11A – EVAPORATIVE COOLING

INQUIRY

Why does perspiration make you feel cooler? How is cooling related to molecular properties?

MATERIALS

- Device with SPARKvue software
- Temperature sensor
- Molecular Model Set
- Beakers, 100-mL (3)
- Rubbing alcohol
- Fingernail polish remover
- Cotton balls
- Marker
- Water

BACKGROUND

Imagine that it is a hot summer day. At the end of a jog, you are drenched in sweat. Once inside your home, you start to feel cool. Why does sweating keep us cooler in warm temperatures? The answer is evaporative cooling, which is the process of liquid water evaporating from a surface, decreasing the surface's temperature. When sweat evaporates from your skin, it removes heat energy and makes you feel cool. Droplets of sweat help to regulate body temperature. Each liquid has its own evaporative cooling rate due to its structure and intermolecular forces.

SAFETY

Follow these important safety precautions in addition to your regular classroom procedures.

- Wear safety goggles at all times.
- Alcohol and acetone are both flammable and can be hazardous if inhaled or swallowed. Use Care.
- Wash your hands with soap and water before leaving the laboratory.
- Dispose of all chemicals in the waste container as directed by your teacher.

PROCEDURE

Part 1 – Cooling rates

1. Pour about 25 mL of rubbing alcohol, nail polish remover, and water into separate beakers. Label the beakers with the substance being tested.

2. Dip a cotton ball into the water and wipe it on the inside of your elbow. What do you feel? Record your observations in Table 1 on your answer sheet.

3. Dip a separate cotton ball into the rubbing alcohol and wipe it on the inside of your other elbow. What do you feel? Record your observations in Table 1.

4. Open SPARKvue.

PROCEDURE

5. Open the 11A Evaporative Cooling lab file in SPARKvue.
6. Use the Bluetooth icon to connect the Temperature sensor.
7. Place the tip of the temperature probe into the cup with water in it. Wait about 30 seconds so the temperature can stabilize.
8. Start data collection. Simultaneously remove the probe from the liquid.
9. Hold the sensor still so that air can move around it. Data collection will automatically stop after one minute.
10. Scale the graph. Determine the maximum temperature, minimum temperature, change in temperature, and time for the cooling region on the graph. Record these values in Table 2 on your answer sheet.
11. Determine the cooling rate (change in temperature / change in time) for the water. Record the result in Table 2.
12. Repeat steps 7 through 11 with the rubbing alcohol and nail polish remover. Make sure to clean and dry the probe between runs.
13. Make sure all runs are visible then sketch the graph of temperature versus time on Graph 1 on your answer sheet. Create a graph legend to identify the substance for each run.

ANALYSIS

Complete the analysis for Part 1 on your answer sheet.

PROCEDURE

Part 2 – Modeling

1. Rubbing alcohol is mostly isopropyl alcohol and nail polish is mostly acetone. Research the structure of these three substances: water, isopropyl alcohol, and acetone.
2. Build a model of water, isopropyl alcohol and acetone.
3. Write the chemical and structural formula for each of the substances in Table 3 on your answer sheet.
4. Make some qualitative observations about the liquids in the beakers. Record your observations in Table 3.

ANALYSIS

Complete the analysis for Part 2 on your answer sheet.

QUESTIONS

Answer the questions on your answer sheet.