

Heating Earth's Surface

Problem

How do the heating and cooling rates of sand and water compare?

Skills Focus

developing hypotheses, graphing, drawing conclusions

Materials

- 2 thermometers or temperature probes
- 2 beakers, 400-mL
- sand, 300 mL
- water, 300 mL
- lamp with 150-W bulb
- metric ruler
- clock or stopwatch
- string
- graph paper
- ring stand and two ring clamps

Procedure

1. Which do you think will heat up faster—sand or water? Record your hypothesis. Then follow these steps to test your hypothesis.
2. Copy the data table into your notebook. Add enough rows to record data for 15 minutes.
3. Fill one beaker with 300 mL of dry sand.
4. Fill the second beaker with 300 mL of water at room temperature.
5. Arrange the beakers side by side beneath the ring stand.
6. Place one thermometer in each beaker. If you are using a temperature probe, see your teacher for instructions.
7. Suspend the thermometers from the ring stand with string. This will hold the thermometers in place so they do not fall.

8. Adjust the height of the clamp so that the bulb of each thermometer is covered by about 0.5 cm of sand or water in a beaker.
9. Position the lamp so that it is about 20 cm above the sand and water. There should be no more than 8 cm between the beakers. **CAUTION:** Be careful not to splash water onto the hot light bulb.
10. Record the temperature of the sand and water in your data table.
11. Turn on the lamp. Read the temperature of the sand and water every minute for 15 minutes. Record the temperatures in the *Temperature With Light On* column in the data table.
12. Which material do you think will cool off more quickly? Record your hypothesis. Again, give reasons why you think your hypothesis is correct.
13. Turn the light off. Read the temperature of the sand and water every minute for another 15 minutes. Record the temperatures in the *Temperature With Light Off* column (16–30 minutes).

Data Table					
Temperature With Light On (°C)			Temperature With Light Off (°C)		
Time (min)	Sand	Water	Time (min)	Sand	Water
Start			16		
1			17		
2			18		
3			19		
4			20		
5			21		



Analyze and Conclude

1. **Graphing** Draw two line graphs to show the data for the temperature change in sand and water over time. Label the horizontal axis from 0 to 30 minutes and the vertical axis in degrees Celsius. Draw both graphs on the same piece of graph paper. Use a dashed line to show the temperature change in water and a solid line to show the temperature change in sand.
2. **Calculating** Calculate the total change in temperature for each material.
3. **Interpreting Data** Based on your data, which material had the greater increase in temperature?
4. **Drawing Conclusions** What can you conclude about which material absorbed heat faster? How do your results compare with your hypothesis?
5. **Interpreting Data** Review your data again. In 15 minutes, which material cooled faster?

6. **Drawing Conclusions** How do these results compare to your second hypothesis?
7. **Developing Hypotheses** Based on your results, which do you think will heat up more quickly on a sunny day: the water in a lake or the sand surrounding it? After dark, which will cool off more quickly?
8. **Communicating** If your results did not support either of your hypotheses, why do you think the results differed from what you expected? Write a paragraph in which you discuss the results and how they compared to your hypotheses.

Design an Experiment

Do you think all solid materials heat up as fast as sand? For example, consider gravel, crushed stone, or different types of soil. Write a hypothesis about their heating rates as an "If ... then...." statement. With the approval and supervision of your teacher, develop a procedure to test your hypothesis. Was your hypothesis correct?