DO YOU DRINK IT?

9-12

SUBJECTS:
Science (Physical Science, Ecology, Earth Science), Social Studies (Geography)
TIME:
2 class periods
MATERIALS:
3-liter soda bottles aquarium gravel sand (coarse) pump from liquid dispenser blue, yellow & Red food coloring paper cups straws student sheets droppers scissors or razor blades markers

OBJECTIVES

The student will do the following:

1. Create an aquifer model.

2. Locate major U.S. aquifers.

3. Explain how a well works.

4. Examine a well's relationship to the water table.

5. Apply principles of well placement.

6. Explain different ways that groundwater is contaminated.

BACKGROUND INFORMATION

An aquifer is an underground layer of rock or soil that holds the water called groundwater. The word "aquifer" is derived from the Latin "aqua" meaning "water ,"and "ferre" meaning "to bring" or "to yield." The ability of a geological formation to yield water depends on two factors - porosity and permeability. Porosity is determined by how much water the soil or rock can hold in the spaces between its particles. Permeability means how interconnected the spaces are so that water can flow freely between them.

There are two types of aquifers. One is a confined aquifer, in which a water supply is sandwiched between two impermeable layers. These are sometimes called artesian aquifers because, when a well is drilled into this layer, the pressure may be so great that water will spurt to the surface without being pumped. This is an artesian well. The other type of aquifer is the unconfined aquifer, which has an impermeable layer under it but not above it. It is the most common type.

Aquifers may be categorized according to the kind of material of which they are made. A consolidated aquifer is composed of a porous or fractured rock formation. Most unconsolidated aquifers are composed of buried layers of sandy, gravelly, or soil-like material.

The top surface of the groundwater is called the water table. The water table depth varies from area to area and fluctuates due to seasonal changes and varying amounts of precipitation. Excessive pumping from the aquifer (wells) can also lower the water table.

Perhaps the largest aquifer in the world is the Ogallala aquifer located in the midwestern United States. This aquifer is named after a Sioux Indian tribe. It is estimated to be more than two million years old and to hold about 650 trillion gallons (2,500 trillion liters)! It underlies parts of eight states, stretching about 800 miles (1,288 km) from South Dakota to Texas. The Ogallala aquifer supplies vast amounts of water to irrigate the crops in this vitally important agricultural area.

Not only is groundwater used to irrigate crops, but it is also used for drinking water. About half of the U.S. population gets its drinking water from groundwater. Wells reach into the water table and bring water to the surface by being pumped by hand, windmill, or motor-driven devices. In ancient days, these wells were dug by hand and lined with stones or bricks to prevent the sides from collapsing. Today, most are formed by drilling a 2-4 inch (5-10 cm) hole and lining it with metal or plastic piping.

The biggest problem facing well water is contamination. Sources of groundwater pollution are leaking underground storage tanks, leaking septic tanks or septic tanks with inadequate drainfields, landfill seepage, animal waste, fertilizer, pesticides, industrial waste, road salt, and some natural contaminants. Another big problem causing groundwater contamination is abandoned wells that are not properly closed. These leave direct channels for contaminants to enter the aquifers. Some wells are even used to inject waste materials into the ground. When a groundwater source is contaminated, it is very difficult and expensive to clean up. The best way to protect well water is to prevent contamination from occurring.

Another type of well is an underground injection well. This type of well is used as a means of wastewater disposal, aquifer recharge, or solution mining of an economically significant mineral from a geologic formation. The most prevalent use of underground injection, however, is for wastewater disposal.

Underground injection wells have even been classified into categories by the U.S. EPA. They are as follows:

Class I	Municipal and hazardous/non-hazardous industrial waste
Class II	Oil and gas field wastes and enhanced recovery injection
Class III	Solution mining
Class IV	Shallow hazardous waste disposal (banned)
Class V	All other types of injection (floor drains, storm drains, etc.)

In most states, Class I hazardous and IV wells are prohibited. All states that have oil and natural gas production have Class II wells. Class III, or mining wells, inject water to solution mine a desired mineral (as salt). Injection wells not fitting any of these categories are Class V wells. Septic systems serving 20 or more people a day and floor drains found at service stations and car washes are examples of Class V wells.

Note: Two background information charts (A&B) should be supplied with this background narrative.

Subsurface disposal by wells depends on the capacity of the geologic formation to attenuate wastes that are properly injected into it.

Terms

aquifer:

porous, water-bearing layer of sand, gravel, and rock below the Earth's surface; reservoir for groundwater

aquifer recharge:
the addition of water by any means to an aquifer

artesian aquifer:
an aquifer that is sandwiched between two layers of impermeable materials and is under great pressure, forcing the water to rise without pumping. Springs often surface from artesian aquifers.

attenuation:
dilution or lessening in severity

confined aquifer:
an artesian aquifer

groundwater:
water that infiltrates into the Earth and is stored in usable amounts in the soil and rock below the Earth's surface; water within the zone of saturation

impermeable (substance):
a substance through which other substances are unable to pass

solution mining:
a type of mining wherein water is injected into a well to remove a desired mineral

unconfined aquifer:
an aquifer containing unpressurized groundwater, having an impermeable layer below but not above it

underground injection well:
a type of well used for wastewater disposal, aquifer recharge, or solution mining of minerals

water table:
upper surface of the zone of saturation of groundwater

ADVANCE PREPARATION

A. Collect materials for activities.

1. Each student can be asked to bring one 3-liter bottle and a pump from a liquid dispenser, or each group may prepare a group water pump model.

2. Fill three dropper bottles with water. Tint the water in each with a different color of food coloring. Set aside.

3. Make a transparency of U.S. Aquifer Map. Make enough copies for students.

C. Make a transparency of Well, Well, Well Map. Make enough copies for students.

D. Make copies of Background Information and sheets on Pathways To Groundwater Pollution for students.

E. Make a transparency of Model Example Sheet.

PROCEDURE

I. Setting the stage

A. Pass out Aquifer Map, Well, Well, Well Map, Background Information, and Pathways to Groundwater Pollution sheets.
B. Divide students into working groups of 3, 4, or 5.
C. Ask students to read Background Information, look at Pathways to Groundwater Pollution sheets, and discuss information in their groups.
D. Put terms on the board and have students copy on the Background Information sheet.

II. Activity

A. Show the students the transparency of the U.S. Aquifer Map.

1. Explain that the crosshatching on this map marks the places in the continental U.S. where abundant fresh water is available from aquifers. In these areas, large groundwater supplies are used by industries, communities, and agriculture. In the areas where there are no markings,

there is less likely to be plentiful groundwater available. These places will, however, have wells that supply individual households and livestock operations. Remind students that small aquifers exist almost everywhere, and that the map shows only major aquifers.

2. Ask the students to answer the following by naming states.

   a. Name several states where plentiful groundwater is available almost everywhere. (Florida, Mississippi, Louisiana, Iowa, Delaware, Nebraska, Michigan, New Jersey)
   b. Name several states that have the least groundwater in many places. (Montana, Washington, Oregon, Idaho, Pennsylvania, Kentucky, West Virginia, Vermont, New Hampshire)
   c. Where does your state rank with groundwater supplies? What is groundwater used for locally?
   d. Why does your group think that some states do not have very much groundwater?
   e. What is an advantage in an area where aquifers are small? (Contamination will not spread as easily.)

B. Show the students the transparency of the Well, Well, Well, Map.

1. Tell the students that one way to keep a well free of contaminants is to select a good site before it is drilled. Tell them that they are not considering the direction of groundwater flow in this activity, but that this would actually be a big consideration.
2. Tell students that they are to mark the place on their map where they think the well should be dug. They may illustrate this in any manner they choose.
3. Have students identify the possible groundwater contaminants on this map. Ask them if they can think of other possible contaminants.

C. Set out materials needed to make water pump and contamination models. Instruct students to follow directions.

1. Using the 3-liter bottle, cut off about ½ the top. Remove the black bottom and fill the remaining clear portion with approximately 2 inches (2.5 to 3.7 cm) of gravel and then 2 inches of sand. (Use transparency of model.)
2. Pour in 2 to 3 inches (5 to 7.5 cm) of water colored blue with food coloring and mark the location of the water table with a black or blue marker.
3. Place the pump into the gravel with the tube extending into the water.
4. Pump water out of the model, catching the water in the cup.

5. Discuss how contaminants like agricultural waste, sewage, road salt, and other surface contaminants can get into the groundwater. Demonstrate this by using the yellow food coloring on the surface of the sand and “rain” on your model. Pump more water out of the well. Observe results.
6. Place a straw into your model to represent an abandoned well. It should reach the same depth as your pumping well. Pour a contaminant (red food coloring) into abandoned well. Pump more water out of the pumping well. Compare this means of contamination with the surface contamination.

