

# Reversible Thermoelectric Demonstrator

P6-2700



## BACKGROUND:

The Thermoelectric Effect is the direct conversion of temperature difference to voltage, and vice-versa. Although thermoelectricity can be used to create electric current or to create temperature differences, in practical applications it is almost exclusively used for cooling, such as portable refrigerators. (Do not confuse the Thermoelectric Effect with the ordinary heating that occurs in all electric circuits. Thermoelectric heating is reversible, while the ordinary heating is not.)

Thermoelectricity refers collectively to the Seebeck effect, Peltier effect, and the Thomson effect. The temperature difference causes charge carriers (such as electrons) to move from the hot side to the cold side, thus creating an electric current. Conversely, the energy transferred into the material by applying an electric current can cause differential heating. One of the most common thermoelectric materials is Bismuth telluride ( $\text{Bi}_2\text{Te}_3$ ), a chemical compound of Bismuth and Tellurium.

## OPERATION AND EXPERIMENTS:

1. To demonstrate thermoelectric power generation, place the two aluminum legs in two containers of water – one very hot and the other very cold.
2. Make sure that the switch is flipped so that the fan will activate (to the left, viewed from the back). Observe the fan blades turning.
3. After a few minutes, remove the legs from the water baths, and observe that the fan continues to turn as long as there is a sufficient temperature difference in the metal legs.
4. Replace the legs in the water baths, and flip the switch. Use a multimeter to measure the voltage difference between the positive and negative (red and black) terminals.

5. Try different temperatures of water, and see what effect this has on the voltage obtained. For instance, hot and cold tap water may not activate the fan. Is a voltage difference still observed with this relatively small temperature difference?)
6. Now reverse the effect.
  - a. Use two equal-temperature water baths, each with a thermometer or temperature sensor.
  - b. Make sure the switch is flipped to connect to the terminals (to the right, when viewed from the back). Use banana plugs to connect a 6VDC voltage source to the terminals.
  - c. Observe the resulting temperature difference in the two water baths. (Be patient! Water has a high heat capacity and takes a long time to heat up. For a qualitative approach, carefully touch the two legs to observe the temperature difference.)
7. Note that thermoelectric devices always create hot and cold regions. Ask students how they would deal with this if they were designing an electric cooler. If you have access to a portable cooler that uses thermoelectricity, challenge students to locate the area that gets hot as the cooler gets cool.

## RECOMMENDED ACCESSORIES:

Digital Multimeter (P6-8015)

250ml beaker (33-0770)

Variable DC Power Supply (P4-3300)

## RELATED PRODUCTS:

Genecon Hand Generator (P6-2631)

Thermoelectric Device (P3-2600)

