Name: T. Signature Marks
Date: Group:

Objective
To verify Ohms low and find an unknown resistance.

Theory
Ohm's law is applied in our every-day life in electrical appliances that we use, such as light bulbs and heaters. The German scientist Jorge Simon Ohm in (1787-1854) stated that the amount of electric current (I) through a conductor in a circuit is directly proportional to the potential difference, voltage, (V) across it. Also, the quantity (V/I) is a constant for a given metallic conductors under steady physical conditions (temperature), this quantity is known as its resistance.
Ohm expressed his finding in a simple equation, describing how voltage, current, and resistance related to each other:

$$\boldsymbol{R = \frac{V}{I}}$$

If the potential difference is measured in Volts (V) and current in Amperes (A), the resistance will be in Ohms (Ω).

You must note that the resistance of a metallic conductor depends only on its length, the area of cross-section, the material of the conductor and its temperature. It does not depend on either V or I.

Equipment

1- DC power supply. 2- Resistor (150-250). 3- Voltmeter. 4- Ammeter.

PROCEDURE

1) Connect the circuit as shown in Fig.1.

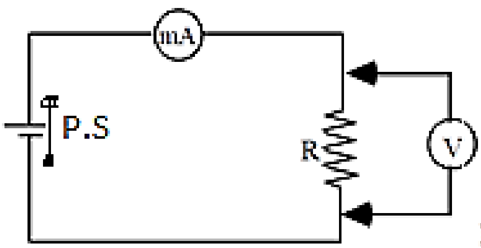


Figure 1.

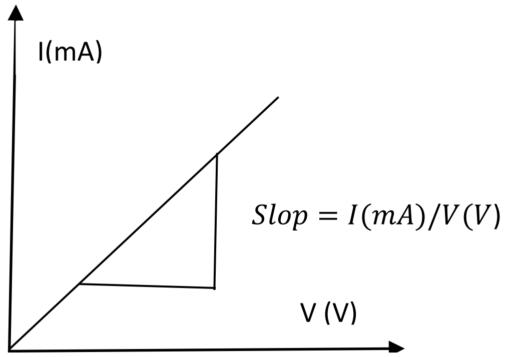
- Note: The voltmeter does not have to be connected to the circuit. You can measure the voltage across any two points by touching the points with the two leads of the voltmeter.

2) Set the value of the voltage of the DC power supply to $1V$ then record the ammeter readings and the voltage across the resistor.

3) Do the same for other voltages.

Table 1

$V_{(power\ supply)}$(V)	I (mA)	V_{load} (V)
1		
2		
3		
4		
5		
6		
7		



1) Use linear graph paper; plot a curve between the voltage values on x-axis and current values on y-axis.
2) Find the slope. The slope represents the conductance (G) of the material and the inverse of it is the resistance: $R = 1/G$
3) Compare this with the actual value.

Questions

Q1) What is the physical significance of the resistance?
Q2) What does the resistance depend on?
Q3) What do the materials called when the resistance is zero?

Name: T. Signature Marks
Date : Group:

Objective
Determine the force between charged parallel plates.

Physics background

When an electric potential difference is applied between two parallel plates each plate receives a charge $\pm q$ and each plate exert an electrical attraction force (F_{att}) on other. The amount of this force depends on the amount of the difference in the voltage V and distance d between them. The voltage difference V between the two plates can be expressed in terms of the work done on a positive charge q when it moves from the positive to the negative plate.

$$V = \frac{work\ done}{charge} = \frac{F_{att}d}{Q}, \qquad then \qquad \boldsymbol{F_{att} = Q\left(\frac{V}{d}\right)}$$

$$F_{att} = QE, \qquad where\ E = V/d.$$

In this experiment, the two plates are of circular plates where the upper one is fixed and the lower one is free to move up and down.
Rotational equilibrium is established by adding mass m to the mass pan attached to the lower plate and/or applying a voltage between the plates.
When the balance arm is levelled, both gravitational force F_g for the mass m and the electrical force F_{att} are the same. The equation of rotational equilibrium is

$$F_g = F_{att}$$
$$\boldsymbol{mg = Q(V/d)}$$

Equipments
1- Triple beam balance. 2- circular plate. 3- power supply (high voltage)
4- wires

Important notes
1. The balance is sensitive to very small forces, air currents and vibrations so avoid sudden movements, such as flipping of pages, which may generate air currents.
2. Avoid touching any plate or the connecting cable while making your measurements
3. Don't move the balance!
5. Do not apply voltage higher than 3500 v as a spark may occur between the plates.