III. Follow-up

A. Have students list at least four possible sources of groundwater contamination.
B. Have students demonstrate knowledge of vocabulary by using the terms correctly in an explanation of groundwater, wells, and groundwater contamination.
C. Students should try simulating other types of contamination (leaking underground storage tanks) with their model.
D. Using the Background Information on underground injection wells, answer the following.

   1. Some states, such as Florida, use injection wells to recharge valuable aquifers used for drinking water. List the pluses and minuses of this practice as it relates to environment and public health. What Class well would this be? Why?
   2. Class II wells are used to re-inject salt water or liquid waste from oil and gas production. They are also used for further recovery of oil when reservoirs are depressurized but recoverable product remains. What is this called? How does it work?

IV. Extensions

A. Have students contact their local health department to obtain guidelines on digging new wells.

B. Share with students the following information about dowsing or “water witching” and divining rods. Some people will not have a well drilled without calling a water “witch”or “dowser” to locate the groundwater. Water witches or dowsers have been around for thousands of years. They use metal or wooden sticks (“divining rods”) to locate places where wells should be drilled. Some even predict the depth of the water table. Dowsers are not always successful in their efforts, but many people believe in their special ability to find water. Ask students to research the local use and efficacy of dowsing.

C. Write the American Groundwater Trust (6375 Riverside Drive, Dublin, Ohio 43017) for more information about wells and groundwater protection.

RESOURCES

Banks, M., British Calendar Customs, Volume 1, William Glaisher, Ltd., London, 1937.

Branley, F.M., Water for the World, T. Y. Crowell, New York, 1982.

"Groundwater Pollution Control," American Groundwater Trust, Dublin, Ohio, 1990.

"Ground Water: Issues and Answers," American Institute of Professional Geologists, Arvada, Colorado, 1984.

Grades 3-5 Water Sourcebook.

U.S. Department of the Interior, Water Dowsing, 1993, p. 15.

Teacher Instructions

Lesson 1: A Drop in the Bucket

Essential Question: Where is the water we use located on Earth?

Materials: Interactive whiteboard or computer and projector, Internet access, water, measuring cup, measuring spoons, empty 2-liter soda bottle, two clear cups, eyedropper, bucket, Student Worksheet A: *Blue Planet*

Time: One class period, plus time to complete the worksheet

Standards: Common Core Math 4.OA.A.3 and Next Generation ESS2.C

Real-World Connections

1. Display the image found at the following website: **nasa.gov/multimedia/imagegallery/image_feature_2159.html**. Ask: *What does this image show?* (a view of Earth from space) *What features stand out?* (white clouds, brown land, blue oceans)

2. Explain that most of the water on Earth is saltwater, which people can't drink. On top of that, a large amount of the freshwater on Earth is ice found near the North and South Poles. In addition, a large percentage of freshwater is trapped underground. That leaves just a small fraction of water that can be directly accessed by the more than 7 billion people on the planet!

Discover More

3. State that there's another factor that affects how much freshwater is available: where people live. A place's landforms, weather and climate, and nearness to lakes and rivers can determine how much freshwater it will have. An area's population and industries, and whether waterways are polluted, dirty, or contaminated with germs, can also limit the availability of freshwater.

Hands-On Activity

4. Fill the soda bottle with 1 liter (4¼ cups) of water. Tell your class that this represents all of the water on Earth.

5. Remove 30 milliliters (2 tablespoons) of water from the bottle and place it in a cup. Explain that this water represents all the freshwater on Earth. The remainder of water in the bottle represents the saltwater found in oceans, which people can't drink.

6. Remove 10 milliliters (2 teaspoons) of water from the cup and place it into a second cup. Explain that this represents the freshwater on Earth that isn't frozen. Remove ¼ teaspoon of water from the second cup. Tell students to listen carefully and release it into a small bucket so they hear the sound of it hitting the bottom. State that this little bit of water represents all the clean freshwater on Earth that is directly available for our use. Explain that the water left in the cup represents freshwater trapped underground or water that is polluted.

Put It Together

7. Tell students that water covers nearly 71 percent of Earth's surface—an area that's close to three times larger than that covered by land. Share another surprising fact: Only a tiny amount of that water is available for people to use. Have students consider why that might be. Write their answers on your whiteboard or chalkboard.

8. Hand out Student Worksheet A: *Blue Planet*. Students will use it to answer word problems related to water on Earth. Answers: 1. 2,900 liters, 4,900 liters; 2. 10,737 millimeters; 3. 14 liters, 56 liters; 4. 186 countries, two fifths of the world's freshwater; 5. 1,900 liters

Sources: worldatlas.com/aatlas/infopage/earth.htm; water.usgs.gov/edu/earthwherewater.html; oceanservice.noaa.gov/facts/et-oceans.html; unwater.org/downloads/Water_facts_and_trends.pdf; www2.worldwater.org/data20082009/Table19.pdf; unwater.org/statistics/en/?page=4&ipp=10&tx_dynalist_pi1%5Bpar%5D=YToxOntzOjE6IkwiO3M6MDoiljt9; bwt-group.com/en/water-technology/element-h2o/Pages/virtual-water.aspx; un.org/waterforlifedecade/pdf/human_right_to_water_and_sanitation_media_brief.pdf; unwater.org/statistics/thematic-factsheets/en/; waterfootprint.org/en/resources/interactive-tools/national-water-footprint-explorer/; waterfootprint.org/media/downloads/Zygmunt_2007_1.pdf; levistrauss.com/wp-content/uploads/2015/03/Full-LCA-Results-Deck-FINAL.pdf

Lesson 2: Water Footprints

Essential Question: Who are the biggest users of Earth's water resources?

Materials: Our Watery World poster, Student Worksheet B: *My Water Footprint*, and Student Resource Sheet: *How Much Water Does It Take?*, interactive whiteboard or computer and projector, Internet access, paper, pencils, scissors

Time: One class period

Standards: Next Generation ESS3.C

Real-World Connections

1. Have students gather around the **Our Watery World** poster. Ask them whether any information on the poster reveals how people use freshwater. State that there are many ways people can conserve water at home and do their part to protect this important resource. Large water users, such as farmers and companies, also take measures to manage how they use water.

Discover More

2. Explain to students that water conservation is a challenge for individuals as well as farmers, companies, and manufacturers. People are doing their part to conserve water by thinking critically about their habits and changing certain aspects of their lifestyles, e.g., taking shorter showers, or watering lawns and gardens in the morning or evening. Farmers, companies, and manufacturers are also evaluating how they use water and coming up with ways to conserve this vital resource. For example, some farmers are capturing and storing rainwater, planting drought-tolerant crops, and scheduling their irrigation; some companies and manufacturers are installing high-efficiency plumbing fixtures, performing periodic irrigation system evaluations, planting drought-resistant turf, as well as collecting rain and condensation water.

3. Introduce the idea of water consumption or a water footprint—the amount of freshwater used by a person, company, or country. Explain that the water usage of people and groups includes both water they directly use for activities, such as watering lawns and flushing toilets, and water they indirectly use, such as what's needed to grow food or to make products. Explain that unlike water we directly use, we don't get to see all the water that goes into making the goods we purchase. Scientists refer to the hidden amount of water it takes to make products—from growing and creating raw materials to manufacturing items and shipping them—as water footprints or virtual water.

4. Distribute Student Resource Sheet: *How Much Water Does It Take?*, which can be downloaded at **scholastic.com/conservewater**.

5. Ask students to think of ways water might be used to make clothing. Students might not know that clothing is often made from cotton, a crop that requires a lot of water in order to grow. After harvest, cotton is transported to a factory where it is turned into fabric, dyed, and sewn into clothing. Water is a central resource in all these stages of the clothing manufacturing process. During the growing and manufacturing processes, water is used to grow cotton, activate dyes, and dilute pollutants to meet important safe water standards. Additionally, water is integral to the "finishing" process—where clothing, such as jeans, is washed to get a certain look or worn-in feel. To explore how clothing manufacturers are working to address water pollution, review the following articles: **theguardian.com/sustainable-business/sustainable-fashion-blog/2014/sep/04/10-things-to-know-water-impact-fashion-industry** and **nrdc.org/stories/fixing-fashion-industry**.

Hands-On Activity

6. Assign students into groups, and have each group trace one member's right foot and left foot on separate pieces of paper. Then have them cut out both prints.

7. Have groups draw a horizontal line to divide each left footprint in half. Tell students to draw or list some direct ways individuals

All lessons were adapted from preexisting **Project WET** activities. For additional resources and to learn more about the **Project WET Foundation**, visit **projectwet.org**.

