, 12 V AC, 230 V 13505-93 1
Digital multimeter 2005 07129-00 2
Connection box 06030-23 1
Connecting cord, 32 A, 2000 mm, yellow 07365-02 2
Connecting cord, 32 A, 750 mm, yellow 07362-02 2
Connecting cord, 32 A, 750 mm, blue 07362-04 1
Connecting cord, 32 A, 500 mm, red 07361-01 2
Connecting cord, 32 A, 500 mm, blue 07361-04 1
Connecting cord, 32 A, 250 mm, red 07360-01 1
Connecting cord, 32 A, 250 mm, blue 07360-04 1
Connecting cord, 100 mm, yellow 07359-02 2
Resistances R_1, R_2, R_3, R_4, R_5 and R
Meter Bridge
Conductor wires with different diameters

THEORETICAL BACKGROUND

The Wheatstone Bridge circuit is a **two simple series-parallel** arrangements of resistances connected between a voltage supply terminal and ground producing zero voltage difference between the two parallel branches when balanced.
With branched circuits, in the steady-state condition, Kirchhoff's 1st law applies at every junction point:

$$\sum_v I_v = 0$$

where I_v are the current values which lead to or from the junction point.
It is customary to take I_v as negative if the corresponding current in the v-th conductor is flowing away from the junction point.
For every closed loop C in a network of linear conductors, in the steady-state condition, Kirchhoff's 2nd law applies:

$$\sum_v (I_v R_v - U_v^e) = 0$$

where R_v is the resistance in the v-th conductor and U_v^e the voltage.
For the Wheatstone bridge circuit, one obtains

$$R_x = R.\frac{R_1}{R_2} = R.\frac{l_1}{l_2}$$

for an unknown resistance, R_x with the designations of Fig. 2, in the balanced condition.

R_{x1}	268	Ω
R_{x3}	15.0	kΩ
R_{x8}	4.81	kΩ
R_{x13}	151	Ω
R_{x16}	682	Ω

Table 1: Resistances measured with the Wheatstone bridge.

From (1) and (2), there follows

$$R_{tot} = \sum_i R_i$$

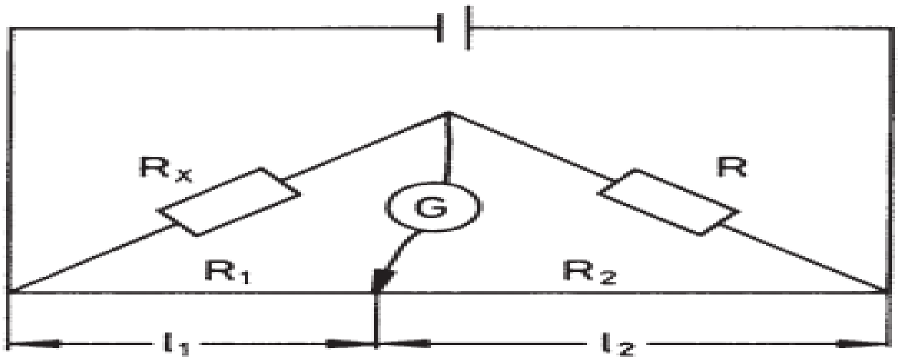


Fig. 2: Wheatstone bridge circuit.