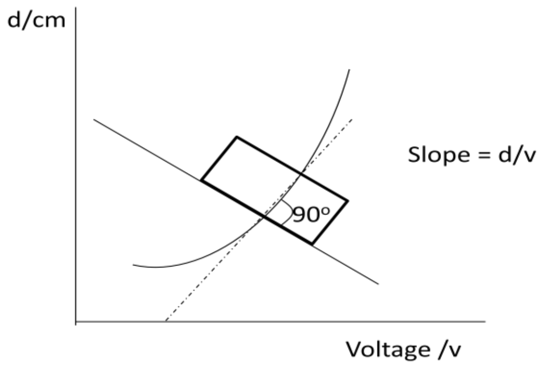
Procedure: Calibrating the balance

1. Check to see whether the plates are parallel to each other.
2. Place 2 g on the mass pan (it is already on). Poise the balance to a position that brings the pointer to a rest at highest level possible but make sure that the **pointer swings freely along the scale**.
3. Record the reading of the pointer on the scale and put it as a zero point (X_0).
4. Set the power supply voltage to 500 volts and record the pointer reading as (X) in the table below.
5. Change the voltage supply to the other values as in the table. Record the pointer reading for each voltage.

X_0 = cm

Voltage/V	Pointer x	Distance d =(X_0 –X) cm
500		
1000		
1500		
2000		
2500		
3000		
3200		
3500		

6. Plot a graph between the distance (y-axis) and voltage (x-axis) and draw a best curve fit between the points.
7. Find the tangent of the curve at the point 2000v. To do this: place a mirror (or a metal ruler) on that point (as in the figure), now you see the reflection of the curve on the mirror. Keep adjusting the mirror until the reflection just coincide with the opposite side of the curve. Draw a line along the mirror. Now the tangent is a line perpendicular to this line at this point.
8. Find the slop of the tangent.
9. Use the relation $mg = Q(V/d)$ to find out the charge q on the plates.
10. Use $F_{att} = Q\left(\frac{V}{d}\right)$



Questions

Q1) How does the error in the distance between plates influence results?

Q2) When two objects attract each other electrically, must both of them be charged? And when they repel each other must they be charged?

Q3) If you had two charged plates with twice the diameter of the lab apparatus, with the same separation distance and same V, how would the force between the plates change? What would you have to do to the separation distance between the plates to make the force between the plates the same as the lab apparatus?

Exp. (3) STUDY OF ELECTRIC FIELD AND ELECTRIC POTENTIAL BY PROBE

Name: T. Signature Marks: ( )
Date: Group:

Objective

To work out a theoretical model of electrostatic field (electric field lines) of electric dipole

Theory

Any static (not moving) electric charge creates an electrostatic field in space around it, as shown in figure (1). If a charge is placed in the field, an electrical force is exerted on it by the field and would move it towards or away from it.

Such an action is an evidence of a field existence and allows estimating its strength.

The strength of the field of a point is characterized by a vector E, which is called electric field lines. The number of lines per unit area through a surface Perpendicular to the lines is proportional to the magnitude of the electric field in that region. Thus, E is great when the field lines are close together (means more lines for a given area) and small when they are far apart.

Numerically, magnitude of electric field E at some point is equal to the force F acting on unitary positive charge q placed at that point.

