CLEAN ENERGY BRIGHT FUTURES
A Program of BEF

LESSON PLAN

Solar Updraft Towers: Innovations in Renewable Energy

Lesson 2: Where Does Energy Go?

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DESCRIPTION
This lesson consists of six demonstration activities that show examples of ways in which water and air absorb heat to transfer energy from one place to another. These demonstration activities act as unique phenomena in which students can generate questions to lead subsequent investigations with each activity in learning centers. Through gaining content from investigations with these phenomena, students will gain insight into how energy conversions work in a solar updraft tower.

GRADE LEVEL(S)
3, 4, 5, 6, 7, 8

SUBJECT AREA(S)
Convection currents, properties of matter, energy fundamentals, energy transformations

ACTIVITY LENGTH
50 min x 6 class periods (300 min = 5 hours)

LEARNING GOAL(S)

1. Students will understand that hot air rises
2. Students will understand why hot water and hot air rise and cold air and cold water sink.
3. Students will learn that wind is produced by warm air rising and cold air sinking.
4. Students will learn that the energy of moving hot air can be converted into other forms of energy.
5. Students will understand that energy from the sun can be converted into heat.
6. Students will discuss the effects of the chimney stack phenomenon.

STANDARDS REMINDERS

- In order to highlight energy conversions, have students engage in consistent discussion about where energy inputs are within the system they are observing and where work is being performed during an energy transformation.
- Work with students throughout their observations as well to determine other places they have seen this type of energy conversion used. In discussing things such as hot air balloons or windmills as a result of this question, it can allow students to begin thinking about how to incorporate this content knowledge into a design challenge.

CONTENT BACKGROUND

STUDENT BACKGROUND

Students participating in this lesson should be familiar with the following:

- Wind is produced by hot air rising and cold air sinking.
- Hot air and hot water rise.
- Hot air mixing with cold air can create energy.
- Wind can make turbine blades spin, which creates energy.

EDUCATOR BACKGROUND

Educators leading this lesson should be familiar with the following:

- A basic understanding of the way hot air and water rise as cold air sinks.
- An understanding of the way wind is produced by warm air rising and cold air sinking.
- An understanding of the way air and heat together can produce power.
- The chimney stacking effect phenomenon explained in the video in this lesson, in which warm air seeks to find the highest location. It will forcefully move up a space, pushing cold air up and out, to reach its highest destination.

MATERIALS NEEDED

HANDOUTS/PAPER MATERIALS

- Worksheet 4-KWL Water Wind Heat
- Worksheet 5-Phenomena Chart

CLASSROOM SUPPLIES

- Pencils
- Paper
- Scissors

- 4 glass bottles or jars that can be inverted on top of one another
- Food coloring blue and red or blue and yellow
- Water
- A Solar Bag (can be purchased inexpensively online.)
- A Norwegian or German Candle Spinner (can be purchased inexpensively online)
- Paper and scissors for cutting spiral
- A lamp without a shade
- Needle and string
- A radiometer (can be purchased inexpensively, online)

LESSON PROGRESSION

PLANNING AND PREP

- Teachers should test each demonstration before presenting them to the class.
- Teachers should preview the videos before showing them to the class.
- Gather 4 identical glass jars or bottles.
- Plan to conduct the solar bag experiment on a sunny morning.
- Prepare a lamp without a shade.
- Light the Norwegian Spinner outside, not in the classroom.
- Plan to leave two radiometers in the window for several weeks to observe changes.

LESSON SEQUENCE

INTRODUCTION

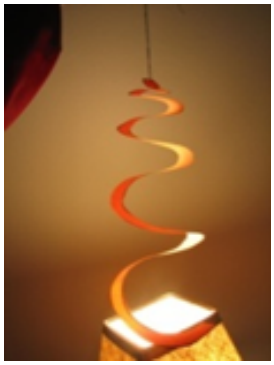
- Before students start investigating different phenomena, pass out "Worksheet 4-KWL Water Wind Heat" and have them brainstorm everything they know about how water, wind, and heat interact.
- Examples can include dew on grass, condensation on cars and cold drinks, weather, clouds, hurricanes, why birds fly so close to mountains and trees, steam on the road after rain, etc.

