Name____________________________

The Case of the Leaky Gyre

Background
Ocean water circulates around the globe at the surface and at great depths. The reasons for this movement of water differ for surface water versus deep ocean water. At the surface, the main reason for ocean water circulation is the prevailing global winds (wind-driven ocean circulation), and at depths the main reasons for ocean water circulation are temperature and salinity differences (density-driven ocean circulation). In this lesson you will explore surface currents within ocean gyres (ocean circulation patterns), and model what would happen should one of these ocean gyres slow down.

Materials

For each team:	9' x 13" (or larger) tray for water water 10 red sequins 10 blue sequins 2 drinking straws
For each student:	Red and blue colored pencil

Procedure
Part I:
1. Acquire the materials listed above and carefully fill the tray almost to the top with water.

2. Place 10 sequins (pick just one of the two colors) in the tray so that they are floating.

3. Hypothesize how the air must move in order for the sequins to move in a circular motion. In Figure 1 which is a model of your tray, use arrows for air flow and small circles to represent the sequins to draw your expected outcome.

Figure 1: Hypothesized model for circular motion of the scraps.

Use the straw to gently blow air on the surface of the water to make the sequins move.

4. Test your hypothesis and draw your observed results in Figure 2 below. When you are finished, set these materials aside for Part III.

Figure 2: Observed results from your tested hypothesis.

5. Results: Was your hypothesis correct? What changes would you make to enhance the circular motion of the sequins on the surface of the water? Test this new hypothesis and write your results below. When you are finished, set these materials aside for Part III.

6. Application: How does your model compare to surface circulation around the globe? What other factors help move surface water?

Part II:

1. In Part I you used a laboratory model to explore ocean circulation. In Part II, you are going to apply your results to the circulation of water in each of the ocean basins. Explore Table 1 to familiarize yourself with the data.

Ocean & Current Name	Hemisphere	Location	Flow	Expected Temperature	Characteristics
Atlantic (N. Atlantic Drift)	Northern	Northern Basin	From Canada to Europe		Slow, shallow & Wide
Atlantic (Canary)	Northern	Eastern Basin	From Pole toward the Equator		Slow, Shallow & Wide
Atlantic (Gulf Stream)	Northern	Western Basin	From Equator toward the Pole		Fast, Deep & Narrow
Atlantic (N. Equatorial)	Northern	North of Equator	From Africa to S. America		Slow, Shallow & Wide
Atlantic (Benguela)	Southern	Eastern Basin	From pole toward the equator		Slow, Shallow & Wide
Atlantic (Antarctic Circumpolar)	Southern	Southern Basin	West to east around Antarctica		Slow, largest volume current
Atlantic (S. Equatorial)	Southern	South of Equator	From Africa to S. America		Slow, Shallow & Wide
Atlantic (Brazil)	Southern	Western Basin	From Equator toward the pole		Fast, Deep & Narrow
Pacific (Kuroshio)	Northern	Western Basin	From Equator toward the pole		Fast, Deep & Narrow
Pacific (N. Pacific)	Northern	North Basin	From Asia to N. America		Slow, Shallow & Wide
Pacific (N. Equatorial)	Northern	North of Equator	From C. America to S.E Asia		Slow, Shallow & Wide
Pacific (California)	Northern	Eastern Basin	From Pole towards the Equator		Slow, Shallow & Wide
Pacific (Peru)	Southern	Eastern Basin	From Pole towards the Equator		Slow, Shallow & Wide
Pacific (E. Australian)	Southern	Western Basin	From Equator towards the pole		Fast, Deep & Narrow
Pacific (Antarctic Circumpolar)	Southern	Southern Basin	West to east around Antarctica		Slow, largest volume current
Arctic (Beaufort)	Northern	North of Canada and Alaska	Clockwise		Fast, contains about 45,000 km^3 of fresh water

Table 1: Details of the ocean currents found around the world.

2. Note that the "Expected Temperature" column of the data table has been left blank. Fill in what you would expect the general temperature of the water making up that part of the gyre to be like. Use the terms warm, cold, warming, cooling to describe the temperature of this ocean water.

3. On your world map, use the red and blue colored pencils to draw arrows of the positions of these currents. Use the red colored pencil for warm and warming currents, and the blue colored pencil for cool and cooling currents.

