615-4596 (10-142) Mixed Material Resistance Board

Introduction: What is electrical resistance? Conductors, especially metals, depend on their atomic structure to be conductive. This same atomic structure is also the cause of resistance. In metals, atoms are bonded together, but the outer electrons are free to move throughout the lattice structure, creating a “sea” of electrons. This sea will react to an electrical field, carrying the current through the lattice. However, these moving electrons are subject to disturbance. In metals, the most common form of this disturbance is thermal energy, which causes electrons to move in directions other than that of the current. These free electrons interfere with those carrying the current, causing resistance. Different metals react differently to heat, giving them different resistances.

Therefore, resistance drops as temperature decreases. Interestingly, most metals become superconductors at extremely low temperatures. A superconductor is a material with no electrical resistance. Superconductivity usually occurs at extremely low temperatures, generally a few Kelvin. For this reason, superconductors are not included in this set.

Description: Our set is a board of known length, with wires of eight different metals mounted to it. Each wire is 60 centimeters long, with a mark every decimeter. The materials are: Aluminum, Brass, Constantan, Copper, Iron, Ni-Chrome, Silver, and Stainless Steel. Their official resistances are below.

Aluminum: 2.82 x $10^{-8}\Omega m$

Brass: 3.5 x $10^{-8}\Omega m$

Constantan: 4.9 x $10^{-7}\Omega m$

Copper: 1.72 x $10^{-8}\Omega m$

Iron: 1.0 x $10^{-7}\Omega m$

Ni-Chrome: 1.10 x $10^{-6}\Omega m$

Silver: 1.59 x $10^{-8}\Omega m$

Stainless Steel: 7.40 x $10^{-7}\Omega m$ Note: each alloy has its own resistance

Operation: The mixed material resistance board can be used for a variety of experiments. You will want a multi-meter capable of reading less than 100 Ω.

1. Take one of the probes and place into one of the jacks on the end of the wire you wish to examine.
2. Place the other probe onto the same wire at the first hash mark. There are handy lines printed every five centimeters for this purpose.
3. Read the multimeter. Record the value.
4. Repeat this step for the mark at ten centimeters.

5. Continue with this step until you have obtained a reading for every mark on the board.
6. Graph your results. The slope of the line will indicate the resistance of the material.

An alternative method is to measure voltage drop across the wire. Use a D-cell battery or low voltage power supply to run a known amount of current through the wire.

1. You can do this by using alligator clips or banana plugs to attach your voltage source to one of the probes of your multi-meter.
2. Attach the other probe to the left hand jack on the wire you wish to examine.
3. To make a complete circuit, use the other lead from the power source to take amperage readings at different lengths on the wire.
4. You can easily convert the amperage readings into a value for resistance by using Ohm's Law: $R = \frac{V}{I}$.
5. Use the graph you drew in the first step. Overlay the results from this experiment on the graph from the same wire you used in step one. Ideally, the lines should overlap perfectly.

From these results, it is easy to see that not all metals conduct electricity equally. The results show that copper and aluminum have lower resistance, which is why they are commonly used as wiring. Silver is more efficient, but costs more and corrodes easily. Ni-Chrome and constantan conduct electricity less efficiently, which causes them to become hotter when they are exposed to electricity. This makes them useful in heating element.

Note: although the resistance board bears a resemblance to a guitar, the wires are fragile and are not designed to be plucked.

Warranty and Parts:
We replace all defective or missing parts free of charge. 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. Not designed for children under 13 years of age.

May we suggest:

615-4545 Unknown Resistance Board: Expands upon the concepts learned with Wheatstone Bridge. Assign each lab group one of 36 different "unknowns". Concise design features nine distinct 1% resistors randomly mounted on a PCB. Connect any two resistors in series.

615-3165 Lightning Leaper: The path of least resistance can often lead to complications and unexpected outcomes. This is certainly true of our creatively named "Lightning Leaper". We provide an insulating plate with two binding clips on either end for connecting to a Van de Graaff generator. On the plate's surface, an incomplete metallic path-with eight small gaps-is drawn in a zigzag pattern. Anyone can see that the shortest path between the binding clips is definitely *not* the metallic path. Yet, the discharge from the Van de Graaff follows just this path-watch as the electricity leaps over each gap!
This plate can be suspended from an insulating stand and connected at either end to a Van de Graaff generator. For hardier souls, it can be held in the hand close to the active Van de Graaff.

615-4540 Wheatstone Bridge: This traditional slide-wire device is the classic way to measure resistance in a conductor by comparing a wire with known resistance to one with unknown resistance. Exceptionally accurate, it is fully assembled and features 7.5 x 110 xm enameled aluminum base; meter-long high resistance nichrome wire; terminal nuts; corrosion-resistant nickel-plated parts; double-ended sliding knife edge contact; low resistance connectors; and 1000 mm scale. Detailed instructions with theory and examples.

615-4500 Resistance Coil Set: Show how resistance varies with type, length, and diameter of wire used. The math is made simpler due to lengths of wire used. Includes 8 labeled coild wound on individual plastic spools with brass terminals.