Procedures:

1. Before introducing the lesson, make up the dice for each station by running off on oak tag. Students or the teacher may label the dice. You could extend this part of the lesson by having a math discussion around the number of faces on a cube, the probability of traveling to a different station versus collecting, etc.
2. Ask students to brainstorm where water is found on the earth. As they identify each of the nine stations used in this game, place the sign up in an area of the room, along with the dice.
3. Explain that in this game students will pretend they are a molecule of water cycling through the earth and its atmosphere. Their path will be determined by rolling a single die at each station and recording their results.
4. Assign students to begin at each of the nine stations in small groups. They should begin the game by writing down the first station on their record sheet. Clipboards are useful, but not necessary.
5. Have students record which stations they visit and how many times they stay or collect at that station.
6. Students should rotate through stations and record their journey for about twenty minutes.
7. Summary: At the conclusion of the game, discuss the different paths taken by students. At which stations did water seem to collect for a long period of time? (glaciers, oceans, ground water) Through which stations did water pass quickly? (clouds, soil, animal)
8. In the second class period, have students use the long strips of paper to illustrate their journeys using their record sheets. Their illustrations should include: numbered steps, the name of the location of the water (ocean, cloud, animal, etc.) and the appropriate vocabulary to describe the change that took place (evaporation, precipitation, condensation, etc.)

Assessment Rubric:

4 Completed record sheet and accurately labeled illustration with title. Illustration must be clear and demonstrate correct usage of the vocabulary words.

3 Completed record sheet, illustration may lack some vocabulary or have some errors.

2 Not completed or illustration is unclear, unlabeled, or incorrectly labeled.

1 Very minimal response or completely incorrect response.

0 No response.

A fun summary to this part of the lesson is to ask students to put their smaller parts of the water cycle together by matching up endings and beginnings to create a larger water cycle journey. For example, a student whose last phase was cloud can link to a student whose first phase was cloud, and so on.

Water Cycle Journey Record Sheet

Number of station	Location of water (ocean, glacier, animal, etc.) (make a tally each time you roll "stay/collect")	Movement of water to get to next location (evaporation, precipitation, condensation, etc.)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

Water Cycle Journey Game

Framework Focus:

Earth and Space Science Learning Standard 10: Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere.

Physical Sciences (Chemistry and Physics) Learning Standard 3: Describe how water can be changed from one state to another by adding or taking away heat.

Objectives:

1. Students will learn about other places water cycles on the earth.
2. Students will understand that water remains in some locations longer than others.
3. Students will practice vocabulary associated with the water cycle and use reading comprehension skills.

Introduction:

In this lesson, students will expand their knowledge of the water cycle beyond just the four basic stages. They will understand that water is present in many other places such as plant and animal life, underground, frozen in glaciers, etc. Students will also use more advanced vocabulary associated with the water cycle.

Time: About two 45 minute periods.

Materials:

Water Cycle Signs

Water Cycle Dice: A template is given which may be run off on cardstock and folded. Place two to three dice at each station, depending on the size of your class.

Water Cycle Record paper

Paper to illustrate journey after the game. Long, thin strips of paper tend to work best.

Water Cycle Vocabulary paper (to use when students are illustrating their journey)

Unit 1: The Hydrologic Cycle

The activities in Unit 1 investigate water from a global perspective. The content is focused on the identification of storehouses where Earth's water is stored, how matter (water) cycles through the geosphere (lithosphere, atmosphere, hydrosphere) and biosphere, and the energy associated with water as it changes between a solid, liquid and gas state. The unit investigations conclude with a short homework assignment on the application of the hydrologic cycle from a regional perspective as you research the quality and availability of fresh water in the state where you live. An important factor is the consideration for the percentage of fresh water that is readily available for human consumption and the impact of human activity on the quality of the water.

Essential questions to guide your thinking over the unit 1 investigation on water:

- *How is matter transferred through the hydrologic system?*
- *What is the primary source of energy that drives the hydrologic system?*
- *How does the rock cycle interact with the hydrologic cycle?*

Credit: NASA Goddard Space Flight Center
http://visibleearth.nasa.gov/view.php?id=57723

Initial Ideas – on your own

Q1. Often called the water planet, if you were to view Earth from a satellite you would observe that about 70% of the planet's surface is covered by water. Of this percentage, what would you estimate is available for human consumption?

____

Q2. Explain where the drinking water you consume may have been stored before it reached your house:

____

____

____

____

____

____

____

____

Q3. Imagine that you are following the path of a single water molecule as it moves through the hydrologic cycle between the geosphere and the biosphere. In the space below sketch a diagram of what this path might look like (indicate the direction the molecule of water is moving with an arrow).

Part 1. Water, Water Everywhere

Original activity from: *http://www.epa.gov/region1/students/pdfs/gwa5.pdf*

Materials for the class

- 5-gallon aquarium or 5-gallon bucket filled with water
- 24 oz. measuring cup
- Green food coloring, ice cube tray, dropper, petri dish, clear plastic cup (at least 8 ounces) filled with sand
- Topographic map of the area where your college is located
- Laptop and overhead screen

Demonstration

Step 1:

Demonstrator fills a 5-gallon bucket or aquarium with water.

Narrator: *Imagine that this aquarium, which holds 5 gallons of water, represents 100% of all the water on Earth.*

Step 2:

Demonstrator removes18 ounces of the water from the aquarium with a measuring cup, and then drops green food coloring into the remaining water in the aquarium.

Narrator: *This green water left in the bucket represents all the water on earth held in oceans. The water in the measuring cup represents all the water in the world that is* ***not*** *ocean water.*

Step 3:
Demonstrator pours 15 ounces of water from the measuring cup into the ice cube tray.
Narrator: *The water in the ice cube tray represents all the water held in glaciers and ice caps. This water is not readily available for our use.*

Step 4:
Demonstrator places a fraction of water (approximately one drop- per of water) into a student's hand.
Narrator: *The remaining 3 ounces represent the world's available freshwater. Of this amount, a fraction of an ounce is held in the world's freshwater lakes and rivers.*

Step 5:
Demonstrator pours the remaining water into a cup of sand.
Narrator*:* *The remaining water (approximately 2.5 ounces) is groundwater, which is water held in pore spaces of soil and fractures of bedrock*

Questions:

Major Storehouses (natural)	Percentage of Water Held in Each Type of Storehouse
Ocean	97.2% of total water
Groundwater	0.397%
Surface water (Rivers, lakes, streams, ponds)	0.022%
Ice caps/glaciers	2.38%
Atmosphere	0.001%
Total % of Earth's water held in storage.	100%
Total % of Earth's freshwater held in storage.	
Total % of Earth's freshwater held in storage and readily available for human consumption.	

1-1. The table to the left lists the average percentage of water held in each type of storehouse. Of the 100% of water held in storage, what percentage is fresh? _______________ **Note:** ice caps and glaciers are not listed with surface water because the water is in a solid state and not considered **readily** available.

1-2. Of the percentage of freshwater held in storage, what percent is **readily** available for human consumption? ______________ How does this percentage compare to your initial idea you described in question Q1?

____

____

____

____

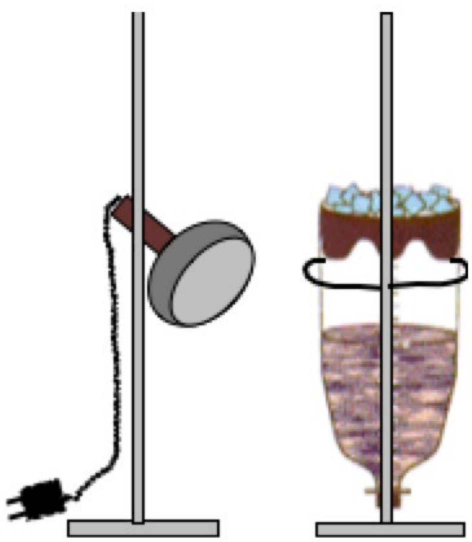
Directions: Before answering questions 1-3 and 1-4, watch the video *Blue Planet* to learn more about how water shapes our planet and nearly every aspect of out lives.

1-3. Why is Earth called the blue planet?

1-4. There is a growing public awareness about the value and importance of water and water resources. Think about where fresh water is held in a storehouse in the region where you live. How might the impact of human activity affect the quality and quantity of the water held in storage?

Part 2: Following the Movement of Matter Through the Hydrologic Cycle

The hydrologic cycle is a conceptual model that illustrates the flow of matter (water) as it moves between Earth systems by energy that is ultimately derived from the Sun. The movement of water can be grouped into three directions: 1) moisture moving into the atmosphere, 2) moisture moving through the atmosphere, and 3) moisture returning from the atmosphere to the Earth.