$$E = F/q \quad ------------------ \quad (1)$$

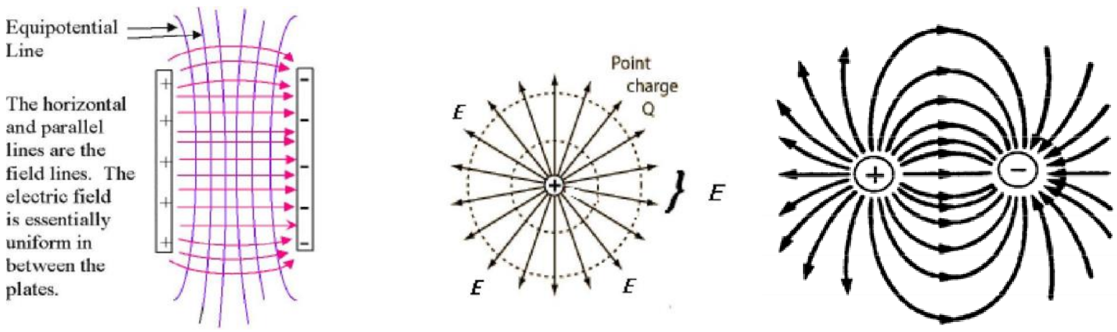


Figure (1)

Electric potential between points 1 and 2 is an energy characteristic of electric field and can be expressed in terms of the work done to move a charge q through a distance ΔL between the two points:

$$\Delta V = V_1 - V_2 = \frac{\text{work done}}{\text{charge}} = \frac{F\,\Delta L}{q},$$

$$F = q\left(\frac{\Delta V}{\Delta L}\right) \quad .... \ (2)$$

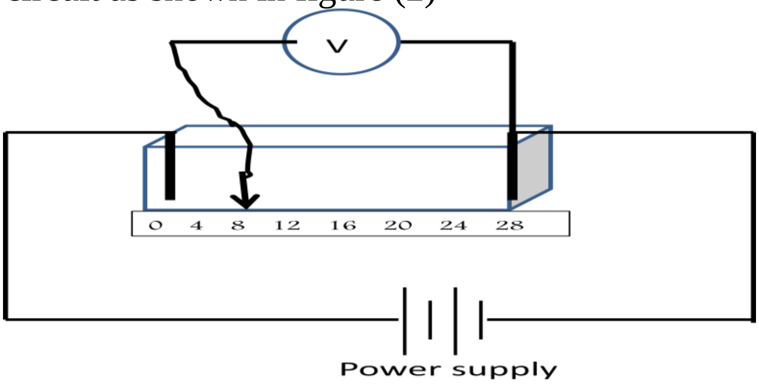
From equations1and 2 we get

$$E = \Delta V/\Delta L \quad ....(3)$$

Which is the value of electric field through a gradient of potential $\Delta V/\Delta L$, and V_1 and V_2 are voltages at point (1) and (2) respectively.

Equipment:
1) Digital Voltmeter. 2) Metallic probes. 3) Two electrodes. 4) Rectangular container. 5) Power supply. 6) a ruler.

Procedure and Analysis:
1- Connect the circuit as shown in figure (2)



Fg.2.

2- For the purpose of the conductivity, put some water in the container.
3- With the help of the ruler (put it either inside or under the container) determine the distribution of the potential along the axis by using the voltmeter. For this purpose fix one of the probes to point (0) and touch the water by the other probe along the ruler at 2 cm away and record the reading as ΔV in the table below.
4- Do the same for every 2 cm until 20-28 cm.
5- Using formula (4) calculate thee magnitude of electric field between points.

ΔL/ cm	Δv/volt	$E = \Delta V/\Delta L$ (V/cm)	ΔL/ cm	Δv/volt	$E = \Delta V/\Delta L$ (V/cm)
2			16		
4			18		
6			20		
8			22		
10			24		
12			26		
14			28		

Questions

Q1) Draw the Electric Field for dipole?
Q2) In what place or places is the Electric Field the strongest and weakest?
Q3) Why we are using water to measure electric field?

Name: T. Signature Marks: ( )

Date: Group:

Objective

Calculate the resistivity of the metal.

Theory

Resistivity is a fundamental property of a material that quantifies how strongly it resists or conducts electric current. A low resistivity indicates a material that readily allows electric current.

The resistance R of a piece of metal or a wire is given by the equation:

$$\boldsymbol{R = \rho\, l\,/A} \quad \ldots\ldots.(1)$$

Where ρ is the **resistivity** of the metal from which the wire is made, l is the length of the wire and A is its cross-sectional area.

