SUGGESTED ACTIVITIES

(*Thermal Energy*)

From *Invitations to Science Inquiry 2nd Edition* by Tik L. Liem:

Activity	Page Number	Concept
Warm a Bottle by Shaking	184	Heat, Friction
The Confused Bottles	206	Convection
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From *NSF/IERI Science IDEAS Project*:

Activity	Page Number	Concept
Heat and Temperature	(see following pages)	Thermal Energy, Capacity

From *Harcourt Science* Teacher's Ed. Unit E: (For ALL grade levels)

Activity	Page Number	Concept
Rubbing Objects Together	F5(3rd grade text)	Heat, Friction
What Gets Hot	F13(3rd grade text)	Conduction
Measuring Temperature	F19(3rd grade text)	Temperature
Testing Insulators	F27(3rd grade text)	Conduction
Heat Flow	F83(5th grade text)	Conduction

WARM A BOTTLE BY SHAKING

A. Question: *Does energy affect temperature?*

B. Materials Needed:

1. A medium size jar with lid.
2. Dry sand (beach sand).
3. A thermometer.

C: Procedure:

1. Fill the jar about two-thirds full with dry sand.
2. Push a thermometer in the sand and let one of the students read off the temperature.
3. Take the thermometer out or the jar, close the jar tightly and let the students take turns shaking the jar for 5 to 6 minutes in total (about ½ minute each for 10 to 12 students).
4. Open the jar after shaking, push the thermometer in the sand and let a student read off the temperature again.

D: Anticipated Results:

Students should observe a change (increase) in temperature after shaking the jar.

E: Thought Questions for Class Discussion:

1. What were the temperature readings before and after the shaking?
2. What is the cause for the temperature to rise?
3. What type of energy was turned into heat?
4. To what type of energy as the original source can this produced heat be traced back?

F: Explanation:

The shaking of the bottle or jar is mechanical energy, which was turned into heat. The mechanical shaking of the sand gave the sand particles kinetic energy, which caused friction between the sand particles, thus creating heat. The energy needed for the shaking of the jar was supplied by muscle power of the students. To give this energy, the students needed to eat (chemical energy), and the food the students ate came from plants and animals. The animals also needed to eat plants, and the plants in their turn, obtained the energy from the sun to grow. All forms of energy can thus be traced back to solar energy.

THE CONFUSED BOTTLES

A. Question: *What are the necessary conditions for convection to take place?*

B. Materials Needed:

1. Four empty identical soda pop bottles.
2. Food coloring.
3. A 3X5" card

C: Procedure:

1. Fill two bottles (A1 and B1) with cold and two bottles (A2 and B2) with warm water (do not reveal to students the temperature difference).
2. Color the water in bottles A1 and B2 with a few drops of food coloring and mix the color evenly (cover the bottle with your thumb and turn upside down).
3. Cover the bottles A2 and B1 with a small piece of the paper card, and place them upside down on the colored bottles (one finger on the card will keep the water from spilling while turning it upside down: center the bottles A2 and B1 carefully over A1 and B2 and slip out the piece of card by holding the top bottle).
4. Let the students observe what is happening to the color.

D: Anticipated Results:

Students should observe a color change in the water bottles due to convection currents.

E: Thought Questions for Class Discussion:

1. Why did the top bottle B get colored and not Bottle A?
2. Do you think the temperature of all four bottles of water was the same?
3. Which of the four bottles were warmer?
4. Does bottle A2 ever get colored; if so, when?
5. What would happen to the color if the temperature of all four bottles were the same?

F: Explanation:

The water in bottles A1 and B1 was cold and that in A2 and B2 was warm. Warm water is lighter in weight or less dense than cold water and thus rises. Since the warm water in B2 was colored this water rises into the top bottle and the cold water sinks bringing with it convection currents. As the water in A2 is warm and already above the cold water in A1, no convection is occurring in this set of bottles, and thus no coloring of the top bottle.

When the water temperature of this top bottle gets to be equal to that of the lower bottle, diffusion of the color will occur, but no convection. This process is much slower than convection and is caused by the constant vibration of molecules.

THE COIL CANDLE-SNUFFER

A. Question: How can heat be transferred?

B. Materials Needed:

1. Insulated solid copper wire (about 30cm).
2. A wire stripper or knife.
3. A birthday candle and matches.

C: Procedure:

1. Take the copper wire and strip ¾ of the insulation off one end (use the wire stripper or knife).
2. Make a spiraling coil of the stripped end of the copper wire.
3. Light the candle and fasten it to the table with a drop of molten wax.
4. Lower the coil over the candle flame quickly; flame snuffed!
5. Relight the candle; and now lower the coil slowly over the flame (hold it in the flame for a while), then lower the coil over the candle; flame stays on!

D: Anticipated Results:

Students should observe a change in temperature when the coil is placed over the flame.

E: Thought Questions for Class Discussion:

1. What made the flame go out when the coil was lowered quickly?
2. Was the flame cut off from the air?
3. Why did the flame stay on after the coil was held in the flame for a longer period?
4. What was the temperature of the coil the first time compared to the second time it was lowered over the flame?
5. Why was the insulation not completely stripped off the wire?

F: Explanation:

In lowering the copper spiral over the flame, it was conducting the heat away from the flame. This made the surrounding of the flame suddenly drop in temperature, which made the flame go out. In other words, the temperature dropped below the **kindling temperature** of the candle wax.

When holding the coil for a longer period of time in the flame, it is heated to a higher temperature. When this hot coil is now lowered over the flame, it will not extinguish it, because the surroundings of the flame have a temperature which is higher than the kindling point of candle wax.

The insulation of the wire was left on at one end of the wire in order to prevent conduction of the heat to the fingers. Without insulation it would be too hot to hold the coil with the bare fingers.

Heat and Temperature

Adapted from *The Hot Bolt*, from Invitations to Science Inquiry, Tik Liem

Goal: To demonstrate the difference between heat and temperature, and to explain the concept of thermal energy.

Materials:

- A heavy steel bolt
- A small iron nail
- Two identical beakers, and two identical thermometers
- One beaker or pot to boil water in.
- A pair of tongs to take things out of the boiling water.
- Burner or hot plate

Procedure:

1. Place the bolt and nail in the beaker or pot, along with about 100 ml of water. Bring the water to a boil.
2. Place 100ml of water in each of the identical beakers. Put a thermometer in each beaker. Measure and record the temperatures.
3. Use the tongs to place the bolt in one beaker, and the nail in the other.
4. Read and record the temperatures in each beaker every 15 seconds until it levels off. Graph the temperature readings.

What Happened?

Thermal energy is the total amount of kinetic energy that is contained in a substance or object. Items with greater mass can contain greater amounts of thermal energy. Thermal energy is transferred from the burner or hot plate to the beaker and the water inside. When you add the nail and bolt to the water, thermal energy is transferred to them as well. This transfer of thermal energy is called **heat**. Yes, “heat” is a verb!

Temperature is the measurement of the **average kinetic energy** contained in a substance. When the water started to boil, we knew that the temperature of the water was 100˚C. After leaving the bolt and nail in the water for a few minutes, we can assume that their temperatures were both 100˚C as well. The molecules in the bolt and nail had an average kinetic energy of 100˚C.

The bolt has more mass than the nail. They may have been the same temperature when you removed them from the water, but because the bolt had more mass, it had more total thermal energy, and so it had more to transfer to, or heat, the water. As the water took more energy from the bolt, its temperature went up.

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