Name ________________________________

Date ____________ Per. _____

Modeling the Hydrosphere

Background

Every person on the planet needs water. Even though over 70% of Earth is covered by water, only a small percentage of freshwater is accessible for human use, and that accessible freshwater is not evenly distributed. In households in the United States, each individual uses, on average, 150 gallons of water a day. In contrast, many developing countries around the world use less than 10 gallons of water per person per day. In Ethiopia, a country with roughly twice the population of California, the daily water use per person is only 3 gallons. Furthermore, household use of water in the United States accounts for only 13% of total water use; industry and agriculture use 87%.

PART I: Distribution of Water

Unfortunately, a huge portion of the Earth's water is saltwater, which is unusable for most of our needs. This activity will put into perspective how much freshwater is available for human needs. A stick of clay represents the earth's supply of water. You will divide the clay into portions that represent the distribution of water into saltwater, icecaps and glaciers, groundwater, and surface freshwater.

Materials: stick of clay, weigh boat, electronic balance, plastic knife

Procedure:

1. Weigh, in grams, the stick of clay. Begin a simple data table in the space below and record the weight. This mass represents the total amount of water on the planet.
2. First, represent the earth's saltwater, 97% of the total water. Multiply the mass of the clay stick by 0.97 to get the mass of clay that represents saltwater. Using the scale and the knife, cut off enough of the clay stick to represent this number. Set that amount of clay aside. Record the mass.
3. Of the remaining 3% of water on the planet, 69% is contained in the polar icecaps and glaciers. Weigh the small piece of clay and then multiply its mass by 0.69, remove that amount of clay, and set it aside. Record the mass.
4. From the remaining piece of clay, remove the amount that represents all the groundwater on the planet. Weigh the piece of clay. Groundwater represents 97% of the water remaining. Multiply the mass by 0.97, remove that amount of clay, set it aside, and record the mass.
5. The remaining piece of clay represents the total amount of surface water-the freshwater found in all the earth's lakes, rivers, and watersheds. (This piece also includes the tiny proportion found in the atmosphere and inside living organisms.) Weigh this piece and record it on the data table as surface water.
6. Answer the questions in the *Results & Analysis* section.

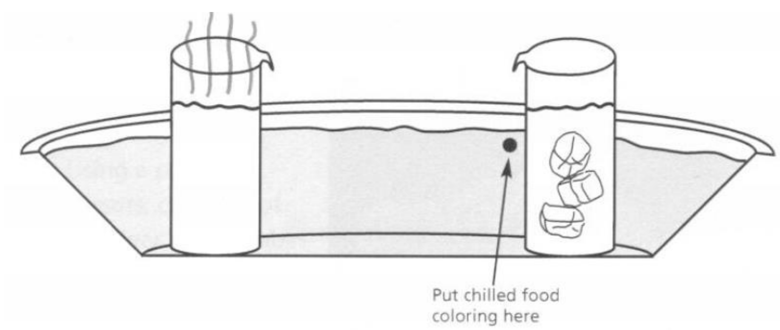
PART II: Ocean Currents

There are many different ocean currents. Surface currents, such as the Gulf Stream, are driven by wind, under the influence of the uneven heating and cooling of the atmosphere, the earth's rotation, and the locations of landmasses. Other ocean currents circulate the deep water. Deep water currents are important both biologically and climatically. These currents make nutrients from the ocean bottom accessible again to surface organisms, and they play a role in the transfer of heat around the globe. In this activity, you will explore the mechanism that drives these deep water currents.

Materials: aluminum pie pan, 2 plastic cups, chilled food coloring, room-temperature water, ice, warm water

Procedure:

1. At your station with your group, fill one pie pan about three-quarters full with the room-temperature water.
2. Fill one of the cups with ice and place it in the pie pan close to one side.
3. Carefully pour the warm water into the other cup and place it on the opposite side of the pie pan.
4. Place 1 drop of chilled food coloring between the two cups, **but closer to the cup containing the ice**.



5. Observe the movement of the colored water. This may take several minutes. In the diagram above, draw arrows that indicate the movement of the food coloring.
6. Answer the questions in the *Results & Analysis* section.

PART III: Modeling an Aquifer

A large proportion of the freshwater on the planet is held in the polar icecaps and glaciers and is not accessible to most people. Much of the rest is found in the ground; most land has some groundwater under it. In this activity, your group will construct a working model of an aquifer, one of the underground basins in which groundwater is held. The size of aquifers and the depth and quantity of the water they contain vary greatly from one region to another.

Materials: large plastic tray, 2 clear tubes, gravel, natural clay, 3 drinking straws, 5 sponges, modeling clay, plastic tubing, bellows pipette, marker, scissors, water container

Procedure:

★ The aquifer model in a place where it can be left, undisturbed, for several days.