INVESTIGATING PHENOMENA

- During the next sections of the lesson, students will be investigating various phenomena in an order and manner determined by the teacher. These can be split into stations in one day, presented in different days, or combined in another manner that makes sense.
- Students will use "Worksheet 5-Phenomena Chart" to track their thought process as they go through each investigation of a phenomena. The chart below explains each phenomena and the content being demonstrated in the display.

- Following completion of their observations of each phenomena, give students time to write down questions they still have and discuss them as a class, perhaps written on a group poster or white board format.
- Discuss as a class how different questions posed by their classmates can be investigated using the materials on hand and any additional materials available.

	HOT AIR RISES/COLD AIR SINKS TO CREATE A CONVECTION CURRENT • A demonstration is performed using four glass bottles. Two with blue cold water and two with yellow hot water. Two bottles will be inverted on top of one another. The bottles with blue on the bottom and yellow on the top will stay the same; the bottles with blue on the top and yellow on the bottom will mix to form green. • Students fill out the convection column of their worksheet.
	LIKE WATER, HOT AIR RISES • This can be demonstrated dramatically with a 50 foot long solar bag. Take the solar bag out to the playground on a cool, clear sky morning. The solar bag demonstrates many scientific principles including buoyancy, convection, thermodynamics and solar power. It also teaches Bernoullis Principle. • Students will fill in the Solar Bag column of their worksheet.
	WIND IS PRODUCED BY WARM AIR RISING AND COOL AIR SINKING • The Norwegian Candle Spinner demonstrates the motion created in the air by rising warm molecules. • Students will fill in the Norwegian Candle Spinner column of their worksheet.

	WIND IS PRODUCED BY WARM AIR RISING AND COOL AIR SINKING • A paper spiral over a light bulb demonstrates this principle as warm air rises from the bulb and pushes the paper spiral. • Cut out a spiral circle from a lightweight piece of paper, and tie a short length of string to the top of the paper spiral. Hold the spiral, by the string over a light bulb and watch it spin. • Patterns can be cut from the Scholastic "Wind Spiral printable" on the Scholastic website. • **Students will fill in the Paper Spiral column of their worksheet.**
	A CROOKES RADIOMETER USES HEAT FROM LIGHT TO MAKE LIGHT AND DARK PANELS SPIN IN A FRICTIONLESS ENVIRONMENT • The radiometer is demonstrated by placing it in the sunlight or near a light bulb. • **Students fill out the radiometer column of their worksheet.** • A video is then shown to explain the history and science behind the radiometer. • RESOURCE: **How Stuff Works/Brain Stuff/ Crookes-radiometer video.** o This YouTube video explains the history of the radiometer and how it works in an entertaining way: http://www.brainstuffshow.com/videos/crookes-radiometer-video.htm

TWO YOUTUBE VIDEOS ARE SHOWN TO EXPLAIN AND DEMONSTRATE "STACK EFFECT."

- "Your Northern Home: Stack Effect Cold Climate Housing" – A housing expert does a thorough job of explaining how cold air pushes hot air up, out and increases in speed, the taller the house is. The students will be able to relate to the things they have seen and experienced in their own houses (5 minutes).
- "Stack Effect Demonstration Dave McGrail" Three firemen in Denver, Colorado open the front door in a high rise, on a cold day. They use a streamer flag to show how intense the updraft is. (1 minute).

ASSESSMENT AND EXTENSIONS

FORMATIVE ASSESSMENT

Students will be assessed on the completeness and thoughtfulness of the probing questions on the worksheet for this lesson.

LESSON EXTENSIONS

These demonstrations offer many opportunities for further discussion and experiments. Depending on the discussion reached by your students in their filling out of the chart and as a whole class, it is possible to determine methods in which groups of students can continue to investigate how each of these scenarios functions more closely using the materials at hand.