Because of the interconnectedness of Earth's systems, a change in one system often results in a change in one or more of the other systems. In this activity we will use a series of mini investigations to model the movement, processes and phase changes that occur as matter is cycled through the hydrologic system on a local and regional scale.

Collecting and Interpreting Evidence -
Part A: ***Evapotranspiration, condensation and precipitation***

Materials needed (per group)

- 2-liter soda bottle
- Ring stand
- Crushed ice
- ~1 liter of sand
- Water
- Volumetric container with 100 ml marked increments
- Stand and clip-on light

Procedure:

Important! If you are the **first lab** of the day, pour **slowly** approximately 200 milliliters of water into the system until the water level is just below the surface of the sand. Be careful **not** to flood the container with water. If the water level rises above the ground surface be patient during the initial stages of the activity, the movement of water in the system will take longer.

1. Fill the lid of the plastic bottle (previously the bottom section of the plastic bottle) with ice and place it securely back on top of the bottle. Push the lid down snugly to avoid any air from escaping.
2. Position the heat lamp so it is pointed at the sand and **not at** the ice.
3. Turn on the lamp. Look closely for any evidence to suggest there has been a movement of water in the system, then answer the following questions:

Questions:

2-1. What evidence did you observe to indicate an initial movement of water?

____

____

2-2. What is the source of energy that moves the water through the bottle-model system?

____

2-3. Explain in detail the processes and phase changes that occurred as water moved through the bottle-model hydrologic system. Start from when you turned on the lamp to where you observed evidence for the initial movement of water.

____

____

____

____

____

____

____

2-4. As water moved through the bottle-model hydrologic system it was transferred between several storehouses. Identify the analog in the hydrologic system for each item in the bottle-model (sand, water, empty space, ice cubes) and the Earth system where the interaction occurs (lithosphere, atmosphere, hydrosphere and biosphere).

Bottle-model	Analog in the hydrologic cycle	Earth system
Sand mixture		
Water in the bottle		
Empty space in the bottle		
Container with ice cubes		

Collecting and Interpreting Evidence
Part 2B: *Transpiration*

Image from: *USGS Water Science Photo Gallery* http://water.usgs.gov/edu/photos-air.html#8

Background

As energy from the sun heats the air surrounding plants, the plants transpire water vapor through their leaves. Environmental conditions such as soil moisture, wind, relative humidity and light are important factors in determining the movement of water out of the plant and the ability to control water loss.

Essential question to answer from this investigation:

- How does the amount of sunlight affect the rate of transpiration?

Materials and setup

Note: *This activity requires set-up at least 24 hours before the investigation*

- Two identical potted broadleaf plants,
- Two clear plastic bags and two twisty ties or rubber bands

2-5. A plastic bag has been placed over a group of leaves on two identical plants. Both bags have been tied tightly to avoid air from escaping. The same volume of water has been added to each plant. One has been placed in a sunny window, the other in the shade for at least 24 hrs. Predict which plant will have the greater amount of water evaporate from its leaves, and explain why.

____

____

____

____

2-6. Two plants have been placed in the classroom under the exact same conditions as described in 2-5. Describe any observational evidence that validates or nullifies your prediction in 2-5.

____

____

____

____

Collecting and Interpreting Evidence

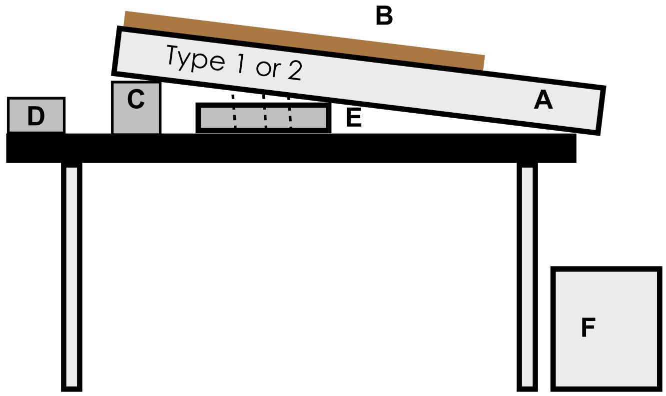
Part 2C: ***Infiltration and run-off***

When precipitation reaches the ground as rain or snow, it will evaporate, infiltrate into the soil, or continue downslope as runoff. There are many variables that can affect the outcome of each condition like the type of soil, the amount of ground cover, the available pore space and the slope of the terrain. In the following activity we will look at the variables of soil type and slope. Each group will simulate the process of infiltration and runoff as precipitation occurs as rain on a hillside.

Essential questions to answer from this investigation:

- How do soil conditions determine whether precipitation will infiltrate into the soil or continue downslope as runoff?
- How does the slope influence infiltration and runoff?

Materials and setup



Setup the materials according to the diagram above. Before starting, make sure that the infiltration catch pan (E) is located directly under the holes that have been drilled through the bottom of the tray.

Important! Half the class should test **soil Type 1,** the other half should test **soil Type 2.**

A. Tray, with holes punched through the bottom
B. Sediment (~ 3cups per tray of Soil Type 1) (~3 cups per tray of Soil Type 2)
C. 1” block of wood
D. 1/2” block of wood
E. Infiltration catch-pan
F. Runoff catch basin or bucket

Not shown: graduated cylinder for measuring runoff and infiltration (at least 500 ml), 500 ml plastic cup with holes to dispense the water, stop watch and mesh screen to place over the holes in the bottom of tray.

Procedure

1. Shape the soil mixture into a wedge. **Lightly** pat down the surface. If the ground surface is compacted this will impede the infiltration of rainwater.

2. Place the **½ inch** block under the tray on the side with the thickest part of the wedge

3. Place a finger over the hole in the bottom of the 500 ml plastic container (which in this model is a cloud) and fill it to the top with "rainwater"

4. Hold the container over the end of the elevated side of the tray, **start the timer** as soon as you release your finger from over the hole. Move the container **continuously** from side to side across **the crest of the hillside** until the container is empty. Try to keep the rate of movement and the height above the tray consistent.

5. The moment that you observe the rainwater runoff entering the fresh water storehouse (catch-basin in the sink) **stop the timer** and record the time on the table below. Continue to empty any remaining rainwater over the surface of the hillside.

6. Wait until the rainwater stops flowing into the storehouse before measuring the volume of runoff. Record the data on the table below. **Important be sure you are entering the data in the table that corresponds to the soil conditions** (Type 1 or Type 2) and slope (1 or 1-1/2" height) you are testing.

7. Carefully slide the catch pan beneath the hillside and measure the volume of rainwater that has infiltrated down to the water table (shallow pan). Record the data on the table below.

8. Remove the **½ inch** block and replace with the **1" inch** block. Make sure to **re-mix** the sediment and gently smooth the surface of the soil before you run the second test. Repeat steps 1-7.

9. After your group finishes collecting data, enter the group average on the class data collection table (use an overhead transparency or whiteboard) so it can be shared with the rest of the class.

Table 1: Runoff and Infiltration

Type 1: fine sand and clay mixture, **1/2" block (gentle slope)**	Test 1	Test 2	Average
Time			
Runoff (Volume of water in catch bucket)			
Infiltration **(**Volume of water in the catch pan)			

Type 1: fine sand and clay mixture **1" block (steep slope)**	Test 3	Test 4	Average
Time			
Run-off (Volume of water in catch bucket)			
Infiltration (Volume of water in the catch pan**)**			

Type 2: med to coarse sand **1/2" block (gentle slope)**	Test 1	Test 2	Average
Time			
Runoff (Volume of water in the catch bucket)			
Infiltration (Volume of water in the catch pan)			

Type 2: med to coarse sand **1" block (steep slope)**	Test 3	Test 4	Average
Time			
Runoff (Volume of water in the catch bucket)			
Infiltration (Volume of water in the catch pan)			

Interpretation of data

2-7. Underline the combination of surface soil and slope conditions that resulted in the **most infiltration** of rainwater:

(1) Steep slope and Type 1 soil, (2) Steep slope and Type 2 soil, (3) Gentle slope and Type1 soil or (4) Gentle slope and Type 2 soil. Explain where in the data you collected there is evidence to support your answers:

