Name: _____

Period: _____

Date: _____

Teacher Key: The Water Cycle, Oxygen-18, and Ice Cores Worksheet

Demonstration

Before the demonstration, look at the styrofoam balls in the plexiglass container and then answer the following questions:

1. In what way are the styrofoam balls the same or different?

The styrofoam balls are the same size but differ in color and mass.

2. What do the styrofoam balls represent?

The styrofoam balls represent the two forms of water vapor (heavy and light water).

3. What do you think that the plexiglass container represents?

The plexiglass container represents the layer of the atmosphere above the equatorial oceans.

4. What do you think that the fan represents?

The fan represents the amount heat energy in the system.

Next, your teacher will turn the fan on to simulate the evaporation of water. Watch the styrofoam balls closely and answer the following questions.

5. Which styrofoam balls seem to be rising the highest?

The white styrofoam balls rise the highest.

6. Which styrofoam balls tend to stay lower?

The red styrofoam balls tend to stay lower.

7. Come up with a hypothesis that will explain the observed motion of the styrofoam balls.

The white styrofoam balls rise the highest in the air column because they have a lower mass and require less energy to be lifted into the air column.

Heavy Water

8. How is heavy water ($H_2{}^{18}O$) different from light water ($H_2{}^{16}O$)?

Heavy water contains a different isotope of oxygen, oxygen-18, which makes heavy water more massive than light water, which contains oxygen-16.

9. The different masses of $H_2{}^{16}O$ and $H_2{}^{18}O$ behave differently in the water cycle.

   a. Which one do you think preferentially evaporates?

   $H_2{}^{16}O$ preferentially evaporates.

   b. Which one do you think tends to remain in the ocean?

   $H_2{}^{18}O$ tends to remain in the ocean.

10. Why would a sample of water vapor taken from above the ocean contain a higher ratio of $H_2{}^{16}O$ compared to $H_2{}^{18}O$? (Hint: think about the styrofoam balls in the demonstration).

The sample would contain a higher ratio of $H_2{}^{16}O$ compared to $H_2{}^{18}O$ because $H_2{}^{16}O$ is less massive than $H_2{}^{18}O$ and therefore evaporates more readily at a given temperature.

Condensation and Precipitation

11. During a period of warmer temperatures, would you expect precipitation that falls over the poles to contain more or less heavy water ($H_2{}^{18}O$) compared to light water ($H_2{}^{16}O$) than during an ice age? Explain.

During periods of warmer temperatures, there is more heat energy in the atmosphere allowing heavy water to remain in the vapor phase longer and therefore travel farther from the equator. Because of this, precipitation that falls over the poles during periods of warmer temperatures would contain more heavy water.

12. Refer to the $\delta^{18}O$ vs. temperature graph. What is the relationship that exists between $\delta^{18}O$ and temperature?

The relationship that exists between $\delta^{18}O$ and temperature is a direct, linear relationship. As temperature increases, $\delta^{18}O$ does as well.