Science Unit: *Water*
Lesson 1: *Water Cycle*

School year:	2004/2005
Developed for:	Queen Alexandra Elementary School, Vancouver School District
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Grade level:	Presented to grades 4 - 5; appropriate for grades 3 – 7 with age appropriate modifications.
Duration of lesson:	1 hour and 20 minutes
Notes:	Extension activities during the week

Objectives

1. Learn that the water cycle is the movement of water in a never-ending cycle on, in and above Earth, and that heat energy from the sun plays a major role in the water cycle.
2. Learn that the states of water change frequently in the water cycle, from solid ice to liquid water to gaseous water vapor and back to liquid water, etc., depending upon the temperature.
3. Learn that water is stored above and below the surface of the earth.

Background Information

Water is essential to life on Earth and comprises more than half the weight of living organisms. A water molecule contains two atoms of hydrogen and one atom of oxygen (H_20). The hydrogen atoms have a positive charge and the oxygen atom has a negative charge; these charges cause water molecules to be attracted to each other (via hydrogen bonds), thereby creating strong surface tension.

Water exists in three states on Earth (as a solid, liquid and gas) and water covers approximately 70% of the Earth's surface. The water cycle describes the continuous movement of water above, below, and on the Earth's surface through processes called evaporation, condensation, transpiration, precipitation, and infiltration. Heat energy from the sun causes the Earth's surface water to evaporate, and water vapor (a gas) rises into the air and travels up into the atmosphere where it condenses into clouds due to cooler temperatures. Eventually, the water in clouds falls to the surface of the Earth in the form of snow, sleet, hail, or rain (precipitation). Water is stored on the surface of Earth in glaciers, ice caps, oceans, lakes, rivers, etc. Some water infiltrates into the ground and is stored in soil, porous rock, and in aquifers. The roots of plants take up water from the soil; the water travels through xylem cells in the plant to the leaves, where the water evaporates from their surfaces through small pores (a process called transpiration).

Water molecules are recycled continuously. For example, a water molecule may exist in your body one moment, then be flushed down the toilet to later enter a water treatment plant, evaporate, fall as rain, enter the soil, be sucked up by the roots of an orange tree, and then end up in a glass of orange juice.

Vocabulary

Water:	A colorless, odorless liquid with no taste or smell and of neutral pH; water can exist as a solid, liquid and gas.
Water vapor:	Invisible gas comprised of water molecules.
Condensation:	The change in the state of water from a gas (water vapor) into a liquid; an object or

	particle is required for condensation to occur.
Evaporation:	The change of liquid water into a gas (water vapor) by the escape of molecules from the surface of the liquid; heat energy is needed to break hydrogen bonds that hold water molecules together in a liquid.
Precipitation:	The discharge of water as a liquid or solid (rain, sleet, snow, and hail) out of the atmosphere and the general travel of the water down to the surface of the earth.
Transpiration:	The discharge of water vapor through openings (pores) called stomata on the above ground surfaces of the plant (mostly the lower leaf surface); the water vapor enters the atmosphere.
Infiltration:	The downward movement of water from the surface of land into the soil or porous rock.
Terrarium:	An enclosed container with small plants and or animals inside it.
Treatment:	To subject something to a specific process; the manner, method, or procedure of treating something.
Incubate:	To keep something in a specific place for a specific period of time; sometimes specific environmental conditions are controlled during incubation (heat, light, humidity, etc.).

Materials

- 2 liter clear plastic bottles with screw tops
- serrated bread knife
- small plastic containers to scoop gravel and soil
- containers to hold water
- measuring cups or beakers
- moss and small non-flowering plants
- gravel (pea sized)
- potting soil
- rulers
- scissors
- lamp with incandescent light bulb
- permanent marking pens
- wide transparent tape and labeling tape
- paper towels

In the Classroom

Introductory Discussion

1. Review the properties and states of water, the most common molecule on Earth.
2. Review the water cycle.
3. Demonstrate condensation by having students exhale forcefully on the surface of a mirror. Ask students to predict how long it will take for a mist of water to evaporate from a chalkboard: spray a fine mist of water on the chalkboard and have students count the number of seconds for the water to evaporate.
4. Review the science experiment, building a terrarium to observe the water cycle.
5. Review how to do a science experiment.
    - Make an observation and then ask a question OR start with a question: How will incubation conditions (the light source) affect the inside and outside surfaces of the plastic bottles after terrariums are incubated for 1 day?

- Think about what will happen to the inside and outside surfaces of the terrarium if it is placed under an incandescent light bulb compared to a windowsill. Write down what you think will happen. This is your prediction.
- Set up the terrarium experiment, treating everything the same except for one thing (what you want to test), the incubation conditions (light source). Treatments will include room temperature incubation under an incandescent light bulb and on a windowsill. Discuss why you only change one thing (a variable).
- Make observations.
- Collect data, record and examine results (think about why things happened the way they did).
- Make conclusions and explain results (compare results to predictions to help you think deeper).
- Communicate results and conclusions.

