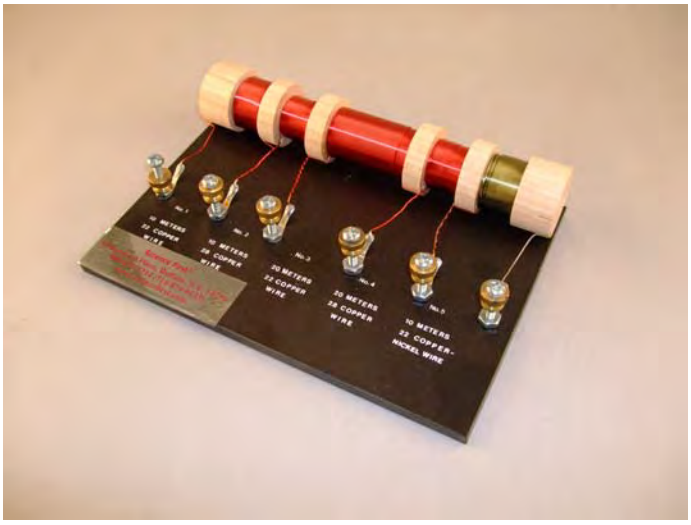
615-0340 (10-153) Resistance Coil Board



Note: you will need a multimeter capable of measuring resistance to conduct this experiment. If you do not posses such an instrument, you can use a source of known voltage, such as a power supply, and a multimeter capable of reading voltage.

Introduction: Resistivity is the bane of most applications using electricity. It robs power from our national electrical grid, produces unwanted heat inside computer circuits, and can cause signals sent over wires to degrade, polluting the information. It is generally unneeded, unwelcome, and a nuisance. There are many scientists and engineers devising ways to cost effectively eliminate it. It does have use in electric heating elements, however.

Resistance is a property of materials, and how willing they are to lose electrons. Consider the material called PTFE. PTFE is a polymer characterized by an extremely low coefficient of friction. It is a chain of carbon molecules, with two carbon atoms and two fluorine atoms making up one segment. Now, fluorine has the highest electronegativity of any element, meaning that it will readily accept electrons, but will not release them easily. Since electricity is the flow of electrons, PTFE is a resistor because its electrons refuse to flow.

On the other end of the spectrum, silver is one of the best known natural conductors. The electrons in its outermost electron shell are connected rather loosely to the atom's nucleus, which makes it very easy to strip these electrons away. Thus, electricity flows very easily along a piece of silver. Because silver has a high cost, copper is used for wiring instead. Copper is also a good conductor and does not corrode as easily as silver.

Materials called superconductors have no resistance at all. In fact, most metals will become superconductors if they are cooled enough, usually to a few Kelvin above absolute zero. Certain alloys become superconductors at higher temperatures, but they still must be cooled greatly. The cryogenic nature and high cost of superconductors means they are unsuitable for most commercial applications.

Description: Your resistance coil board uses copper and nickel wires instead of more exotic materials. There are five coils of wire present. There properties are as follows:

- 10 meters of 22 gauge copper wire.
- 10 meters of 28 gauge copper wire.
- 20 meters of 22 gauge copper wire.
- 20 meters of 28 gauge copper wire.
- 10 meters of 22 gauge copper-nickel wire.

These coils are secured to the board, and separated by wooden discs to prevent the passage of electricity from one to another. In front of the coils are six posts which you can attach your instruments to. Note: these posts serve more than one coil, so be careful to measure one coil at a time. To measure resistance, connect a multimeter which can read resistance. Conversely, first connect a known source of voltage, such as a power supply, to the first post. Connect a multimeter to the second post and measure the voltage drop. You can use this to calculate resistance.

Operation: Before using your resistance coil board, there are several key ideas that must be learned.

- resistance increases as a wire gets longer
- resistance decreases as a wire is cooled
- resistance increases as diameter decreases.

For a given temperature, this relationship can be expressed by the following:

$R = \rho l/A = 4\rho \, l / \Pi d^2$, where

p= resistivity
l= wire length

A= cross sectional area
d= wire diameter

In addition, you can use voltage drop to determine the resistivity using the formula derived from ohm's law: V/I=R, where
V= voltage
I= current
R= resitivity

The first method allows you to determine resistivity through calculation, while the second depends on experimental data. You can use one to verify the other.

The official value for the resistivity of commercial grade copper is 1.72×10^{-8}. Does your value lie close to this? Calculate the percent difference.

Do you expect the copper-nickel alloy to be a better or worse conductor than pure copper? The official value for the resistivity of nickel is 6.99×10^{-8}. Based on this, where do you expect the value of the copper-nickel wire to lie? Does your experimental data support your conclusion?

Warranty and Parts:
We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.

May we suggest:

615-4545 Unknown Resistance Board: *For use with Wheatstone Bridge.* Expand upon the concepts taught by the Wheatstone Bridge (615-4540). Assign each group a different "unknown", which are "disguised" so their value cannot be read. Our compact device features nine 1% resistors from 1 to 100 kiliohm, randomly mounted on a printed circuit board, any two of which can be connected in series. The resistors are wired in such a way that over 360,000values can be found. Each 1/4 watt resistor survives direct application up to 12 volts. Includes instructions.

615-4596 Mixed Material Resistance Board: Our set is a board of 25.5 inches long by 8.5 inches wide, with wires of eight different metals mounted to it. Each wire is 60cm long, with a mark on every decimeter. The Materials are: Aluminum, Brass, Constantan, Copper, Iron, Ni-Chrome, Silver, Stainless steel

615-3005 Electroscope, Positive/Negative: Now you can determine the net charge on your statically charged objects. Works with charged rods and electroscopes for determining the final charge type after experimentation. Uses two LED's to indicate positive or negative charge.

615-3170 Electric Fields Apparatus: *Use with overhead projector, Van de Graaff or Wimshurst machine.* Show the lines of electric field produced by a Van de Graaff generator or Wimshurst machine. This transparent device is suitable for use on an overhead projector. Fill the dish with oil and mount your choice of electrodes just beneath the surface. Sprinkle iron filings and connect to show the patterns created. Includes: bottle of oil; 2 parallel charge electrodes; 2 point charges: 2 round field electrodes; iron filings.