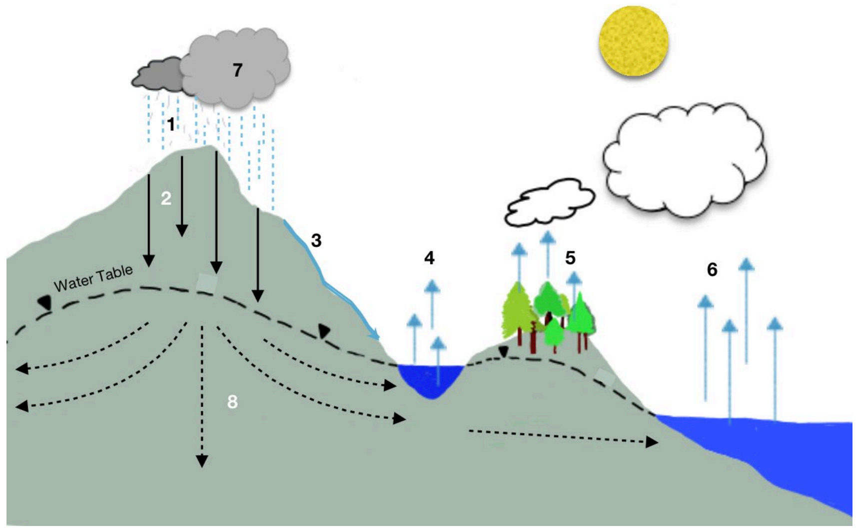
2-8. Underline the condition that resulted in the **greatest** amount of surface runoff:

(1) Gradual slope, (2) Infiltration rate exceeds the rate of rainfall, (3) Surface soil has reached saturation (all the pore spaces between the grains are filled with water) or (4) permeability of the surface soil. Explain where in the data you collected there is evidence to support your answers:

2-9. Apply your understanding of infiltration and runoff to explain how human activity might affect the rate of water infiltration and runoff where the university you attend is located.

Part 3: Summarizing What You Have Learned

Q1. Imagine that you are a water molecule on a journey through the hydrologic cycle. Identify the process that is occurring at each numbered location on the diagram.



Source of diagram: *Julie Monet 2014*

1) ________________________________ 2) ____________________________________

3) _________________________________ 4) ____________________________________

5) _________________________________ 6) ____________________________________

7__________________________________ 8) ____________________________________

Q2. Begin with the source of energy that ultimately drives the hydrologic cycle. At each numbered location, explain the process and or phase change that occurs as matter (water) moves through one complete cycle in the hydrologic system.

____

____

____

____

____

____

____

____

____

____

____

Activity 5: How Do We Know?

What You Will Do: Make additional weather sensors; set up a home weather station

Big Idea

Our understanding of the climate system is improved through observations, theoretical studies, and modeling.

(Climate Science Principle 5)

What You Will Need*

Wind Vane Materials

Adult partner
1 – Broomstick or long wooden dowel, about 1 inch diameter
1 – Aluminum baking dish, about 6 x 9 inches
1 – Wood stick, about 3/4 inch square and 12 inches long
1 – Nail, about 1 inch long
1 – Metal washer with a hole slightly larger than the nail
Duct tape
Small saw or serrated knife
Scissors strong enough to cut the aluminum baking dish
Ruler or tape measure
Silicone or other glue that will stick to aluminum
Leather gloves
(Optional) Hand drill, and small drill bit slightly larger than the nail

Barometer Materials

1 – Ruler, about 30 cm (12 in)
1 – Clear drinking glass, glass jar, or other container with sides tall enough to support the ruler
1 – Clear plastic drinking straw or piece of clear plastic tubing, about 30 cm (12 in) long
Clear tape
Modeling clay or chewing gum
(Optional) Food coloring, your choice of color

Rain Gauge Materials

- Straight-sided glass or plastic container, with a diameter of about two inches or less (such as an olive jar)
- Coat hanger or wire bent to make a holding rack (see Figure 4)
- Measuring spoons: One teaspoon and 1/4 teaspoon
- Hammer and nails to secure the rack
- Felt tip marker

We all know that weather can change quickly, sometimes in only a few minutes. Climate also varies, but over longer periods of time. You may have heard someone say, "Expert weather forecasters can't accurately predict what the weather will be next week; how can anyone possibly know what the climate will be years from now?"

The answer is that forecasting climate is not the same as forecasting weather. Local weather predictions are based on natural processes that are more random and by their nature are difficult to precisely predict. Earth's climate systems, though, obey the basic physical laws that operate throughout the Universe. For example, when a planet's atmosphere traps heat, the planet's surface tends to become warmer. This means that the behavior of the climate system can be understood and predicted by careful scientific studies. Environmental observations are the foundation for these studies. Instruments carried on satellites, ships, buoys, weather stations, and other platforms can gather information about many pieces of the present climate system. Information about past climates can be found in natural records such as tree rings, ice cores, and layers of sediment, as well as in historical documents and local knowledge.

Image courtesy NOAA

This information can be combined with theories about climate to construct computer models that make predictions about what the climate will be when the ocean and atmosphere have certain characteristics. Comparing these predictions with knowledge about actual climate when these characteristics exist allows scientists to improve the computer models and make additional observations and experiments to make better predictions about future climate conditions.

A lot of research has been done about Earth's climate system, and climate prediction models continue to improve. Today's climate models are able to reproduce the average global temperature changes that occurred in the 20th century when they include all of the known natural and human-caused factors that affect climate. This gives us additional confidence that predictions about future climate conditions provide accurate information that will help societies decide how to prepare for the impacts of climate change.

* Scientists use many different instruments to make measurements that help predict weather and climate; but only a few instruments are needed to set up a Home Weather Station that can help you make your own weather predictions. You need to be able to measure temperature, wind speed, wind direction, and atmospheric pressure. You already know how to make an instrument for measuring temperature from Activity 4. Table 1 lists some clues that will help you estimate wind speed. To complete your Home Weather Station, you need a wind vane to measure wind direction, and a barometer to measure atmospheric pressure.

How It Works

Weather Vane: Winds are named according to the direction from which the wind is blowing, so a "north wind" is blowing from the north. The head of the Weather Vane will point to the direction from which the wind is blowing.

Beaufort Scale

Table 1
In 1805, Sir Francis Beaufort invented a scale from 0 – 12 for estimating wind speed based on features that can easily be observed.
Sailors still use the Beaufort scale, but professional weather forecasters usually report wind speed in miles per hour or kilometers per hour.
(source: *http://www.srh.noaa.gov/jetstream/ocean/beaufort_max.htm#beaufort*)

Beaufort Scale No.	Wind Speed (km/hr)	Wind Speed (mi/hr)	Forecast Term	Observations	
				Sea	Land
0	0-1	0-1	Calm	Sea surface smooth	Smoke rises vertically
1	1-5	1-3	Light	Sea surface rippled	Smoke drift indicates wind direction, wind vanes do not move
2	6-11	4-7	Light	Small wavelets, crests have glassy appearance but do not break	Wind felt on face, leaves rustle, wind vanes begin to move
3	12-19	8-12	Gentle	Large wavelets, crests begin to break	Leaves constantly moving, light flags extended
4	20-28	13-18	Moderate	Small waves, numerous whitecaps	Leaves, and loose paper lifted, small tree branches move
5	29-38	19-24	Fresh	Moderate waves, many whitecaps	Small trees in leaf begin to sway
6	39-49	25-31	Strong	Larger waves, whitecaps common, some spray	Larger branches moving, whistling in wires, umbrella use difficult
7	50-61	32-38	Strong	Sea heaps up, white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	62-74	39-46	Gale	Moderately high (18-25 ft) waves, foam blown in streaks	Twigs breaking off trees, walking difficult
9	75-88	47-54	Gale	High waves (23-32 ft), dense streaks of foam	Slight structural damage may occur, slate blows off roofs
10	89-102	55-63	Whole Gale	Very high waves (29-41 ft) with overhanging crests, sea white with foam	Trees broken or uprooted, considerable structural damage
11	103-117	64-72	Whole Gale	Exceptionally high (37-52 ft) waves, foam covers sea	Extensive damage
12	118-132	72-82	Hurricane	Air filled with foam, waves over 45 ft, sea completely white	Countryside devastated

Barometer: The water level in the barometer tube will rise and fall as atmospheric pressure changes. When atmospheric pressure increases, air presses on the surface of the water in the container causing the height of the water in the tube to rise. When atmospheric pressure decreases, there is less pressure on the surface of the water in the container so the height of the water in the tube falls. Decreasing atmospheric pressure usually indicates that a low-pressure area is approaching, and this often brings clouds and rain. Increasing atmospheric pressure often indicates fair weather.

How to Do It

Make the Wind Vane

Be careful of the sharp edges on the pieces of cut aluminum! Use gloves to protect your hands until the edges are taped.

1. Use the saw or serrated knife to cut a notch about 1/2-inch deep into each end of the wood stick. The notches should be parallel (Figure 1).