The resistance of a component (including the wire) in a circuit is given by Ohms' law:

$$R = V/I \quad \ldots\ldots\ldots.(2)$$

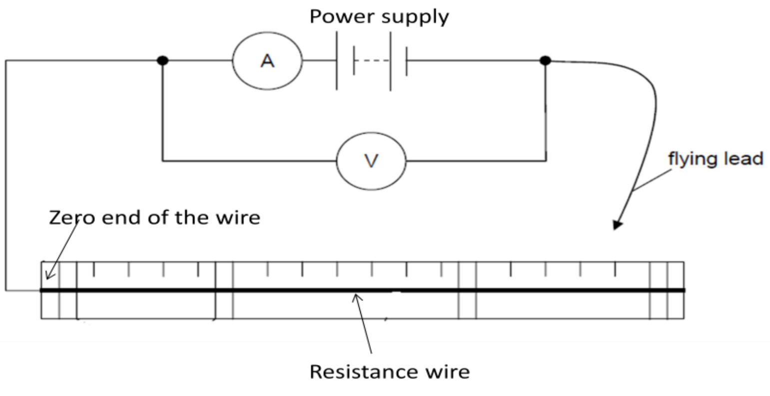
Where V is the potential difference across the component or a length of the wire and I is the current through the component.

Making use of both equations 1 and 2 and measuring the current I and voltage V for different lengths L of a wire using the circuit below, one can find the resistivity ρ of the wire.

Equipment:

1m of constantan wire of diameter d= mm,

12 V power supply, 2 multimeters, a micrometre



Procedure

1. Set up the circuit as shown in the diagram.
2. Set the power supply to 1V. This limits the current through the wire in order to reduce any heating effect (specially for short lengths) which may change the resistivity of the wire.

3. Record the readings on the ammeter and voltmeter for 7-8 different lengths (begin from 20 cm) in the table below.
4. Calculate the resistance of the wire for each length using Ohms' law.
5. Using the micrometre, measure the diameter of the wire in three different places.
   a. Calculate the average d.
   b. Determine the cross-sectional area **A** of the wire by: **A** = ¼πd ^{2}.

Length (cm)	Voltage (V)	Current (mA)	Resistance (Ω)

6. **<u>You Results</u>**
   a. Plot a graph between the resistance (y-axis) against length (x-axis).
   b. Find the slope of the curve $(= R/l)$.
   c. From eq.1: $\rho = A\,(R/l) = A \times slope.$
   d. ρ =??? (unit)

Thus by multiplying the slope of the curve by the cross-sectional area, you will get the resistivity of the wire.

<u>Questions and discussion</u>

Q1) How does the value **ρ** compared with the actual value?
Q2) Suggest ways in which the accuracy of the measurements could be improved.
Q3) What is the relation between Resistivity and Conductivity?
Q4) Does the resistivity depend on the shape and the size of the metal?
Q5) Does the resistivity depend on temperature? And how?
Q6) Which wire has higher resistivity, the common wire (copper) or Heater's wire?

University of Duhok
College of Science
Department of Physics
1st Year Students
Electricity and Magnetism Lab.
First semester

Name:
Group:
Exp. No.: 5
Exp. Date:
Mark:

Resistance Measurement (Color code and Ohmmeter)

Objective:

Apparatus:

Resistors and Ohmmeter.

Introduction:

