TESTING WATER AND SOIL

BENCHMARK and TASK

SC.D.1.2.3 The student knows that the water cycle is influenced by temperature, pressure, and the topography of the land.

- The student compares the rate at which land and water heats and cools and relates this uneven heating to the weather.

KEY QUESTIONS

Which heats faster, soil or water?
Which cools faster, soil or water?

BACKGROUND INFORMATION

Soil absorbs **heat energy** faster than water but also releases it more quickly. Water warms and cools very slowly. Soil is opaque; water is transparent. The **sun's** rays pass through transparent materials more readily than opaque materials, distributing the heat energy to greater depths. Since sunlight can't pass through the rough, dark surface of soil, the heat energy is absorbed only at the surface.

Water moves easily because it is a **liquid.** The water molecules help transport heat to different areas and depth. Soil, a **solid**, is more stationary and the heat remains at the surface. The heat energy absorbed in land is transferred by contact. Water has a greater capacity for heat. It takes more heat to raise the temperature of water than it takes to raise the temperature of the same amount of soil. Water is slow to take in heat but then equally slow about releasing it. Water temperatures vary less over time than soil temperatures.

Temperatures are affected by altitude or elevation, the height of land above or below sea level. The higher the altitude, the cooler the climate will be. Even near the **equator,** areas of higher altitude have cooler temperatures than do those near sea level. Oceans usually have a moderating effect on nearby land masses, because water heats up and cools down more slowly than land does. Air masses coming from the oceans can have a great cooling or warming effect on temperature over land areas, depending upon whether the air masses are coming from cold waters or warmer waters.

MATERIALS

Per group or whole class (See Teaching Tips)

1 box lid or shallow box
1 Styrofoam cup of soil
1 Styrofoam cup of tap water
2 thermometers
tape
1 ruler
1 timer or clock
1 lamp (unless the activity is done outdoors)

TEACHING TIPS

1. This activity can be done in small groups or as a whole class lesson. The main consideration is the number of box lids and lamps that can be gathered.
2. The activity may also be done outside on a sunny day.
3. Students should have prior experience using a thermometer. Make sure students have identified the scale (Fahrenheit or Celsius) they will be using. Have them note the increments on the scale. When the liquid stops moving, students should bring their eyes level to the thermometer and read carefully.
4. Construct the following table before beginning this activity.

Temperature Differences of Water and Soil (Heating)

Materials	Beginning	Ending	Change
Water (tap)			
Soil			

Temperature Differences of Water and Soil (Cooling)

Materials	Beginning	Ending	Change
Water (tap)			
Soil			

ENGAGE

Ask: *Have you ever been to the beach on a hot, sunny day and tried to walk across the sidewalk or sand? What did it feel like?*
Did you run very fast to get into the water to cool off? What did the water feel like?

EXPLORE

Student instructions:

1. Fill one cup with soil and one cup with tap water. Use equal amounts and fill to just below the top of the cup.
2. Set the cups next to each other in the back of the box lid.
3. Place a thermometer in each cup. The cups should be pushed against the back of the box. Make sure the thermometers are about ¼ inch below the surface of the soil or water. Tape the thermometers to the back of the box so they do not slip inside the cups lower than ¼ inch.
4. After 5 minutes, record the beginning temperature of both the soil and the water on your recording sheet. Do not remove the thermometers from the cups.
5. Have students predict how the temperatures of the soil and water will change during the investigation.
6. Place a lamp over the box about 10 inches away from the box. Make sure the light bulb is not touching the box!
7. Wait 15 minutes; turn off the lamp. Record the temperature of each material. This will be the ending temperature of the heating and the beginning temperature of the cooling.
8. Record the change in temperature from the beginning measurement to the ending measurement.
9. Measure the temperature again after the lamp has been off for 15 minutes.
10. Prepare a double bar graph or a double line graph to display the data.

EXPLAIN

What was the temperature of the water and the soil at the beginning of the experiment?
How did the temperatures of the water and the soil change after they were heated?
Which heated up faster, the water or the soil? (soil)
Which cooled faster, the water or the soil? (soil)
What conclusion can you make about the heating rates and cooling rates of water and soil? (Water heats up more slowly than soil. Heat energy travels through transparent water and heats up the entire cup of water. Water also takes longer to release the heat energy. Heat energy does not travel easily through the opaque soil; the heat energy stays near the surface. For this reason, soil releases the heat energy more quickly than the water.)

EXTEND/APPLY

1. Discuss:
   According to the double bar graph, which material cools faster, the water or the soil? How can you apply this knowledge to the way the land and oceans heat? Do you find that it is cooler at the beach than in the middle of the city? Why?
   (Inland areas usually have greater temperature extremes from day to night because land absorbs and loses heat energy quickly. Locations along an ocean usually have more moderate daily temperatures. Heat energy released from the soil makes the air temperatures heat up quickly in the sun and cool down quickly in the shade. The air temperature right above the water would not change as much since the water doesn't heat up and cool as quickly as soil.)
2. Check the newspaper for some high and low temperatures of both inland and coastal cities and discuss.

EXTENSIONS

1. Test different types of soil and graph the results.
2. Read *Weatherworks* by Jeri Cipriano.

ASSESSMENT

Ask: *What conclusions can you make about the heating and cooling rates of water and soil? Use data from the investigation to support your answer.*