2. Rotate the stick so that the two slots are vertical. Use the ruler or tape measure to find the exact center of the wood stick. Mark this spot on the upper surface of the stick, and drive a nail through the marked spot. Be careful: if the nail is too big, the stick will probably split. To avoid this, drill a hole slightly larger than the nail through the marked spot. You may need your adult partner to help with the drilling.

3. Cut the head and tail pieces of the Weather Vane from the aluminum baking dish using Figure 2 as a guide. **Be Careful—The Edges Are Sharp!** Use duct tape to cover the sharp edges.

Figure 1. Wind Vane Assembly

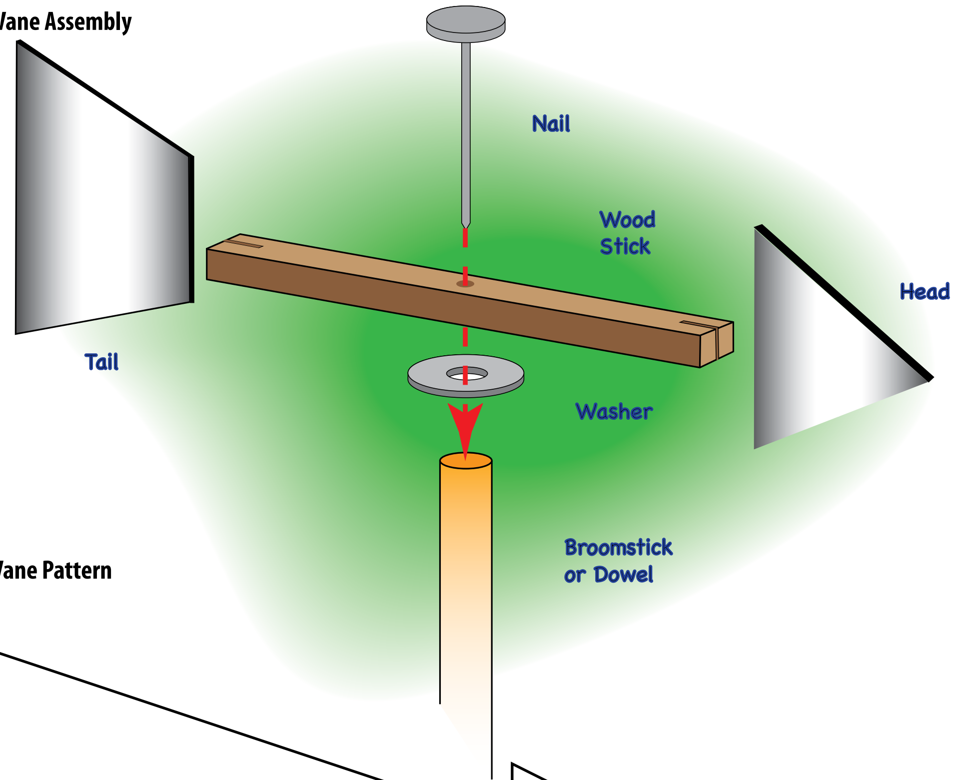
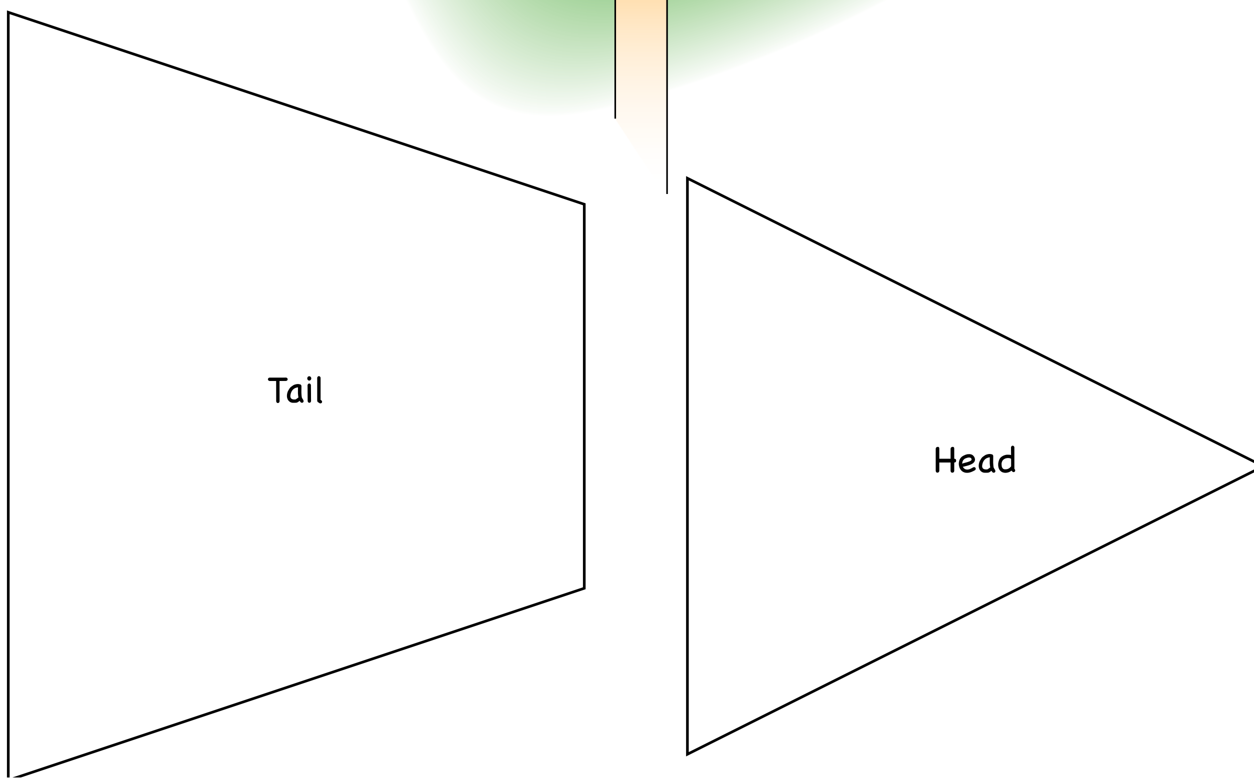


Figure 2. Wind Vane Pattern



4. Fit the head piece into one of the slots in the wood stick and fit the tail piece into the other slot. Glue the head and tail pieces into place and allow the glue to dry.

5. Attach the Weather Vane to the broomstick or dowel, by placing the washer on one end of the dowel and hammering the nail through the wooden stick into the dowel. Be sure the stick still moves freely around the nail.

6. Mount your Weather Vane outside where there are no nearby obstructions to block the wind. Try to get the dowel as high as you can while still keeping it steady and secure.

Make the Barometer

1. Tape the plastic straw or plastic tubing to the ruler so that one end is lined up with the "1 cm" ("1/2-inch") mark on the ruler.

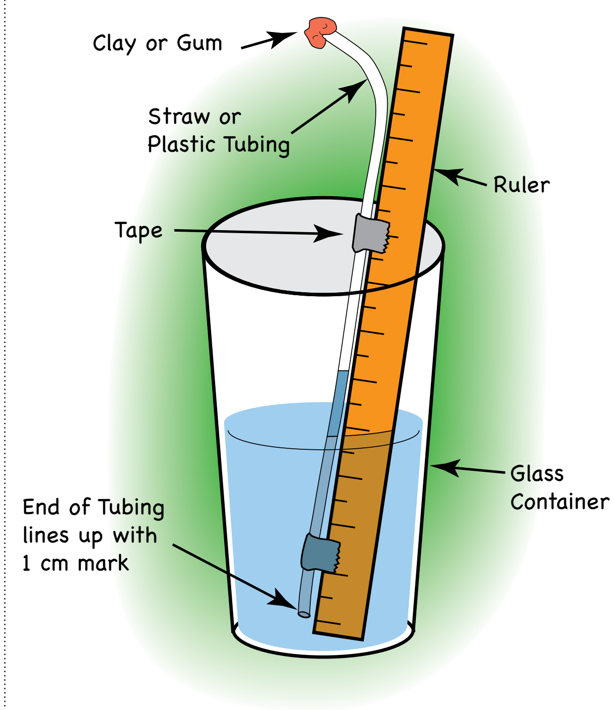
2. Stand the ruler-tubing assembly upright in the glass (or other container), and tape the assembly to the top of the container.

3. Fill the container about 3/4-full of water. If you want colored water, first mix food coloring with the water in another container.

4. Use the modeling clay or chewing gum (you'll have to chew it until it is soft enough) to plug the end of the straw or plastic tubing near the top of the ruler.

