What's Cooking 2

Student Objective
The student:
- will be able to calculate the calorie heat gain for several different containers
- given containers of several different materials will be able to determine which will work the best in a solar oven.

Key Words:
conduction
convection
dependent variable
independent variable
radiation
solar collector
solar thermal
thermal conductivity

Materials
- box cooker from previous What's Cooking investigation
- containers made of various substances such as: foam cup, clear plastic glass, colored glass, metal can, ceramic mug, glass beaker, ½ pint milk carton, milk carton painted black (per group)
- graduated cylinder
- thermometers (5 per group)
- plastic wrap
- pot holders

Time:
1 class period

Internet Sites
http://solarcooking.org/
Solar Cooking International, solar cooking archive includes solar cooking plans, documents and a list of resources and manufacturers.

Related Readings
Dr. Art's Guide to Planet Earth, pages 48 - 49 "Energy From the Sun" and pages 50 - 53 "The Greenhouse Effect"

Background Information
The transfer of heat is accomplished by convection, conduction and/or radiation. **Convection** requires the movement of a substance (or mass) from one position to another. The

movement of air or water is an example of heat transfer by convection. The transfer of heat energy by air and water currents is essential in distributing heat energy over the Earth's surface.

Conduction is the transfer of heat energy by molecular activity. The kinetic energy of the molecules is transferred from one molecule to another through collisions. The heat flows from the higher temperature to the lower temperature, with the rate of flow being directly proportional to the temperature difference. Some substances are very good conductors of heat, others are not. The thermal conductivity of a substance is a measure of its ability to conduct heat with the better conductors having a higher thermal conductivity value.

Radiation is the process of transferring heat energy through space by means of electromagnetic waves. These waves carry energy and can travel through a vacuum, such as the energy of the sun traveling through the vacuum of space to our Earth. Heat energy in the form of electromagnetic waves is both absorbed and reflected when it hits a surface.

Procedure

1. Place box of various containers in the front of the room
2. Divide students into groups of 4 - 5 students in each group.
3. Explain procedure to the class:
   - each group will be testing four containers for their ability to gain heat in their solar box cooker
   - pour 100 ml water into each container
   - put the thermometer in the water and record the temperature in the chart in their Science Journal
   - cover the top around the thermometer with plastic wrap
   - place the cooker in the sun. Put the containers in the cooker, and one thermometer that is in the oven but not in a container
   - record the temperature after 45 minutes and calculate the calorie heat gain
4. Help students as needed during the experiment
5. Write the formula for calorie heat gain on the board

   $\text{Time}_{\text{finish}} - \text{Time}_{\text{start}} = \hat{I}T$

   Calorie Heat Gain = $\hat{I}T \times 100$
6. Students should complete their Science Journal.

Energy Whiz

See if you can 'ace' the solar thermal crossword puzzle at **http://energywhiz.com/**.

Related Research

1. Test additional types of containers.
2. Check the temperature each hour. Does the rate of heat gain change? Explain.
3. What will happen if the clear containers had a black bottom or a black outside?
4. What will happen if the containers were placed on a wire rack?
5. Will one large container reach the same temperature as fast as several smaller containers with the same total amount of water?

What's Cooking 2

			.1	.2	.3	.4	.5	.6	.7
Nature of Matter	**Standard 1**	**SC.A.1.3-**							
	Standard 2	**SC.A.2.3-**			**X**				
Energy	**Standard 1**	**SC.B.1.3-**	**X**	**X**	**X**		**X**		
	Standard 2	**SC.B.2.3-**							
Nature of Science	**Standard 1**	**SC.H.1.3-**					**X**		
	Standard 2	**SC.H.2.3-**							
	Standard 3	**SC.H.3.3-**							

Benchmark SC.A.2.3.3 - The student knows that radiation, light and heat are forms of energy used to cook food, treat diseases, and provide energy.

Grade Level Expectations

The student:

Sixth

- knows forms of radiant energy and their applications to everyday life

Seventh

- knows uses of radiation, light, and thermal energy to improve the quality of life for human beings

Eighth

- extends and refines knowledge of uses of forms of energy to improve the quality of life

Benchmark SC.B.1.3.1 - The student identifies forms of energy and explains that they can be measure and compared.

Grade Level Expectations

The student:

Sixth

- knows different types of energy and the units used to quantify the energy
- understands that energy can be converted from one form to another (for example solar energy to heat energy)

Eighth

- understands that energy can be transferred by radiation, conduction, and convection
- knows examples of natural and man-made systems in which energy is transferred from one form to another.

Benchmark SC.B.1.3.2 - The student knows that energy cannot be created or destroyed, but

only changed from one form to another.

Grade Level Expectations

The student:

Sixth

- understands that energy can be changed in form
- uses examples to demonstrate common energy transformations.

Benchmark SC.B.1.3.3 - The student knows the various forms in which energy comes to Earth from the Sun.

Grade Level Expectations

The student:

Sixth

- knows types of radiant energy that come to Earth from the Sun

Eighth

- knows ways to measure the various forms of energy that come from the Sun.

Benchmark SC.B.1.3.5 - The student knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature.

Grade Level Expectations

The student:

Eighth

- knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature
- knows that the average kinetic energy of the atoms or molecules that make up an object changes when the temperature of the object changes.

Benchmark SC.H.1.3.5 - The student knows that a change in one or more variables may alter the outcome of an investigation.

Grade Level Expectations

The student:

Sixth

- knows how to identify the independent and dependent variables in an experiment
- uses appropriate experimental design, with consideration for rules, time, and materials required to solve a problem.

Seventh

- extends and refines knowledge of how to identify the independent variables in an experiment
- extends and refines use of appropriate experimental design, with consideration for rules, time, and materials required to solve a problem

Eighth

- extends and refines knowledge of how to identify the independent variables in an experiment
- extends and refines use of appropriate experimental design, with consideration for rules, time, and materials required to solve a problem

What's Cooking 2

conduction - the movement of heat or cold through materials that are solid.

convection - the movement of heat through air or in liquids

dependent variable - a condition of the experiment that is found by testing different values of the manipulated condition. The values of the dependent variable are the effects that are seen from manipulating the independent variable.

independent variable - a condition of the experiment whose values are specified first or before an experiment is performed and are used to find other values or results. Changing the values of the independent variable can be said to cause what happens to the dependent variable.

radiation - the way we receive heat from the sun each day. The energy is emitted in the form of waves/particles, and can move from one object to another without heating the area in between.

solar collector - a device that collects and traps solar energy

solar thermal - using the Sun's energy to heat something

thermal conductivity - the measure of a substance's ability to conduct heat. The higher the value, the more conductive the substance.

What's Cooking 2

1. Record your results below. Fill in the first column with the types of containers you tested. To calculate the calories of heat gain, use the formula:

Î T x 100 = calories of heat gain

Hint: Î T is the change in temperature

Container type	Temp (start)	Temp (45 min)	Calories of Heat Gain
Control (air in box oven)			

2. What was the independent variable in this experiment?

3. What was the dependent variable?

4. Which container of water gained the most heat?

5. Did any containers reach the same temperature as the air in the solar box cooker? Why do you think this is occurred?

6. Which containers are made of materials that insulate?

7. Which containers are conductors?

8. Why do you think different containers gained different amounts of heat?

9. From what materials are oven containers usually made?

10. From what materials are microwave containers usually made?

11. From your investigation, should containers in a solar box cooker be like those used in a conventional oven or like those used in a microwave? Explain your answer using examples from your classes' investigation.