1. Set the plastic tray in place and find the middle ridge. Using the modeling clay, create a wall 2 cm high that divides the tray in half. (*fig. A*)
2. Fill half of the tray with the gravel about 2.5 cm deep. (*fig. B*)
3. Using a pair of scissors, cut both of the clear plastic tubes in half. Place each of the four pieces into the gravel section of the tray. The tubes should reach the bottom of the tray and should not contain any gravel. The tubes can be placed randomly in the gravel. (*fig. B*)
4. Place the sponges on top of the gravel. Lay three sponges side-by-side along the long dimension of the tray and the fourth, at the ends of the other three. Cut the fifth sponge to cover the remainder of the gravel area. Where there is a tube sticking up, cut a hole in the sponge so that the tube sticks through. (*fig. C*)
5. Use the natural clay to create a slope that covers the modeling clay and climbs to the top edge of the sponges. (*fig. D*)
6. Fill the system with water by using a large beaker, carefully "rain" over the sponges. As you do, watch what happens in the rocks. Fill until the water level reaches the top of the gravel. Slowly pour water into the area that does not have any rocks, taking care not to disturb the clay slope. Add water until the level is less than 0.5 cm from the top of the clay slope.
7. Using a marker, place a line on the outside of the tray that marks the water level. To measure the water level under the sponges, stick a clear plastic straw inside one of the plastic tubes down to the bottom. Clamp a finger over the top of the straw to block air, and then remove the straw from the tube. The water inside the straw shows the level of the water in the gravel. Mark the water level on the straw.
8. Drain the water from the gravel by using a piece of tubing to create a siphon. Stick one end of the tubing down into one of the plastic tubes to the bottom. Insert the bellows pipet into the other end of the tubing. Use the pipet to withdraw water through the tubing to start the siphon. Lower that end into a large beaker or container that is positioned lower than the aquifer model. Remove the pipet to let water drain into beaker. Drain as much water from the aquifer as you can.

fig. A

fig. B

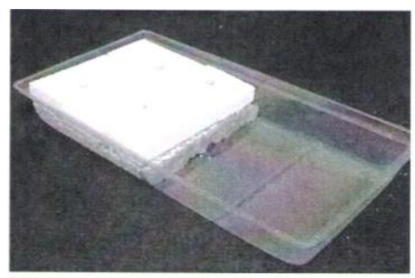


fig. C

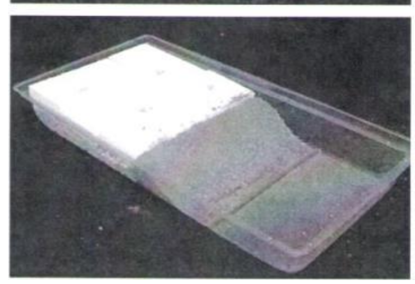


fig. D

9. With a new straw, measure the amount of water that remains below the sponges, and mark the level on that straw.
10. Leave the model overnight and measure the water level the next day, using a third straw.
11. Answer the questions in the *Results & Analysis* section.

Results & Analysis

On a separate sheet of paper, answer the following questions thoroughly using complete sentences. You may complete your work on the computer. Staple your work to the back of this packet.

1. From the masses of the pieces of clay, calculate the percentages of Earth's water found in saltwater, icecaps/glaciers, groundwater, and surface water.
2. Create an appropriate graph that represents each source of water: saltwater, icecaps/glaciers, groundwater, and surface water.
3. Considering the entire planet, what do you think is the best place to get freshwater?
4. What is the water source for your home and school? You may need to research this; "a faucet" is not an appropriate answer.

5. Describe what happened to the food coloring after it was dropped in the water.
6. What causes the movement of the food coloring?
7. What areas of the planet do the cup of ice and cup of warm water represent?
8. Explain how deep water currents move and in what direction on the earth.
9. Water rising from the depths is called upwelling. Where would you expect to have upwelling on the planet? Of what importance is this to marine life and fishermen?

10. Tell which part of the model represents each of the following: aquifer, topsoil and subsoil, wells, reservoir, impermeable rock, permeable rock, recharge zone.
11. Can draining a well affect other wells in the area? How?
12. What other factors can cause a well to go dry?
13. In this model, does the reservoir recharge the aquifer? Why or why not?
14. If the topsoil and subsoil dry completely from lack of rain, might there still be water in the aquifer? Explain.
15. "Withdrawn" and "consumed" are terms applied to water. When water is used, it is withdrawn. When that water is not returned to the ground or waterway, it is consumed. Give some examples of situations in which water is withdrawn and in which it is consumed.