Learning Cycle Planner

Making a Solar Air Heater Lesson

Common Curriculum Goal:

Topic: Energy efficiency, alternative energy, green building

Learning Objective: Involve students in creating a potentially simple solution to an ongoing classroom problem (science classroom is too cold in the winter).

Exploration Phase:

Hands-on Activity: Making a Solar Air Heater

Exploration through Media: Solar Pool Heater video (see second half of video) http://www.youtube.com/watch?v=HVjJE0_Ok0c

Concept Development Phase:

Concepts to be taught: Resource consumption, renewable energy, heat transfer: radiation, convection, and conduction energy conversion, passive solar heating

Procedures to be taught: Inquiry, experimental design, problem solving, temperature measurement, recording and organizing data, following instructions to construct a solar air heater, calculating energy savings.

Activities: Videos: PS 10 Solar Thermal Power Station at:

http://www.youtube.com/watch?v=0OkqJw1oTMk provides an extreme example of harnessing the solar thermal energy.

Written assignment to reinforce monitoring of temperatures in the room over time and graphing temperature changes.

Connections to other Lessons:

Solar cooker Pringles can, energy efficient homes, tracking the sun in the sky

Teaching across the curriculum:

Math- temperature change and energy savings calculations

Making a Solar Air Heater (Department of Energy, 1994)

Allow two 45 minute class periods

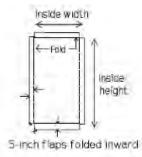
Materials:

Cardboard, measuring tape, scissors, acrylic gesso paste, black acrylic paint, paint brush, thumbtacks, duct tape, thin string, plastic wrap, masking tape, thermometer, graph paper.

Procedure:



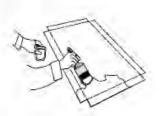
 Find a south-facing window and measure its width and height.



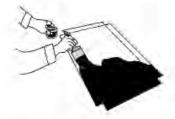
 Cut out a piece of cardboard the same height and width of the window but with four 5-inch (12.7-centimeter) flaps extending from the top, bottom, and sides.

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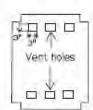
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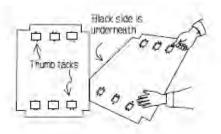
 Apply a coat of gesso paste to one side of the cardboard. Allow the paste to dry for 10 minutes.



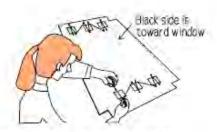
 After the paste has dried, paint the same side of the cardboard with flat black, acrylic paint. Allow the paint to dry.



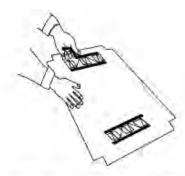
 Cut vent holes 3-inches (7.6-centimeters) wide by 3-inches high near the top and bottom flaps of the cardboard.



 Push thumbtacks into the cardboard around the vent holes on the inside surface.



Weave some thin string around the thumbtacks and across the vent holes.



 Cover the thumbtacks with thin strips of duct tape to prevent them from falling out of the cardboard.

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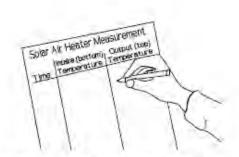
Cut enough plastic wrap to cover the vent holes and tape the plastic to the outside (black side) of the bottom vent holes and to the inside (string side) of the top vent holes.

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10. Slide the cardboard inside the window frame with the black side facing the window and the top vent holes up. (The plastic flaps should be hanging over the vent holes.) Tape the cardboard to the window frame with masking tape and leave an air space between the window and the cardboard.

Hint Don't leave your collector taped to the window frame for too many days, or the tape may pull paint off when you remove it.



- On the graph paper, draw lines marking three columns, and write the words "Time," 'Intake (bottom) temperature," and 'Output (top) temperature" at the top of the columns.
- 13. Did your solar collector work? During what time of the day was the collector's output temperature the highest? What was the highest output temperature of the collector on a cloudy day? On a sunny day?



12. Once every hour for a few hours on a cloudy day, and for a few hours on a sunny day, hold the thermometer under the plastic flaps covering the vent holes for 2 minutes to measure the collector's air intake (bottom) and output (top) temperatures. Mark your temperature readings on the graph paper.

Extensions:

In addition to monitoring the temperature of the vents, classes can monitor the temperature inside the classroom. During a period of cold clear days the solar air heaters may be able to improve the warmth in a basement science classroom. Students will be encouraged to build solar air heaters to test in other classrooms.

On another day close to the solar heater construction, classes can be led outside and just down the street in the neighborhood of the school to view a solar hot water heater on a neighbor's roof. Students can observe how the solar hot water heater is oriented to maximize solar gain, facing the South.

Helpful Information:

The results of this experiment are designed to be undetermined in advance. Students will be engaged in true problem solving since the temperature in the science classroom at Mt. Scott is often in the low 60's in the winter. The classroom is in the basement and has four large windows that face southwest, but are made of opaque glass. Regardless of the outcome of the experiment, students will be challenged to solve the problem of warming the classroom.

Provide students with the information below in the form of a hand out or notes.

Heat Hand Out/ Notes (Nye, 2005)

Snow cones, flowers, hot dogs, people -- everything is made of molecules. No matter what they're in, solid, liquid, or gas, molecules are always moving, even if just a little bit. The speed of the molecules depends on their temperature. Cold things have slow-moving molecules, while hot things have fast-moving molecules. In fact, temperature is really a measurement of molecule speed. For a cold thing to get warm, its molecules have to speed up.

Heat moves in three different ways -- conduction, convection, and radiation. Conduction is the flow of heat between two solid objects that are touching. Heat conducts from your warm fingertips into a cold can of soda. Convection is the transfer of heat with a liquid or gas. A hot bath feels warm all over not just where you're sitting. Convection also happens naturally. When air gets warmed by a hot burner, it's molecules speed up and spread out. Then, cold air molecules squeeze the warm spread-out molecules up. That's why people say hot air rises. It's natural convection. Radiation is when heat beams or radiates from a warm object to cold surroundings. Sit in front of a window at night. Hold your hand up with your palm facing the window, then twist your wrist so your palm faces inside. You'll feel the heat radiate from your hand into the dark outside.

References:

Nye, B. (2005). Heat. Retrieved July 28, 2009, from, http://nyelabs.com/episode_pdfs/episodeguide30.pdf

U. S. Department of Energy (1994). *Solar Heating and You*. Retrieved June 30, 2009, from, http://www.builditsolar.com/Projects/SpaceHeating/SolarHeatingIntro15772.pdf

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