5. Carefully pour out some of the water so the container is about half full. Be sure the lower end of the straw or tubing stays beneath the water surface while you do this! When you are finished, the water in the straw or tube should be higher than the water in the container. Your barometer is now finished. Since barometers are sensitive to minor changes in weather conditions, keep your barometer indoors for greatest accuracy. (See Figure 3 for finished barometer.) The water level in the tube will rise and fall as atmospheric pressure changes. When atmospheric pressure increases, air presses on the surface of the water in the container causing the height of the water in the tube to rise. When atmospheric pressure decreases, there is less pressure on the surface of the water in the container, so he height of the water in the tube falls. Decreasing atmospheric pressure usually indicates that a low pressure area is approaching, and this often brings clouds and rain. Increasing atmospheric pressure often indicates fair weather.

Figure 3. Barometer



Sample Weather Journal Data Form

Date	Time	Temperature	Barometric Pressure		Wind		Precipitation		Other Events
			Instrument	NWS	Speed	Direction	Type	Amount	

Keep a daily record of outside temperature, barometric pressure, wind speed, wind direction, and recent precipitation or other significant weather events. When you record barometric pressure, record the height of the water in the barometer tube (using the scale on the ruler), as well as barometric pressure reported by a local office of the National Weather Service. That way, you will know how readings from your Home Weather Station barometer compare to measurements from barometers used by professional weather forecasters.

Make the Rain Gauge

1. Rain gauges measure the amount of rainfall in cubic inches. So your first task is to make a scale for your container that shows how many cubic inches of water are in the container. One cubic inch of water is about 3 1/4 teaspoons, so you can draw the scale on your container by measuring 3 1/4 teaspoons of water to your container, then drawing a short line at the level of the water. If you look closely, the top of the water will seem to be slightly curved and thickened. Draw your line so that it matches the bottom of the curved surface (which is called a meniscus). This line corresponds to a rainfall of one inch.

2. Add another 3 1/4 teaspoons of water to the container and draw another line. The second line corresponds to a rainfall of two inches.

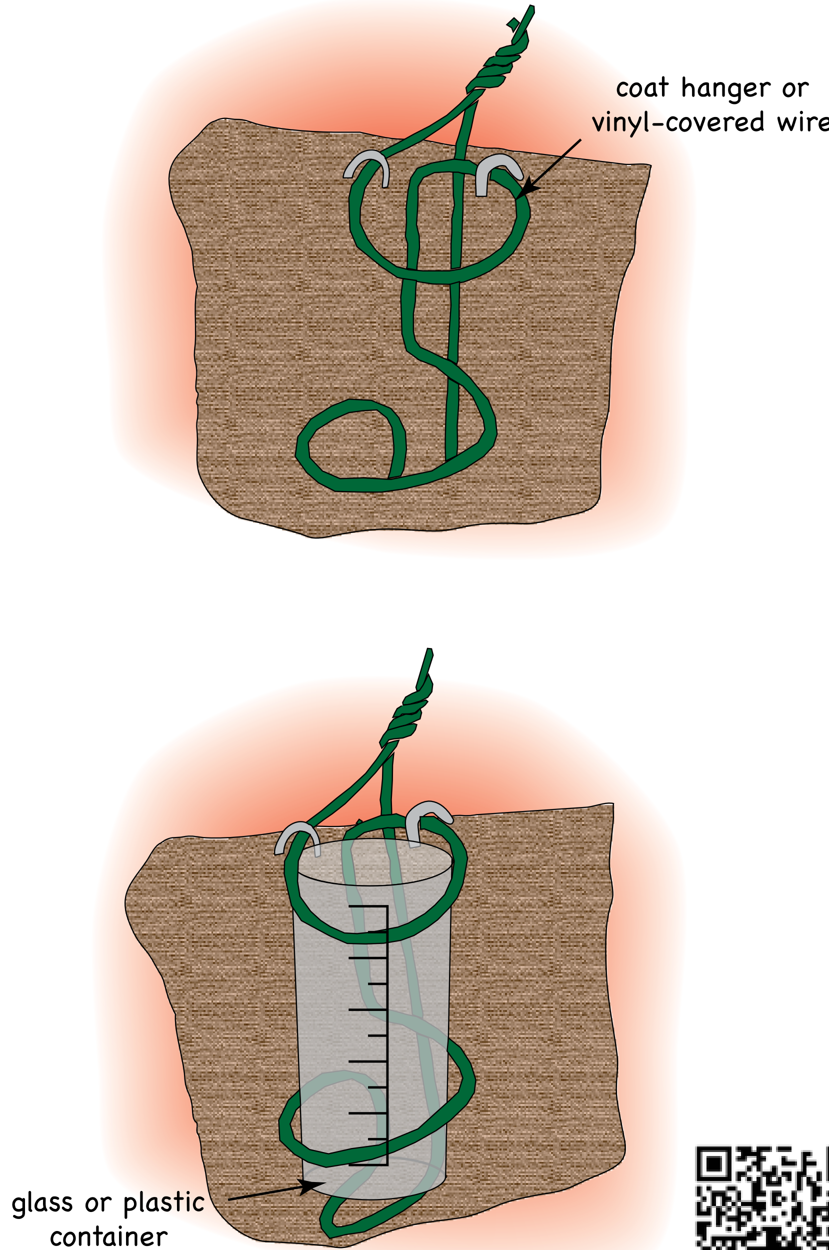
3. Repeat Step 2 until you have at least five marks on the container. This will be enough for most rain events; but you may want to add another line or two, just in case!

4. Find a location for your rain gauge where there is nothing overhead (such as trees or a building roof) that could direct water into or away from your gauge. The edge of a fence away from buildings is often a good spot. Another possibility is to attach your rain gauge to a broomstick driven into the ground in an open area. Be sure to record rainfall soon after a rain event to avoid false readings caused by evaporation.

Empty your gauge after each reading, and you are ready for the next event!

This activity is adapted from "Build Your Own Weather Station" by the Educational Technology Programs Team at the Franklin Institute, Philadelphia, PA (*http://www.fi.edu/weather/todo/todo.html*).

Figure 4. Rain Gauge



ACTIVITY 1: Have students pair up, tour the school, and search and record evidence of single-use items or packaging. Go to the cafeteria, photo copy room, teachers lounge, maintenance area, offices, other classrooms, etc. (You may need to prearrange these visits in the school. It is also recommended that the teacher visit before-hand so that you know what the students might find.) Have the student pairs do some online research as to where these single-use disposables go when they are thrown away. (Hint: Where is AWAY?? THERE IS NO AWAY!! Away is over flowing landfills, clogged rivers, islands of trash in our oceans and even our very own toxic bodies.) Use the information from *Bag It* to guide this research.

ACTIVITY 2: CREATE A "TO-GO KIT"

A To-Go Kit is your own set of personal reusable items that you can take with you anywhere, so you don't have to use and purchase single-use disposable products. If your school lunch cafeteria uses throwaway plastic forks, plates and cups, bring your To-Go Kit so you don't have to use these once and then throw them away.

Creating a To-Go Kit can be done at home with parent support, or in school. If it is done in school, then the teacher may need to supply the items, or have a "To-Go Kit Drive" for one week during which the students bring in as many of the listed items as they can to share with the entire class. Have each student build a kit. Brainstorm ways and places where they can use the kits.

ITEMS FOR "TO-GO KIT":

Reusable Shopping Bag
Reusable Cup or Bottle
Silverware
Sturdy To-Go Container and/or Plate
Cloth Napkin (a Bandana is a good alternative)

WRAP UP: Have the students record a "reaction journal." It starts to become fun to say, "I'm not using any single-use containers, so I brought my own plate (or bag or cup)." Did they get a strange look? A comment or statement? People asking questions? Have the class create its own blog and record these reactions on the blog for the entire class to see.

ASSESSMENT/FOLLOW UP: Assess the students on their research and recording procedures in Activity 1. The teacher may want to create a specific worksheet and rubric for these procedures (depending on age/grade level and classroom research expectations).

COMMUNITY EXTENSION: Present the list of single-use plastics that are being used in your school to your administration. Ask if your class can attend the next teachers meeting or school board meeting to discuss these uses, and to try and work together to find ways that the school can cut down on this use.

RESOURCES/LINKS/LITERARY CONNECTIONS:

How to Create a Blog: www.blogger.com
Rubric Example: http://bit.ly/eo0396

STEM IN THE LAB
innovate. explore. discover.

Idaho National Laboratory

BUILD A BIRD FEEDER

Did you know that there are about 10,000 different types of birds in the world? You don't have to go far to see some of them. Birds live outside in backyards and parks and can even be found in a busy city! Do you know what kinds of birds live in your neighborhood? Have you ever taken a close look at the birds you see in your backyard to identify them and observe their behavior? In this activity, you will build a bird feeder to attract birds, so you can study them.

