Thought-provoking discussions provide a good way to assess the overall depth of student understanding. The following are some suggested discussion topics.

- Have students look for objects in the classroom that seem to give off heat and those that do not. Discuss the apparent differences between the two groups of objects.
- Brainstorm a list of ways that heat energy is used on Earth. Ask students to decide which uses of heat are the most important and which are the least important, and then have them explain why they think so.

Follow-up Activities

- Provide your students with an opportunity to experience how hot air expands and cold air contracts. Place a balloon over the mouth of a two-liter plastic bottle (make sure that you stretch the balloon out before affixing it to the bottle). Ask students to predict what will happen to the balloon when the bottle is placed in hot water and in cold water. Record their predictions. Partially submerge the bottle in a bucket of hot water, followed by a bucket of ice water. Compare observations and reflect on students' predictions.
- Using what students have learned about heat, sponsor an ice cube melting race! Each small group will get a cup with an ice cube. Without touching the ice cube directly with their hands, students must try to melt their cube. Students can use their creativity to generate melting strategies, including placing the cup in sunlight, blowing on the ice or holding the cup in their hands. After the race has ended, discuss with students the most effective methods for heating the ice cube. Classify students' strategies as examples of radiation, conduction or convection.
- Have students retell the story of Goldilocks and the three bears, focusing on the bears' porridge. Using three thermometers and three similar bowls of different sizes filled with hot water, see if Goldilocks' determination of the porridge temperature was accurate. As the water cools, have students discover which size bowl has a temperature that seems "just right". (Be sure to have students follow safety precautions to prevent burns.) Encourage children to rewrite the story to reflect what they have learned.
- Have students collect food labels to compare the amount of calories in different foods. Extend this to a study of balanced diets.

TEACHER'S GUIDE

Internet Resources

Periodically, Internet Resources are updated on our web site at www.LibraryVideo.com

- **www.ase.org/uploaded_files/educatorlessonplans/besunsible.pdf**
  This web page for elementary students developed by the Alliance to Save Energy contains a reproducible plan to build a solar heater and insulators as well as background information for students to investigate the relationship between color and heat.
- **nesen.unl.edu/lessons/weather/amihotoramicold.htm**
  "Am I Hot or Am I Cold" is an elementary science unit about temperature and thermometers developed by the Nebraska Earth Systems Education Network.
- **www.energyquest.ca.gov/saving_energy/index.html**
  This page from the California Energy Commission's "Energy Quest" web site lists numerous ways kids can help save energy.

Suggested Print Resources

- Lauw, Darlene. *Heat.* Crabtree Publishing Company, Mankato, MN; 2001.
- Olien, Rebecca. *Temperature.* Capstone Press, Mankato, MN; 2005.
- Walker, Sally M. *Heat.* Lerner Publishing Group, Minneapolis, MN; 2005.

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TITLES

- **ALL ABOUT THE CONSERVATION OF ENERGY**
- **ALL ABOUT THE TRANSFER OF ENERGY**
- **WHAT IS ENERGY?**
- **ALL ABOUT THE USES OF ENERGY**
- **ALL ABOUT HEAT**

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TEACHER'S GUIDE

Energy for Children™

All About Heat

Grades K–4

This guide is a supplement, designed for educators to use when presenting this program in an instructional setting.

Before Viewing: Research in learning suggests that it is important for the teacher to discover what the students know — or think they know — about a topic, at the start of a new unit, so that their accurate conceptions can be validated and reinforced, and their misconceptions identified and corrected. Therefore, after reviewing the pre-viewing discussion questions provided for your class, create an "Everything We Know About…" list. Preview key vocabulary words and have students raise additional questions they hope will be answered by this program. Most importantly, students should be told that as "science detectives" they must listen closely, so that after viewing the program, they will be able to tell whether or not the facts/beliefs they put on their list were scientifically accurate.

After Viewing: After a brief discussion about the program, challenge your "science detectives" to prove or disprove the accuracy of the facts they put on their "Everything We Know About…" list. Discuss what else they learned and use the follow-up questions and activities to inspire further discussion. Encourage students to research the topic further with the Internet and reading resources provided.

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Program Summary

Energy is what it takes to make things happen or to do work. You are doing work whenever you move something or change it in some way. Heat energy comes from the movement of the atoms and molecules that make up everything around us. The faster that atoms move, the more heat energy is produced. There are moving atoms even in frozen objects, but there is less heat because when things get colder, atoms and molecules slow down. Most objects also contract or get smaller when cooled. When heated, most things expand. When solids are heated, most become liquids. The temperature at which this occurs is called the melting point. When liquids reach the boiling point, they change from liquids to gases.

A thermometer is a tool people use to measure temperature, which is actually a measure of how much the atoms and molecules of an object are moving. In the 1700s, German scientist Gabriel Fahrenheit developed a thermometer based on a temperature scale that we now call the Fahrenheit scale. Around the same time, Anders Celsius, a Swedish scientist, developed a scale to measure temperature called the Celsius scale. The temperature scales are like two languages saying the same thing.

