612-1050 (15-025) Conductometer

Safety tip:
Wear gloves and safety goggles.

Warranty and Parts

We replace all defective or missing parts free of charge.. All products are warranted to be free from defect for **90 days.** Warranty does not apply to accident, misuse, or normal wear and tear.

Additional Materials Needed:

- Bunsen burner
- Ring stand (optional)
- Mossy zinc (optional)
- Red phosphorous (optional)
- Match head (optional)

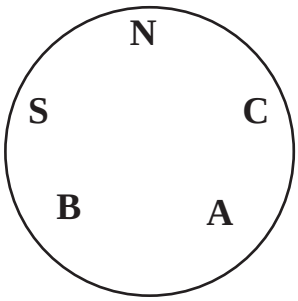
Description:

This spoke-type heat conductometer demonstrates the diverse thermal conductivity of five distinct metals. It consists of five (5) spokes radiating from a steel hub which represent these metals:

Aluminum
Brass
Iron (Steel)
Nickel
Copper

To use, cut off a piece of wax, insert it in the indentation at the end of each spoke, and hold the hub over a Bunsen burner flame. Observe the rates at which the wax at the ends of the spokes begin to metal. *Which melts first? Why?*

The diagram below depicts the order in which the spokes are arranged on the hub.



A	=	*Aluminum*
B	=	*Brass*
S	=	*Iron (steel)*
N	=	*Nickel*
C	=	*Copper*

Theory:

Heat transfers by conduction and materials differ in conductivity. All forms of energy, including heat, tend to flow from places of high intensity to places of low intensity. Flow of heat in the conductometer takes place from the central hub, over the flame, toward the cooler spoke ends. The heat transfer occurs molecule by molecule through matter by means of collision, impact or bombardment. All portions of the metal in question tend to attain the same average molecular activity.

As heat radiates along the spokes, some is consumed in raising the temperature in the metal. Some heat is lost to the air through convection, some by radiation. Heating the spokes therefore involves atomic weight (specific heat) and color (black body radiation effect) as well as thermal conductivity.

Although all metals are generally good conductors, some are better than others. Good conductors are in groups 1A and 1B of the **Periodic Table.** Thermal conductivity is highest in metals having large number of free electrons. Alloys of these metals, members of Groups 6, 7 and 8, are usually poor conductors - even poorer than pure-form metals in these groups.

Use the chart on Page 2 to determine which spokes demonstrates little, if any, heat transfer. One of the spokes will show little heat transfer since the metal in question is a very poor conductor.

Operation:

- **First Method**

Place a strip of wax, about 1/8" x 1/8", over each spoke. The wax may be draped or rolled into small balls to fit into the indentations. Heat the hub with a Bunsen burner and observe the rates at which wax melts. The spoke that conducts heat most rapidly will melt wax first.

Metal	Chemical Symbol	Hub Marking	Conductivity *Cal/Sec ° C cm*
Copper	Cu	C	1.00
Aluminum	Al	A	0.50
Brass	Cu/Zn	B	0.26
Iron (Steel)	Fe	S	0.11
Nickel	Ni	N	0.22

- **Second Method**

Place a match head into the indentation at each spoke's end. Observe the rate at which each match head ignites. Matches will flare up in order in which the heat is conducted from hub to ends.

Grains of red phosphorous placed in each indentation behave in a similar fashion. The red phosphorous lights up when heated sufficiently.

Other Tips for Operation

Temperature may be checked by means of a piece of *mossy zinc*. When placed directly onto the brass hub, mossy zinc serves as a temperature indicator. If zinc melts, the conductometer is being overheated.

While it is safe to hold the conductometer over a Bunsen burner flame by hand, you can also mount it to a *ring stand.* This way it will always be held at the appropriate height above the flame. It can be clamped at any height using a *ring stand clamp* fastened onto the wood handle.

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Safety

As with all apparatus involving the use of high temperatures, use safety precautions:

- Wear gloves and safety goggles when using
- Take care to avoid burning finger. Use caution during and immediately following the heating process.
- Do not exceed temperatures of 500° F.
- Do not use a propane torch or heating source other than a Bunsen burner.
- Turn down flame of bunsen burner to maintain flame height of no more than 1.5 inches.

How to Teach with Conductometer

Concepts: Transmission of heat; conduction; rate of conduction; thermal conductivity of a material; conductors and insulators.

Curriculum fit: Physics Sequence/ energy. *Unit: Heat-Second Law of Thermodynamics.* **Grades 6-8.**

Concepts: Conductivity and atomic structure (free electrons); relation to Periodic Table of Elements.

Curriculum fit: Chemistry sequence; Structure of Matter. *Unit: Atoms* **Grades 9-10.**

Sample Heat Conductivities

Heat conducted in btu per minute through layer 1 sq foot in area and 1 inch thick, when temperature difference between the surfaces is 1° F.

Silver	79
Copper	44
Aluminum	23
Iron (wrought)	5
Lead	4
Window glass	0.1
Water	0.066
Concrete	0.05
Glycerin	0.030
Snow	0.027
Hydrogen	0.018
Corkboard	0.005
Wool felt	0.005
Air	0.0027

Related Products:

The following products may be ordered from many science distributors or, if unavailable, directly from us.

15-035 Precision Linear Expansion apparatus - New! with dial indicator (English readings). Study and measure how four different metals expand when heated.

15-120 Aneroid Calorimeter - No water needed in this new design that's five times more sensitive than traditional versions. One-pound core in die-cut insulation.

15-050 and 15-060 Specific Heat specimens - Same mass and same volume, respectively, in five different metals. Represents 5 groups of Periodic Table.

15-095 Thermostat Model- Demonstrate the action of a switch. Bimetallic strip opens, closes circuit when you connect battery.

15-075 Steam Generator - A safe source of steam for your experiments. Two rubber stoppers, tripod, dipping cup with handle.