

Which Gets Hotter, Land or Water?

TITLE: Which Gets Hotter, Land or Water?

TOPICS: Weather, climate, uneven heating of the Earth's surface

GRADE LEVEL: 6-10

CONTENT STANDARD: Earth and Space Science

CONTENT OBJECTIVE: To illustrate how dark land surfaces, light land surfaces and water all heat at different rates. This will illustrate that water heats more slowly than land and therefore the surface of the Earth must heat at different rates, causing our weather.

TIME REQUIRED:

90 minutes, have other worksheet activities to do while waiting.

MATERIALS NEEDED:

3 identical waterproof containers (1–2 cup size plastic containers, U-shaped dishes, large Styrofoam cups, etc.)

3 thermometers

Large reflector lamp and ring stand with at least a 100-w bulb

Black or dark brown sand, white sand and water, all at room temperature (Wards sells sand)

Stop watches or a large clock with second hand

TEACHER DIRECTIONS FOR INSTRUCTION/ACTIVITY:

This is a laboratory to be used when studying weather. The uneven heating of the Earth's surface causes weather. When you have differences in air temperature, the hot air will rise and the cold air will sink. These movements create wind (which also is affected by the rotation of the Earth). Hotter air has lower air pressure. Higher air pressure will flow into areas of lower air pressure, also creating wind. This activity will demonstrate how, even at this small scale, water heats up much more slowly than land. This will lead into a discussion about how continents will be warmer, the air above continents will be warmer and therefore the different temperatures of the air will lead to wind and weather. The activity also gives a good lead-in to a discussion of sea and land breezes, and why there are more moderate temperatures along ocean coasts. Cities on the coast are milder in winter, cooler in the summer (think San Francisco). Inland areas (think South Dakota) can be in the upper 90's in the summer, and well below zero in the winter.

If you do not have a block schedule, you may shorten the time spent heating up and cooling. I have used 30 minutes of heating and 15 minutes of cooling, but you want to make sure you have high wattage light bulbs or the experiment won't work well. Also use smaller amounts of sand and water, perhaps in a smaller cup. Emphasize that it is important that the sand and water start at the same temperatures.

Have students gather materials and check to make sure set up is correct (most importantly that the heat source is directly over all three cups evenly!). Make sure each group has a reliable timekeeper and that they all know how to read the thermometers. Since there is a lot of waiting during this activity, I usually give them a reading and worksheet assignment to complete during the experiment.

EVALUATION:

Graphs should generally show the dark sand heating up the fastest and cooling the fastest, the light sand a little slower, and the water the slowest.

Answers to questions:

1. This answer should describe the results shown in the table and on their graph (as explained above). The graph, of course, should match with the numbers in the table.
2. Students should conclude that the water absorbs the same amount of heat without going up in temperature as quickly. If they know the concept of heat capacity, urge them to discuss that here (you may want to put that term in the question). Most will know that darker colors absorb more wavelengths of color and therefore the dark sand was the hottest (and cooled faster as well).
3. The results indicate that the Earth, being covered by large bodies of water and land, will heat unevenly. The interior of larger continents will probably get hotter than smaller landmasses
4. A. The uneven heating of the Earth's surface, creating air with different temperatures and pressures, will cause wind and therefore weather to occur. B. The ability of water to hold more heat means the Earth's temperature will be much more moderate than if there were a larger percentage of land, making the surface of the Earth more habitable for humans and all life (lucky for us).

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STUDENT PAGES FOLLOW:

Name: _____ Date: _____

Which Gets Hotter: LAND OR WATER?

OBJECTIVE: You will determine if land or ocean absorbs heat faster and discuss the implications of your findings on the Earth's weather system.

Materials: Obtain 3 identical waterproof containers, three thermometers, a reflector lamp and ring stand, room temperature water, and light and dark room temperature sand. Mark the color of your two sand samples on the data table

Preparation: Fill one container about half full with light sand, one with dark sand, and the third with water to the same level. Place the thermometers upright into the sand and water, submerging the ball of the thermometer into the material. Place the containers under the light source so that they all obtain equal amounts of light rays from it. Make sure the thermometers are upright and not receiving direct light.

Procedure: Before you turn the light on, take the initial temperature, adjusting the water's temperature if needed to match the sand's temperature. Turn the light on and measure the temperature of each material in Celsius every 5 minutes. Record on the data table below. After 40 minutes, turn off the light and record the falling temperatures for about 30 minutes. Graph the results on the graph paper provided, using different colors or patterns for each material. Answer the questions below.

DATA: Color of light sand: _____ Color of dark sand: _____

Time:	0														
Water Temp:	°C														
Light Sand:															
Dark Sand:															

ANALYSIS:

1. Please describe the results of your experiments for the three cups:
2. What can you conclude from these results? (I.e., which material heats and cools the fastest/slowest?)
3. What do these results indicate about the heating of the Earth?
4. Explain how these results affect the weather on the Earth **in detail**. What do you think would happen if the Earth were covered with over 70% land instead of water?

