23B - THE WATER CYCLE

INQUIRY

What are the properties of water that drive the earth's water cycle? How does the water cycle transfer water molecules around the earth?

MATERIALS

- Device with SPARKvue software
- Conductivity sensor
- Colorimeter and turbidity sensor with cuvettes
- Test tube, 20 mm x 150 mm (LED)
- Beaker, 150-mL
- Beaker, 50-mL
- Stirring rod
- Heater stirrer
- Condenser
- Muddy water
- Salt
- Ring stand
- Crushed ice
- Wash bottle filled with distilled water

BACKGROUND

Fluctuations in energy push water through the water cycle around Earth. The unique properties of water enable it to drive Earth's atmospheric and ocean cycles as it redistributes energy around the globe. The water molecule's structure enables it to form strong attractions to other water molecules. Because of this, water molecules can form amazing crystal structures in solid ice, flow together as a liquid, and then separate from each other during evaporation as the molecules carry heat energy away during the process. The processes of evaporation and condensation allow water to purify itself as it travels through the water cycle.

SAFETY

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

- Wear safety goggles at all times.
- The water is being heated to a high temperature and may burn.

PROCEDURE

Part 1 – The water cycle

1. Fill a 150-mL beaker about half full of crushed ice. Add some water until it is about 2/3 of the way full.

2. Place the beaker on the heater stirrer.

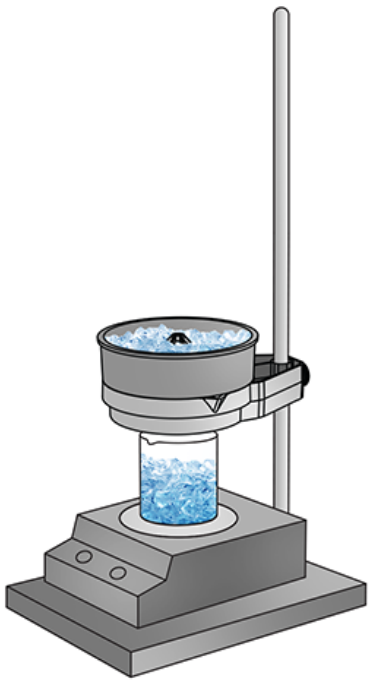
3. Make sure the temperature sensor opening on the condenser is closed with a stopper. Fill the top of the condenser with crushed ice. Pour salt over this crushed ice.

4. Use a ring stand to suspend the condenser over the beaker.

5. Begin heating the ice–water mixture. Allow the mixture to come to a boil.

6. Record observations in Table 1 about what is happening in the beaker and what is happening on the bottom of the condenser.

7. The bottom of the fill line under the spout of the condenser indicates approximately 10 mL. When you have collected about 10 mL of water in the bottom of the condenser, pour it in a test tube.



ANALYSIS

Table 1 – Water cycle observations

Location	Observation
Beaker	
Bottom of condenser	

QUESTIONS

Part 1 – The water cycle

1. Is the melting and evaporation of water an endothermic or exothermic process?

2. At the molecular level, what happened to the water as it melted, warmed and evaporated? Why is energy needed for these phase changes to occur?

QUESTIONS

3. Is the condensation of water on the bottom of the condenser an endothermic or an exothermic process?

4. What happens to the amount of water vapor in our air as the surface temperatures on Earth rise? Explain your thinking.

5. What environmental factors affect evaporation besides temperature?

6. Scientists predict storms and hurricanes will increase in power as a result of global warming. Explain how this is possible in terms of energy distribution by means of the water molecule.

PROCEDURE

Part 2 – Recycling muddy water

1. Open SPARKvue.

2. Connect the conductivity sensor and the colorimeter and turbidity sensor.

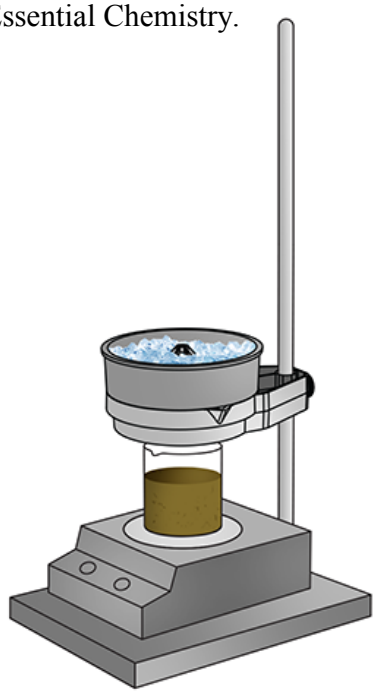
3. Turbidity is a measure of the cloudiness of the water. It is measured in nephelometric turbidity units (NTU). Calibrate the turbidity measurement on the colorimeter and turbidity sensor with distilled water (0 NTU) and a 100 NTU reference solution.

4. Open the 23B Water Cycle lab file in SPARKvue under Experiments > Essential Chemistry.

5. Collect a 75-mL sample of muddy water in the 150-mL beaker.

6. Start collecting data.

7. Stir your sample of muddy water in the beaker so the contents are as evenly suspended as possible. Fill a cuvette ¾ full with the stirred sample.



8. Use the colorimeter and turbidity sensor to measure the turbidity of the water. Turbidity is a measure of the cloudiness of the water. Record your results in Table 2.

9. Place the conductivity sensor in the beaker containing the muddy water. Record the total dissolved solids in Table 2, then remove the conductivity sensor. Rinse the sensor with distilled water to clean it.

10. Place the beaker on the heater stirrer. Follow steps 2-7 of the Water Cycle procedure using muddy water instead of ice water.

PROCEDURE

11. Stop heating the muddy water once you have collected about 10 mL of clean distilled water in the test tube.

12. Measure the turbidity and the total dissolved solids of the clean water sample. Record your results in Table 2.

13. Stop collecting data.

ANALYSIS

Table 2 – Recycling muddy water

Water sample	Turbidity Observation	Total dissolved solids
Muddy		
Clean		

QUESTIONS

Part 2 – Recycling muddy water

1. What happens to the dissolved solids as the muddy water is heated?

2. How does this affect the cleanliness of the water change as water goes through the evaporation and condensation portion of the water cycle? Use your observations from the investigation to justify your answer.

THE WATER CYCLE

Analysis: The water cycle

Table 1 – Water cycle observations

Location	Observation
Beaker	
Bottom of Condenser	

Questions: The water cycle

1. Is the melting and evaporation of water an endothermic or exothermic process? Explain your answer.

2. At the molecular level, what happened to the water as it melted, warmed and evaporated? Why is energy needed for these phase changes to occur?

3. Is the condensation of water on the bottom of the condenser an endothermic or an exothermic process? Explain.

4. What happens to the amount of water vapor in our air as the surface temperatures on Earth rise? Explain your thinking.

5. What environmental factors affect evaporation besides temperature?

6. Scientists predict storms and hurricanes will increase in power as a result of global warming. Explain how this is possible in terms of energy distribution by means of the water molecule.

Analysis: Recycling muddy water

Table 2: Muddy and clean water

Water Sample	Turbidity Observation	Total Dissolved Solids
Muddy		
Clean		

Questions: Recycling muddy water

1. What happens to the dissolved solids as the muddy water is heated?

2. How does this affect the cleanliness of the water change as water goes through the evaporation and condensation portion of the water cycle? Use your observations from the investigation to justify your answer.