

Learning Cycle Planner

Ocean Currents Lesson

Common Curriculum Goal:

Topics: Climate Change, Fluid Dynamics, Properties of Water

Learning Objective: Students understand, witness, and interact with the properties of water and discover the role of the oceans in the global climate.

Exploration Phase:

Hands-on Activity: 1. Surface tension of water activity and 2. “Current Event” by Bill Nye (see procedures below)

Exploration through Media:

Videos: The Global Conveyor Belt:

<http://www.youtube.com/watch?v=L9zjmC8InKA&feature=related>

Detailed information on water density, salinity, and the global conveyor:

<http://www.youtube.com/watch?v=FuOX23yXhZ8&feature=related>

Concept Development Phase:

Concepts to be taught: The oceans’ impact on climate, properties of water, polar covalent bonds, hydrogen bonding in water, surface tension of water, water density and salinity, cycles, heat transfer, feedback loops.

Procedures to be taught: Inquiry, experimental design, interpreting models, mapping

Activities: 1. Hydrogen bonding assignment and 2. Drawing the North Atlantic Ocean Conveyor

Connections to other Lessons:

Chemistry- covalent bonds are formed by the sharing of electrons. In a water molecule the electrons are NOT shared equally, the oxygen atom has a greater pull (or attraction) on the shared electrons than the hydrogen atoms. This causes water to be a polar molecule. The oxygen atom has a partial negative charge and the hydrogen atoms have partial positive charges.

Teaching across the Curriculum:

Math: positive and negative integers

1. Surface Tension of Water

Allow one 45 minute class period

Materials for each group of 2 students:

Pin

Beaker

1 cup of water

Tweezers

Tooth pick

Procedure:

1. Using the tweezers, place the pin on the surface of the water horizontally and gently.
2. Once the pin has been made to rest on the surface of the water, pick it up and put the pin into the water vertically and watch it fall to the bottom of the sample.
3. Using the tweezers, place the toothpick on the surface of the water horizontally and gently.
4. Push the toothpick to the bottom of the sample.

Follow up Activity (on paper):

Allow 15 minutes

Hydrogen bonding

1. Students receive a paper with 39 blank space-filling models of the water molecule (hand drawn and copied). The molecules are drawn to appear inside a glass of water.
2. They are asked to draw as many connections between the partial positive (Hydrogen atoms) and the partial negative (Oxygen atom) as they can using dashed lines to represent the attractions of Hydrogen bonds.
3. Record all observations

Helpful Information

Expected results: Students find that they can draw hundreds of connection between water molecules. Students discover that the water molecules at the surface of the water sample only have connections with those next to them and below them.

Explanation:

Water molecules at the surface of the water are drawn in toward the center of the sample because of the attraction between molecules created by the hydrogen bonds. This decreases the surface area of the sample of water (just slightly) and allows water to support an object like a pin laid flat. The pin does not float on the water; it is supported because of the surface tension of the water. This can be described as a thin film of wax paper that covers the surface of all water samples (lakes, oceans etc.). If you jumped through it you would break through, but some organisms can use their small mass and specially shaped feet to stay on the surface of water. The toothpick floats, it keeps coming back to the surface of the sample even when carried to the bottom.

2. Ocean Currents Adapted from (Nye, 2005).

Allow one 45 minute class period

Materials:

1. a glass bread loaf dish
2. 30 milliliters of salt
3. blue food coloring
4. ice cubes

Procedure:

1. Mix 30 milliliters (2 tablespoons) of salt and a liter of water in a glass bread loaf dish
2. Put it in the freezer until it's good and cold so that chips of ice form on the surface
3. Remove the dish from the freezer and drip a few drops of blue food coloring onto the surface
4. Observe what happens as the ice melts
5. Place an ice cube at one end of the dish
6. Observe what happens

Expected Results:

The blue layer of food coloring does not sink initially, it remains near the surface. Adding an ice cube will cool the surrounding fresh water and cause it to become denser than the salt water, this fresh water will sink and pull some of the blue color with it.

Helpful Information

Explanation:

Water becomes denser as it cools (cold water sinks) and salt water is denser than fresh water, but water becomes less dense once it freezes (ice floats!). This is due to the polar nature of a water molecule and hydrogen bonding between water molecules. These characteristics are responsible for the surface tension of water, the specific heat of water, the way water can dissolve substances, and the unusual way water expands when it freezes.

Ocean currents such as the Gulf Stream are driven by the flow of heat and salt in the ocean. These currents are called thermohaline (therm-oh-HAY-leen) currents. Thermo refers to temperature and haline refers to salt.

Follow-up Activity (on paper): Connection to Climate Change

Allow 15 minutes

Thermohaline Circulation of the Atlantic Ocean (The North Atlantic Conveyor)

1. Students receive a map of the Atlantic Ocean (with Continents)
2. Students watch a videos listed above of the Thermohaline Circulation in the Atlantic Ocean)

Students draw the Thermohaline circulation of the Atlantic Ocean on their maps and make a color coded key to explain.

References:

Nye, B. (2005). Current event. Retrieved June 26, 2009, from, <http://nyelabs.com/>
Pathway: <http://nyelabs.com/> > Home Demos > Planetary Science > Earth Science >
Current Event

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