4. Results: Describe the motion as well as the water temperatures of each gyre found in each ocean basin.

Gyre location	Direction of motion and temperatures around the gyre
North Atlantic	
South Atlantic	
North Pacific	
South Pacific	
Antarctic	
Arctic	

5. Write a general statement about the flow and temperature of currents in the northern hemisphere.

Besides winds, what else may help to move surface currents in each of the ocean basins?

What would cause one current to move at a faster rate than other currents within a gyre?

6. Application: All of the above currents appear to be in their own basins around the Earth. How does the surface water circulate through other areas of the oceans or between ocean basins?

Part III

1. In Parts I & II, you explored what is normally found in surface circulation. Now you are going to explore what would happen should the circulation of water in one of these gyres weaken. In the space below, hypothesize what would happen to the water in the Beaufort gyre if the circulation of the gyre was to slow down.

2. Acquire the materials you used in Part I. In this model you are going to test your hypothesis. Place the blue sequins on one side of the tray of water, and the red sequins on the other. One person in your team gently blows air on the blue sequins to create a Northern Hemisphere gyre, while another teammate gently blows air on the red sequins to move the sequins across the tray towards the gyre created by the blue sequins. After a circulation pattern is created, the person blowing on the blue sequins stops blowing air. Observe what happens to the blue sequins, and record in Figure 3 below using the same symbols used in Part I.

Figure 3: Observed results of movement of water in the Arctic.

3. Results: Was your hypothesis correct? Explain.

4. Using your red and blue colored pencils draw the circulation of the Beaufort gyre and the Gulf Stream and North Atlantic Drift on Figure 4. Next draw the movement of the water in the Beaufort gyre towards the North Atlantic.

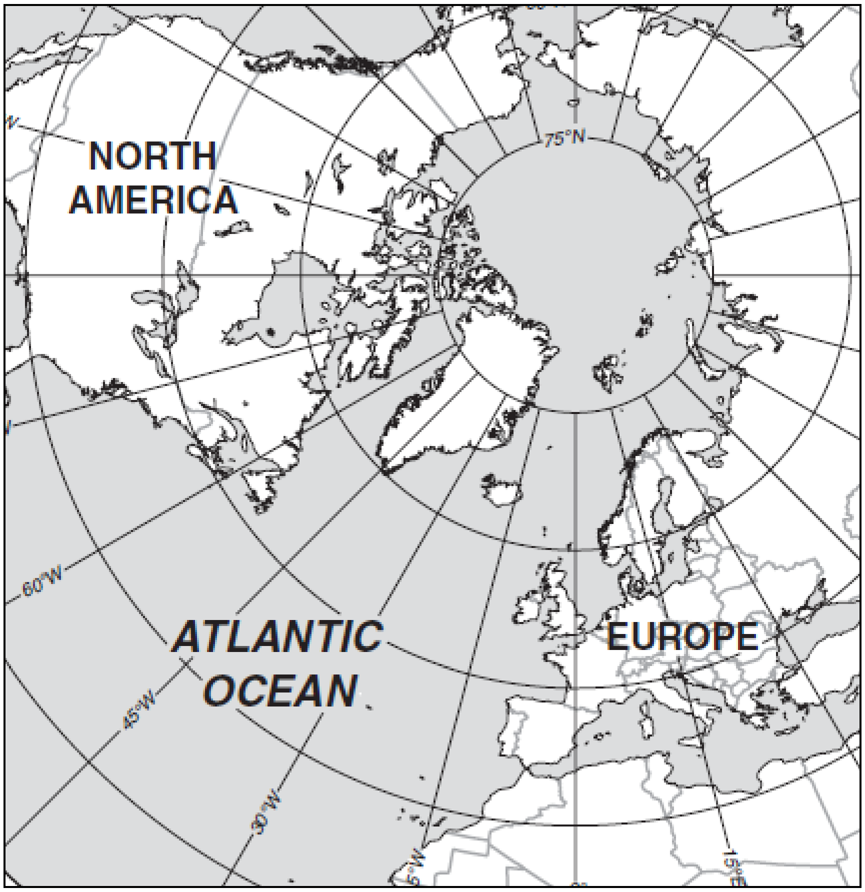

Figure 4: North Atlantic.
(Map courtesy of http://www.eduplace.com)

5. Application: As you saw in Part II of this lesson, ocean gyres circulate warm and cold water around ocean basins and thus are important components for distributing energy throughout the Earth System. This distribution of energy assists in creating the climates found around the globe. If the Beaufort gyre were to weaken, what will occur to the climates of the countries around the North Atlantic? Explain your ideas with evidence from this lesson.