Heat Balance – Radiation & Conduction Lesson

The Sun is the primary heat source that warms the Earth. The tilt of the Earth on its axis and the orbit of the Earth around the Sun every year cause mid-latitude countries to experience seasons. During the transition from one season to another, processes in the Earth's ocean and atmosphere tend to distribute heat energy over the surface from warmer to cooler areas. The focus question for this lesson is:

? How does solar radiation and conduction influence the daily weather **?**

MATERIALS

Materials are listed with each section of the lesson.

Part A: Angle of Solar Radiation

Materials: flashlight, globe, graph paper, ½ cup uncooked rice

PROCEDURE

1. With your partner, take a globe and review the reasons for seasons on Earth. Write a few sentences in your notebook describing your thoughts. Do you still have any questions? If so, record them for later discussion.

2. Hold or place the globe tilted on its axis at 23.5 degrees, as shown here. If your globe does not have a stand that maintains the tilt, you may want to tape a straw to the north pole to make it easier to see the tilt.

3. With the flashlight turned on and approximately 10 cm from the globe, shine the light to simulate radiation during the Northern Hemisphere's summer. Keep the flashlight horizontal to the ground at all time; move it higher or lower to illuminate different portions of the globe.
   a. Describe the light hitting the globe when the flashlight shines on the Equator.
   b. Keeping the flashlight the same distance from the globe, shine the flashlight on the central part of Colorado. Compare how the light shining on Colorado with light shining on the Equator. Write down your observations.
   c. Now shine the flashlight on Alaska. Compare how the light shining on Alaska is the same or different than on the Equator. Write down your observations.
   d. Now, experiment with the Earth during the Northern Hemisphere's winter.

3. Take the flashlight and a piece of graph paper and shine the light a given distance on the paper. Trace the outline of the light.

4. Keeping the flashlight at the same distance from the paper, tilt the flashlight to represent the angle of the light at a different latitude. Trace the new outline of light.

5. Fill the first outline of light with one layer of uncooked rice. The rice represents packets of light energy that strike the Earth. Count and record how many pieces of rice were needed to completely fill the light circle.

6. Take the same number of rice kernels you used in the previous step and spread them evenly within the second light drawing. Describe your observations.

Analysis Questions

1. Observe the two light images. Describe how they are the same and different in terms of light energy.

2. Using the rice to explain your answer, describe how light energy from the Sun strikes different surfaces of Earth.

Part B: Heat Energy Flow

Materials: 500 mL beaker half full of hot tap water, zip-lock baggie of crushed ice, two thermometers, timing device

PROCEDURE

1. To observe heat flow, you will place a baggie of crushed ice into a beaker of hot tap water. You will then record temperatures of the ice and the tap water over 30 minutes.

2. Sketch a line graph showing what you predict will happen to the temperature of the ice over 30 minutes. Add a second line showing your prediction of what will happen to the temperature of the water over 30 minutes.

2. Set up your materials for observation. First, place one thermometer into the baggie of crushed ice and close the zip-lock from each side until the thermometer is supported by the closed baggie. Let the baggie sit until the temperature stabilizes. Record the beginning temperature of the crushed ice in your notebook.

3. Obtain the 500 mL beaker and fill it half full of hot tap water. Place the other thermometer into the beaker and let it sit until the temperature stabilizes. Record the beginning temperature of the hot tap water.

4. Now, place the baggie into the beaker of hot water. Record the temperature of each material every minute for 30 minutes. Graph your results.

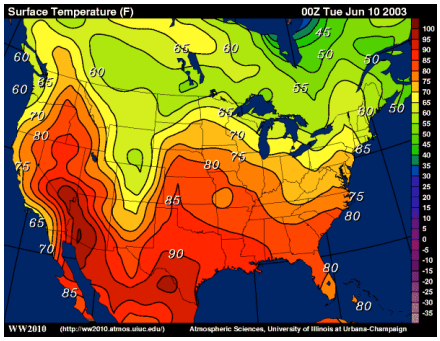
Analysis

3. Describe any patterns you see in the data.

4. Explain how heat energy moves from one object to another.

Part C: Temperature Data
Materials: U.S. map with temperatures, printer, pencil. Map is found at http://www.ametsoc.org/amsedu/dstreme/images/sfcptemp.gif

PROCEDURE



1. Meteorologists use temperature data from all over the United States to make weather maps and predict upcoming weather conditions. One of the basic pieces of information that people want on their local weather reports is current temperature. Meteorologists make ***isotherm*** maps with current temperature data and from that data predict future patterns of temperature. An isotherm map shows lines of "equal" temperature for the United States.

2. Go to this website and follow their interactive tutorial to learn how to draw isotherm lines: http://www.uni.edu/storm/downloads/Level2/Drawing Isotherms-2.pdf

3. Print out and observe a map of today's temperatures across the U.S. at http://www.ametsoc.org/amsedu/dstreme/images/sfcptemp.gif

You will note a date and time in the upper left-hand corner of the map. "Z" stands for Zulu time on the Prime Meridian – subtract 7 hours to represent the time in Mountain Standard Time, for example. The temperatures you see were recorded by various weather stations throughout the country at that time.

4. What season, day, and time, does the U.S. temperature map represent? What patterns do you see in the temperature data?

4. Make an isotherm map on the U.S. temperature map data.
   a. These temperatures are in Fahrenheit which is the scale normally reported on TV weather programs and in the newspaper.
   b. Isotherms are usually reported in 10°F increments. Using a pencil, start with the 60°F isotherm—it will be the easiest one to draw. When you draw the line, you should take any two numbers and determine if that numbered line would fall between those two numbers—if it doesn't, the line should go around the numbers in another way.
   c. When you have successfully drawn the 60°F line, draw the other isotherms. They will generally follow the shape of the first line.

Analysis

5. Compare the data on the isotherm map with the data the class obtained when heating water and dark soil in the Module 2 Heating and Cooling Different Materials lesson. What similarities do you see in these two sets of data?

6. How do the data on the map support the fact that latitude is connected to seasons?

7. If you had to draw in a line that represents a "cold" front, where would you put it? Pencil it in.

Part D: National Weather
Materials: computer lab
Web site: www.ametsoc.org/amsedu/dstreme/

PROCEDURE
1. You had the opportunity earlier to make an isotherm map with temperature data from a previous day. Now, go to the DataStreme Atmosphere website and scroll down to the Surface section. In the middle column of the table, click on "Isotherms & Temperatures." What patterns do you see for this current data? How is this isotherm map different than the one you made from earlier data?

2. Next, go to the "Isobars & Pressures" map. Look for patterns on the map.

3. Next, go to the "Isotherms, Fronts, and Data" map. Compare it with the previous two maps you have seen.

4. Finally, scroll farther down to the section of the web site called Satellite. Click on the "Visible-Latest" link. Can you see the leading edge of any cold fronts? How do you know?

Analysis

8. Based on all of the maps, where do you think it is raining? Explain your answer.

CONCLUSION
Use what you learned in this lesson to write a conclusion to the focusing question.