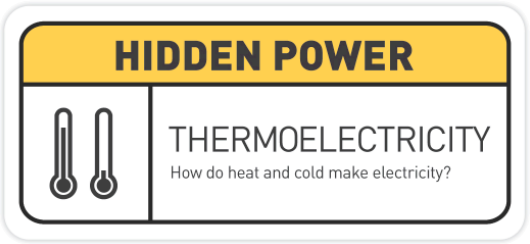

GOAL:

Visitors will understand how differences in the temperature of materials can be harnessed to produce electricity.

MATERIALS:

- Thermoelectric fan
- Cup of ice water (filled ~3" deep)
- Cup of hot water (filled ~3" deep)
- Shake table model
- Paper towels or dry cloth

PROCEDURE:

Set-up:

1. Place the water cups next to each other with the fan nearby.

2. Place the shake table horizontally so both ends can be accessed from the front of your demonstration area. Arrange the beads so that they are somewhat evenly spaced over the entire surface of the board.

Doing the demonstration:

1. Ask visitors if they have ever heard of thermoelectricity. Break down the word and ask visitors to think of other words that contain "thermo" (meaning heat or temperature), e.g. thermometer, thermostat, etc. Explain that thermoelectric devices have special materials inside that use differences in temperature to create electricity.

2. Explain that one cup contains hot water and one cup contains ice water. Take the fan and place it in cups with one metal fin in each cup of water. It may take a moment or two but the fan should begin spinning.

3. Point out the white thermoelectric generator sandwiched between the metal fins. Explain that this material uses the differences in temperature to create an electric current, which makes the fan spin. Once the fan starts spinning, take it out and let visitors feel the temperature of the fins.

4. Ask for 2 volunteers and have one stand on each side of the shake table model. Explain that the model is an example of the thermoelectric effect, and that the beads represent the electrons that are free to move between two conductive materials. When materials heat up, the electrons, atoms, and molecules inside it move around and shake rapidly, while the particles in a cold material are more sluggish and have much less movement.

5. Designate one side of the board to be the hot material and the other side to be the cold material. Ask the “cold” side volunteer to hold their pad and keep it still. Then direct the “hot” side volunteer to add heat energy to their side by repeatedly drumming on their pad with their fingers. As they do, the beads will move and concentrate themselves near the “cold” side, representing the movement of the electrons within the material and a build-up of electric charge. This distribution of charge can then be used to generate electrical currents in circuits that are attached to the thermoelectric material. Once most of the beads have traveled to the cold side, the volunteers can switch roles and watch the effect again.

6. Discuss some applications of thermoelectricity, for example using automobile engine exhaust heat to produce electricity, or in reverse, using electricity for food storage that keeps food warm and drinks cold.

Clean-up:

1. Pour out the cups of water and dry off the legs of the fan. Gather all materials and return to storage.

EXPLANATION:

Thermoelectricity is the generation of electricity that results from a temperature difference between two conductive materials. Inside conductive materials, electrons are free to move around. As the temperature of the material goes up, the electrons move around more. When placed in contact with another, cooler material, the electrons exhibit a net movement into the cold material, causing the two materials to become oppositely charged and creating a difference in electric potential.

The greater the temperature difference between the two materials, the larger the current. **Note:** The electric current is dependent upon the temperature differential, not the absolute temperature. Using liquid nitrogen (-196˚C) and ice water (4˚C) to drive the fan would therefore produce a larger current than ice water and boiling water (100˚C).

The thermoelectric effect also works in reverse. Applying an electric current to two thermoelectric materials will increase the temperature of one and decrease the temperature of the other.

Currently, thermoelectric generators are used to recycle waste heat in power plants and in cars to increase efficiency. They are also used in space probes for electricity, using radioactivity to produce the temperature difference. The reverse effect has many everyday applications, such as electric picnic coolers, refrigerators, and car seat warmers.

WHAT COULD GO WRONG?

If the fan doesn’t start spinning, wait a few seconds, try giving it a nudge to help it start spinning, or refresh the hot and cold water to increase the temperature difference. Using Styrofoam or other insulated cups will help maintain the water temperature.

Use water as hot as possible, but not boiling, to avoid burns. The preheated hot water from a water cooler paired with ice water usually starts the fan spinning in less than a minute.

GENERAL MAINTENANCE:

Keep the thermoelectric fan clean and dry between uses. Make sure the plexiglass cover to the shake table remains attached on all sides.