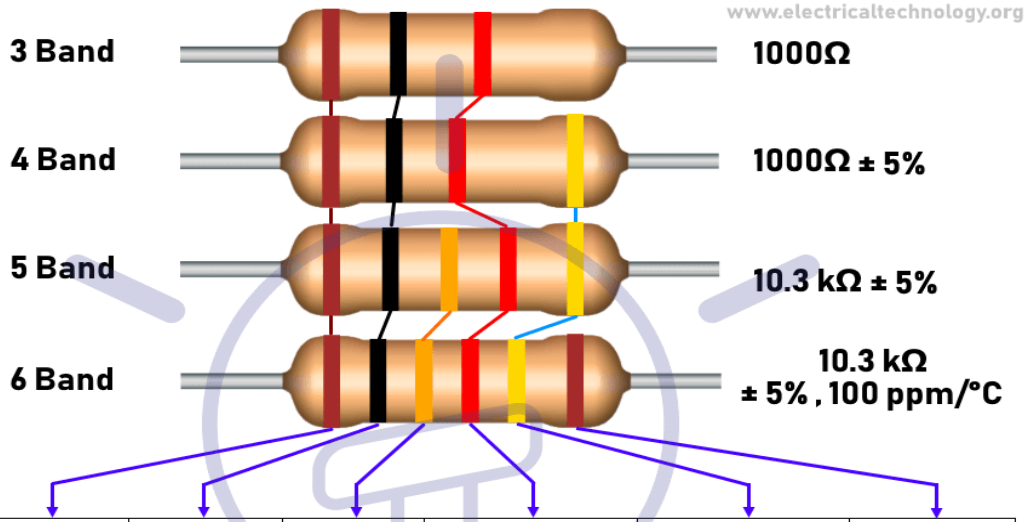
Resistance is one of the most important characteristics in any electric circuit. Resistance is the measure of electrical "friction" as electrons move through a conductor. It is measured in the unit of the "Ohm," that unit symbolized by the capital Greek letter omega (Ω). Resistors are widely used in any electronic device, there are many different types of resistors, but the most important property is their measured resistance. In this experiment we will learn two different methods to measure the resistance of any unknown resistor.

A-Measuring resistance using color code

Color coding system for resistors consists of three colors to indicate the resistance value in ohms of a certain resistor, sometimes the fourth color indicates the tolerance value of the resistor. By reading the color coded in correct order and substituting the correct value of each corresponding color coded as shown in the table (1), you can calculate the exact value of the resistor.

The color of the first and second color bands indicates the first and second digit of the resistance value or the first and second significant digit respectively and the color of the third band specifies the power-of-ten multiplier. The fourth band indicates the tolerance.

Table (1): Color coding table



COLOR	1st DIGIT	2nd DIGIT	3rd DIGIT	MULTIPLIER	TOLERANCE	TEMP .Co
BLACK	0	0	0	1Ω		
BROWN	1	1	1	10Ω	± 1% (F)	100
RED	2	2	2	100Ω	± 2% (G)	50
ORANGE	3	3	3	1kΩ	± 3%	15
YELLOW	4	4	4	10kΩ	± 4%	25
GREEN	5	5	5	100kΩ	± 0.5% (D)	
BLUE	6	6	6	1MΩ	± 0.25% (C)	10
VIOLET	7	7	7	10MΩ	± 0.10% (B)	5
GREY	8	8	8	100MΩ	± 0.05% (A)	
WHITE	9	9	9	1GΩ		
GOLD				0.1Ω	± 5% (J)	
SILVER				0.01Ω	± 10% (K)	

B-Measuring resistance by Ohmmeter

The meter that used to measure the resistance is an ohmmeter. When using an ohmmeter, there should be no voltage present across the resistors except for the ohmmeter battery, otherwise your ohmmeter would be damaged. To measure resistance the ohmmeter is simply connected parallel with resistor as shown Fig. (1).

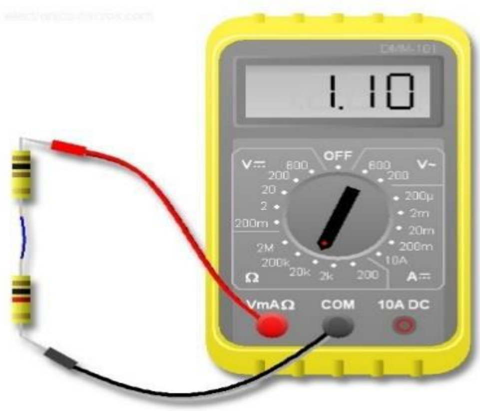


Figure (1): Ohmmeter

Readings:

Measure the value of the given resistors using color coding system and ohmmeter.

Resistors	Band 1		Band 2		Band 3		Band 4		Resistor value by color code	Resistor value by ohmmeter
R 1	Color	Color code	Color	Color code	Color	Color code	Color	Color code		
R 2	Color	Color code	Color	Color code	Color	Color code	Color	Color code		

Questions:

1-Calculate the value of the below resistors that have the following colors.

A-Yellow Violet black Gold.

B-Brown Green Orange Silver.

2- What is the difference between ohmic and non-ohmic conductors?

3- What did you learn from this experiment?