Heat can move from place to place in one of three ways: conduction, convection or radiation. When the surfaces of two objects are touching, like an egg on a hot frying pan, heat travels through conduction from the hotter object to the cooler one. Convection is another way heat travels through liquids and gases. As water or air heats up, it expands and moves upwards, while cold air or water contracts and drops downwards. Radiation is the way that heat travels in a straight line from a hot object. We feel heat energy from the sun because it radiates through space. Heat energy travels quickly through some objects, known as conductors, and does not travel easily through other objects, which are called insulators. For that reason, you can use potholders (insulators) to pick up hot metal pots. Most metals are good heat conductors.

A calorie is the measurement of heat energy in food. Our bodies get energy by releasing and burning the calories contained in foods. Different types of food have different amounts of calories; some foods, like chocolate, have a lot, while foods like celery and lettuce have few calories.

Vocabulary

The following words are included for teacher reference or for use with students. They are listed in the order in which they appear in the show.

heat — The energy produced by the movement of the tiny atoms and molecules of an object. The more they move around, the more heat is produced.

energy — The ability to make things happen or to do work. Heat is a form of energy.

work — To move or change something. Doing work takes energy.

atoms — Tiny particles that make up everything around us. These particles are constantly moving.

(Continued)

molecules — The smallest units of a substance, made of one or more atoms.

contract — To get smaller; most substances contract when they are cooled.

expand — To get bigger; most substances expand when heated.

thermometer — A tool used to measure heat.

temperature — A measure of how fast the atoms and molecules of a substance move.

Celsius scale — A scale used to measure temperature that was invented by Anders Celsius, a Swedish scientist. On the Celsius scale, 0 degrees is the freezing point of water and 100 degrees is its boiling point.

Fahrenheit scale — A scale used to measure temperature that was invented by Gabriel Fahrenheit, a German scientist. On the Fahrenheit scale, 32 degrees is the freezing point of water and 212 degrees is its boiling point.

melting point — The temperature at which a solid turns into a liquid. A solid becomes a liquid when it is heated, and its atoms and molecules move faster and faster.

boiling point — The temperature at which a liquid turns into a gas. A liquid becomes a gas when it is heated, and its atoms and molecules move faster and faster.

conduction — The way in which heat energy is passed directly from one object to another. If you stir a pan of hot soup with a cold spoon, heat energy will be conducted to the spoon, warming it up.

convection — The movement of liquids and gases from a warm spot to a cooler spot. An example of convection is the wind that forms when cold air sinks and warm air rises.

radiation — The movement of heat energy in a direct line away from hot objects. The sun radiates heat in rays — even though we do not touch the sun, we can still feel its heat.

conductors — An object that lets heat flow through it easily. Metals are good conductors of heat.

insulators — An object that does not let heat flow through it easily. Air, wood and plastic are examples of insulators.

calorie — A measurement of the amount of energy contained in food.

Pre-viewing Discussion

Before students generate their list of "Everything We Know About..." this topic, stimulate and focus their thinking by raising these questions so that their list will better reflect the key ideas in this show:

- What is energy? Where does it come from?
- How does heat travel from one thing to another?
- How is heat measured?

(Continued)

After the class has completed their "Everything We Know About..." list, and before watching the show, ask them what other questions they have that they hope will be answered during this program. Have students listen closely to learn if everything on their class list is accurate and to hear if any of their own questions are answered.

Focus Questions

You may wish to ask your class the following questions to assess their comprehension of key points presented in the program.

1. Where does heat come from?
2. What is energy? Why is energy important?
3. What is the Earth's most important source of heat?
4. What is work? Give an example of work being done.
5. What do atoms and molecules have to do with heat?
6. Compare the movement of atoms and molecules in cold water and warm water.
7. What does it mean to expand or contract?
8. Why do roads, bridges and railroad tracks have spaces built in every so often?
9. How is heat measured?
10. What happens to the atoms and molecules in an object when it melts?
11. What happens when objects reach their boiling point?
12. What are the three ways that heat energy travels?
13. Can you give an example of heat conduction?
14. What is the difference between conduction, convection and radiation?
15. How does heat energy travel from the sun to the Earth?
16. What are conductors and insulators?
17. Why are certain things, like plastic and wood, used for handles of metal pots while metals are used for the pots themselves?
18. What is a calorie?

Follow-up Discussion

The most important part of this segment is to examine both the facts and beliefs generated by the class in their "Everything We Know About..." list. Research indicates that students will retain their previous misconceptions — in preference to the new information — until they actively recognize and correct their own errors. Because of this, it is important to lead students to the correct ideas while identifying and correcting any misconceptions from the class list. After reviewing the list, encourage students to share the answers they got to the questions raised before viewing the program.

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