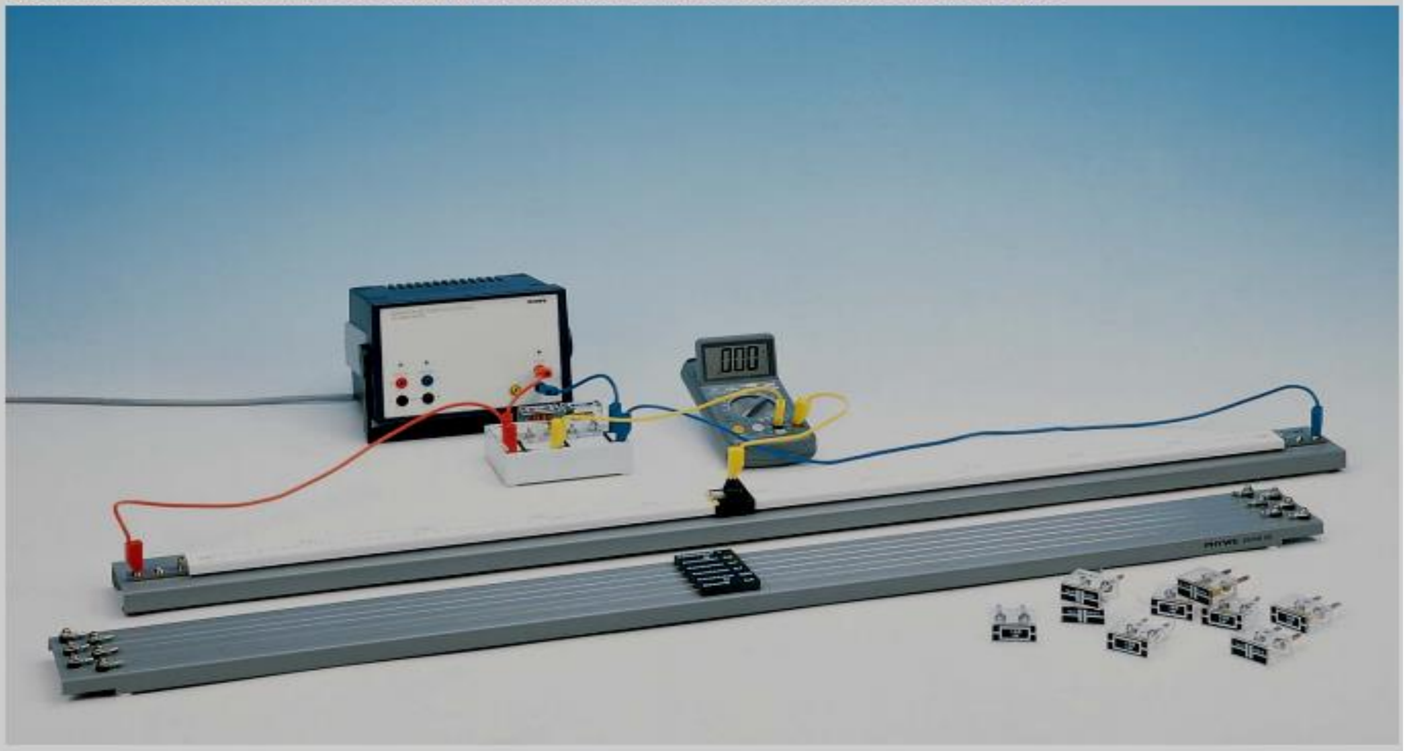
SETUP AND PROCEDURE:

1. Connect the circuit as shown in fig. 1.
2. The resistance to be investigated (series-connected and wire resistances) are shown in Fig. 2 as R_x
3. Ensure to balance the measuring resistance (R=1000KΩ) to the order of magnitude of Rx by moving the slider of the meter bridge until the voltmeter balances to zero.
4. At zero reading of the voltmeter, read and record the value of L_1 and L_2 (either sides of the slider) on the meter bridge
5. Repeat the experiment for Rx= R_1, R_2, R_3, R_4, and R_5 and record the corresponding L_1 and L_2 respectively
6. Tabulate your reading as shown in the table and calculate the resistances of R_1, R_2, R_3, R_4, and R_5

TASK II

7. Connect the source in series to conductor wires with different diameter.
8. Change the multi-meter function from voltage to resistance.
9. Vary the diameter of the conductor as you record the resistance of each of the diameters provided
10. Plot the graph of Resistance against conductor wire radius and evaluate the slope
    NB The power unit is so designed that resistances from milliohms to Mega ohms can be investigated, but in the milliohm, range the resistances of the connecting leads must be taken into account. Through the pilot light, the power unit is short-circuit proof. R is maintained as 1KΩ throughout the experiment.

Fig. 1: Experimental set up for determining an unknown resistance with the Wheatstone bridge.



DATA

R_x (Ω)	L_1 (mm)	L_2 (mm)
R_1		
R_2		
R_3		
R_4		
R_5		
R_6		

S/N	Diameter (mm)	Conductor wire radius (mm)	Resistance (Ω)	Resistivity (Ωm)	Conductivity (S/m)
1	1.0				
2	0.7				
3	0.5				
4	0.35				

Instructor signature and Date____

TITLE: **SCALE:**

CALCULATIONS:

1. Calculate the percentage error for each of the resistor if the real values of the resistors are given as:

R_1= 100Ω
R_2= 150Ω
R_3= 220Ω
R_4= 330Ω
R_5= 470Ω
R_6= 680Ω

2. A car headlight filament is made of tungsten and has a cold resistance of 0.451Ω. If the filament is cylindrical in nature and is 3.6m long. What is its cross-sectional area?

PRECAUTIONS:

State the Precautions taken to ensure accurate result

SHOW YOUR WORKINGS HERE