GRADE LEVELS: K-8

VOCABULARY

Ornithology- *The scientific study of birds.*

Ecology- *the branch of biology that deals with the relations of organisms to one another and to their physical surroundings.*

Oxygen- *a colorless, odorless reactive gas, the chemical element of atomic number 8 and the life-supporting component of the air.*

MATERIALS

- *Plastic milk/juice container with cap*
- *Scissors or craft knife*
- *Wooden dowel, twig, or wooden coffee stirrer*
- *Bird seeds*
- *Mini cup(s)*
- *Water*
- *Tape*
- *Optional: paper plate*
- *Possible decorations: tree bark, shells, stones, stickers, etc.*
- *Note: Make sure that any materials you use to decorate the bird feeders are safe for the birds. If possible, stick to as many natural materials as possible.*
- *Optional: paintbrushes, when using paint*
- *Glue or glue gun*
- *Twine, yarn, or thin rope*
- *Pen or pencil*
- *Binoculars (optional)*
- *Bird field guide (optional)*
- *Lab notebook*

PROCEDURE

PREP WORK

1. *Clean out the milk or juice container with warm water and soap. Let the container dry completely.*

INSTRUCTIONS

1. *Ask an adult to help you cut an opening into the flat side of the container. The opening should be at least one inch above the bottom of the container and at least three inches in diameter.*
2. *Use tape to cover the sharp edges of the opening so the birds don't get harmed when coming into your bird feeder.*
3. *Cut a small hole below the opening and insert a wooden dowel or stick to build a perch for the birds. Secure the stick in place with glue.*
4. *Glue one or more mini cups onto the floor of your bird feeder or onto the inside walls.*
5. *Prepare a place for your bird food. You can either put a paper plate into your bird feeder or plan to put the seeds directly in the container.*
6. *With the help of an adult, poke two holes on opposite sides next to the opening/cap of the container. Then thread the twine, yarn, or rope through the holes and tie the ends in a knot to create a handle.*
7. *Once you are done, start decorating or coloring your bird feeder. Make sure all the materials are safe for birds. Good choices are natural materials such as pebbles, shells, tree bark, etc.*

   What type of decoration would be best to attract the most birds?

8. *Fill the bird feeder with bird seeds and add some water to the mini cup.*
9. *Set the bird feeder up outside. You can, for example, hang it in a tree or let it sit on a table. Observe the birds that come to your bird feeder.*

   What do the birds look like that visit your bird feeder? Which birds can you identify? Can you differentiate them by their appearance or their songs?

WHAT HAPPENED?

Once you set up your bird feeder, it may have taken a while before you saw birds visiting. This is because the birds first have to get used to the bird feeder that they haven't seen before, so they know it is safe. After a couple of days, you should have started seeing birds come to your bird feeder. They will come for the bird seeds and the water that you have provided for them. If you have binoculars and a field guide for birds, you might have been able to identify some of the birds you saw. Which birds live in your backyard depends on the area you live in. Different places on Earth have different birds living there.

If you tested different bird seeds in your bird feeder, you might have noticed that different birds prefer different seeds. This is because every animal has their own special diet and can only eat certain things. Some seeds that birds like to eat are millet or sunflower seeds. Depending on where you have set up your bird feeder, you may have also seen other animals besides birds come to your bird feeder, such as squirrels, mice, or rats. These animals also need to hunt for food and must find water in order to survive in the wild.

THE SCIENCE BEHIND IT

Every animal on our planet, including birds and humans, needs food, water, air, and shelter to survive. Animals need to eat regularly to get energy for their bodies to function. What kinds of foods an animal eats depends on the type of animal; some animals hunt or prey on other animals (carnivores), whereas others will search for foods like plants or fruits (herbivores) or eat both plants and fruits and other animals (omnivores). A wild bird's diet consists of plants such as grains or seeds and animals like insects, worms, or fish. Each animal chooses to live where they can find the food they need to survive.

Water is also important. An animal's body can consist of as much as 90% water. Most animals lose water when they sweat or exhale. In order to replenish their water supply, they have to drink on a regular basis. Some animals that live in the desert where there is not a lot of water get most of their water from the food they eat.

Almost every animal needs air, or a special gas called oxygen that is part of the air. Even fish that live under water need to take up oxygen with their gills. The oxygen is important to keep the processes in the body going. For example, oxygen is needed to make energy from the food an animal eats. Because birds need lots of energy and oxygen for flying, they have special air sacs in addition to their lungs for breathing.

Shelter, or a protected place to live, is important for all animals. Each animal can only live within a certain temperature range. When the temperature gets too high or too low, an animal will die. A shelter can help protect them from temperatures that are too high or too low. In addition, a shelter is a place where animals can raise their young and helps protect them from dangers such as predators. The type of shelter, or home, an animal builds or chooses can vary. Some animals build underground borrows, some build nests in trees, and others prefer to live in caves. In the wild, birds build nests made of twigs and other materials as their shelter. This is where they lay their eggs and raise their young. Some birds also live in hollow trees.

Building a place that provides birds with some of the things they need to survive, such as a ***bird feeder****, is a great way to learn more about the birds in your area. A bird feeder will attract birds, allowing you to get a closer look without disturbing the birds. When bird watching, features such as the bird's size, plumage color, or beak shape help to identify a specific bird species.*

People who study birds are called ***ornithologists****. They try to learn as much as they can about each of the different types of birds. They study what each bird looks like, what they eat, where they fly, how they sound, and much more.*

EXTENSIONS

- *In addition to using your bird feeder to find out what kinds of birds live in your neighborhood, you can also find out what kind of food these birds like best. Instead of a bird seed mix, put just one kind of bird seed into your bird feeder. Some seeds to try are sunflower seeds, millet, or corn. Then observe the bird feeder for about one week to see which birds visit the feeder. The next week, change the type of bird seed in the feeder and again observe the birds that are coming to your bird feeder. Test several different seeds this way. Which seeds are most popular? Do some types of birds prefer a specific seed?*
- *Build several bird feeders and decorate them each with different colors. Hang them up in a tree and observe how many birds come to each bird feeder. Is there a certain color that the birds are more attracted to compared to the others?*
- *Compare the types of birds that come to your feeder. Observe their size, shape, or behavior. How are they different or similar to each other?*
- *Find out more about the types of birds that come to your feeder. Where else in the world do they live? What do they usually eat? Where do they build their nests? Are they common birds or endangered? Create a report about one specific type of bird with all the information that you can find.*

RESOURCES

https://www.sciencebuddies.org/stem-activities/build-bird-feeder#summary

LEARN MORE ABOUT INL

STUDENTS + PARENTS + EDUCATORS

*For information on grants, training and student opportunities; curriculum ideas and resources, please visit us at: **stem.inl.gov**.*

ACTIVITY 1: (Additional Materials: worksheet, calculator) Using data from *Bag It*, convert information from the movie into a unit that is more personally impacting. A worksheet is provided at the end of the lesson that lists data from the film.

NOTE TO TEACHERS: Try not to print the sheet… try to keep the document electronic! Contemplate the volume of waste you save from the landfill by using an electronic document instead of a print out.

ACTIVITY 2: (Additional Materials: scale or spring scale, reused plastic or paper bag)

- Reuse a paper or plastic bag from the store to save your reusable waste for one day. Make conscious choices about items that can be reused in a creative way. For example, save the plastic bags from your lunch to be used the following day for the same food!
- What items are in your bag at the end of the day? How can you reuse these items?
- Weigh the amount of reusable goods in the bag, subtract the weight of the bag, and you will have the amount of trash you saved from entering the waste stream.
- Convert this amount into the amount you would save from entering the waste stream:
- Each week?
- Per month?
- How about in a year?
- What if your family did the same as you?
- What if all the kids in your class saved the same amount?

WRAP UP: (Additional Materials: class data, graph paper or graphing software)
Create a line or bar graph to represent the amount of trash the class as a whole was able to save for one day. Extrapolate what this savings would be if the school as a whole were to cut down on the amount of waste they disposed of. Discuss how the school as a whole could make small changes that would lead to big savings.

ASSESSMENT/FOLLOW UP: Grade the line or bar graphs for accuracy, content, and presentation.

COMMUNITY ACTION: Using the items you saved, create a trash sculpture that can show other students how their single-use disposables can have a longer life! Put the trash sculpture next to the trashcan in the lunchroom or near the entrance of your school to demonstrate to others how to think carefully about each piece of trash that goes into the can. Provide an explanation with the sculpture so people can understand that their small, thoughtful actions can indeed change the world.