What's Cooking 2

Student Objectives
The student:
- will calculate the calorie heat gain for several different containers
- given containers of several different materials will determine which will work the best in a solar cooker.

Materials:
- cookers 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
- graduated cylinder
- thermometers (5 per group)
- plastic wrap
- pot holders

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

Time:
1 class period

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 a box of various containers in the front of the room.
2. Divide students into groups of 4 - 5 students in each group.
3. Explain the procedure to the class:
   - Each group will be testing four containers for their ability to gain heat in their solar cooker.
   - Pour 100 ml water into each container.
   - Put the thermometer in the water and cover the top around the thermometer with plastic wrap.
   - Place and position the cooker in direct sunlight. Put the containers in the cooker, and also one thermometer (that is not in a container) in the cooker to measure the air temperature.
   - Record the temperature after 20 minutes (box and panel cookers) or 5 minutes (parabolic cookers) and calculate the calorie heat gain.
4. Help students as needed during the experiment.
5. Write the formula for calorie heat gain in water on the board:

   $\text{Temperature}_{\text{finish}} - \text{Temperature}_{\text{start}} = \triangle T$

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

Key Words & Definitions

- **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.

Related Research

1. Test additional types of containers. Will one large container reach the same temperature as fast as several smaller containers with the same total amount of water?
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? Test to find out.

Related Reading

- ***Catch the Wind, Harness the Sun: 22 Super-Charged Projects for Kids*** by Michael Caduto (Storey Publishing, 2011)
  Twenty-two projects plus stories, background information, cartoons and photos covering solar thermal, photovoltaics, solar cooking, climate change, energy production and energy conservation.
- ***Cooking With Sunshine: The Complete Guide to Solar Cuisine with 150 Easy Sun-Cooked Recipes*** by Lorraine Anderson & Rick Palkovic (De Capo Press, 2006)
  This book describes how to build your own inexpensive solar cooker, explains how solar cooking works and its benefits over traditional methods and then includes more than 100 recipes that emphasize healthy ingredients.
- ***Solar Energy Projects for the Evil Genius*** by Gavin Harper (McGraw-Hill, 2007)
  This book includes more than 50 solar energy projects with plans, diagrams and schematics. Included are five solar cooking projects, along with solar stills, a solar powered ice-maker and solar electricity projects.

Internet Sites

http://solarcooking.org/
Solar Cooking International Network, solar cooking archive includes solar cooking articles and worldwide news.

http://solarcooking.wikia.com/wiki/Category:Solar_cooker_plans
Compendium of solar cooking plans and cooking advice.

http://www.webquest.hawaii.edu/kahihi/puzzles/energytransfer/energy2.php
Math & Science Webquests, Conduction, Convection and Radiation Puzzle. Students match conduction, convection and radiation with their definitions and an example.

What's Cooking 2

Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6	.7	.8	.9	.10	.11	.12
Grade 6														
Practice of Science	**# 1**	**SC.6.N.1**	**X**			**X**								
Earth Systems & Patterns	**# 7**	**SC.6.E.7**	**X**											
Grade 7														
Practice of Science	**# 1**	**SC.7.N.1**	**X**			**X**								
Energy Transfer & Transformations	**# 11**	**SC.7.P.11**	**X**	**X**										
Grade 8														
Practice of Science	**# 1**	**SC.8.N.1**	**X**											
Properties of Matter	**# 8**	**SC.8.P.8**				**X**								

Sixth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.6.N.1.1 - Define a problem from the sixth grade curriculum, using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
- SC.6.N.1.4 - Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.

Science–Big Idea 7: Earth Systems and Patterns

- SC6.E.7.1 - Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through Earth's system.

Seventh Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.7.N.1.1 - Define a problem from the seventh grade curriculum, using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

Science–Big Idea 11: Energy Transfer and Transformations

- SC.7.P.11.1 - Recognize that adding heat to or removing heat from a system may result in a temperature change and possibly a change of state.
- SC.7.11.2 - Investigate and describe the transformation of energy from one form to another.

Eighth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.8.N.1.1 - Define a problem from the eighth grade curriculum, using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

Science–Big Idea 8: Properties of Matter

- SC.8.P.8.4 - Classify and compare substances on the basis of characteristic physical properties that can be demonstrated or measured; for example thermal conductivity, and how that this property is independent of the amount of the sample.

National Next Generation Science Standards - Sixth to Eight Grade Standards

Science–Energy

- MS-PS3-4 - Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

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:

$\triangle$T x 100 = calories of heat gain

Hint: $\triangle$T is the change in temperature

Container type	Temp (start)	Temp (end)	Calories of Heat Gain
Control (thermometer not in the container)			

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. Which containers are made of materials that insulate?

6. Which containers are conductors?

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

8. From what materials are cooking containers for a conventional electric or gas oven usually made?

9. From what materials are stove-top cooking containers usually made?

10. From what materials are microwave containers usually made?

11. From your investigation, should containers for your type of 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.

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