Science Activity/Experiment

This lesson is based on The Returning Raindrop experiment in The Water Sourcebook, Grades 3-5. See Reference 2 for additional information.

Experiment Title: Build a Terrarium to Observe a Miniature Water Cycle.

Purpose of Experiment: The purpose of this experiment is to observe a miniature water cycle in a student-made terrarium, and to experiment with different incubation conditions to determine the effect on the water cycle within the terrarium.

Experimental Treatments: Four to six students will work together in a group. There will be six groups of students. Each group will build a terrarium. Three groups will incubate their terrariums under an incandescent light source (treatment 1). The other three groups will incubate their terrariums on a windowsill (treatment 2).

Treatment 1	Incandescent light source
Treatment 2	Light that is present on a window sill

1. Three of the terrariums (representing 3 replicates) will be incubated under an incandescent light source distant from windows, and the other 3 terrariums will be incubated near a window. The terrariums can be grouped into treatments after 1 and 3 days incubation and placed in front of the class so that all students can observe the results.
2. Students will record their hypotheses based on the following question prior to starting the experiment.
    - How will incubation conditions affect the inside and outside surfaces of the plastic bottles after terrariums are incubated for 1 day?
    - Students can make a second hypothesis after observations are recorded after 1 day of incubation. How will incubation conditions affect the inside and outside surfaces of the plastic bottles after terrariums are incubated for 3 days?

Methods:

Prior to the lesson: Use a serrated bread knife to make a horizontal cut in each plastic bottle approximately 1/3 down from the top. Leave approximately 2 cm of one side of the bottle intact to act as a hinge. The top part of the bottle will stay attached to the bottom part and the top section can be opened up and left inverted when the terrarium is assembled. It is easiest to lay the bottle on its side while cutting.

1. Add gravel to fill the bottom 2 cm of the bottle.
2. Cover the gravel with potting soil until the level of the soil is 8 cm from the base of the bottle.
3. Slowly and gently water the surface of the soil until the soil and gravel become moist (approx. 100 – 200 mL of water). Add more soil to bring the soil level to the 8 cm mark.
4. Carefully plant moss and a small non-flowering plant in the soil. (Flowering plants develop mold on dying flowers in the terrarium so it is best to use non-flowering plants.)
5. Place the top section of the bottle on the bottom section of the bottle and tape the top securely in place using wide transparent tape. Cover all cut surfaces with tape.
6. Use labeling tape and a marking pen to label each terrarium with the group name and treatment. Place the terrariums under the appropriate incubation conditions and mark the side of the terrarium that faces the window or incandescent light bulb.
7. Record observations after 1 and 3 days of incubation. Describe the outside and inside surfaces of the bottle and make drawings of the pattern of condensation. Record conclusions about what happened to the water.
8. Terrariums can be opened up, condensation can be wiped off the plastic, and terrariums can then be taped shut and incubated in different locations to continue exploring the water cycle within the terrariums.

Closure Discussion

1. What segments of the water cycle do you think you will observe in the terrariums after 1 day of incubation?
2. How does rain form?
3. What is fog?

References

1. e.enclyclopedia Science, Google. 2004. Pp. 40-41, DK Publishing Inc.
2. Water Cycle, Bill Nye the Science Guy, Video, 1995, 26 minutes.
3. http://www.epa.gov/safewater/kids/wsb/index.html#3-5 http://www.epa.gov/safewater/kids/wsb/pdfs/351.pdf The Water Sourcebook, A Series of Classroom Activities for Grades 3-5. 1994. Introduction to Water, The Returning Raindrop. [The Water Sourcebook was produced for Legacy, Inc. Partners in Environmental Education, in cooperation with US Environmental Protection Agency and prepared by Tennessee Valley Authority, Environmental Education Section].
4. http://ga.water.usgs.gov/edu/ US Geological Service, Water Science for Schools [Information about the water cycle].
5. http://www.gvrd.bc.ca/education/curriculum-resources.htm Greater Vancouver Regional District [Curriculum resources].

Extension of Lesson Plan

1. Introduce students to the water cycle by viewing the Water Cycle video by Bill Nye the Science Guy.
2. Students can pretend to be a drop of water and role-play or write a story about what happens to the drop of water during the water cycle.

3. Surface tension of water can be explored using a penny or wax paper, an eyedropper, and water.
4. Condensation can be explored using clear plastic cups, water, and ice cubes.

Water Cycle in a Bottle: Building a Terrarium

Water Experiment #1

Name of Scientist: _____

Purpose: to observe a miniature water cycle in a student made terrarium

Materials:

- 2 litre clear plastic bottles with screw tops
- serrated bread knife or scissors
- small plastic containers to scoop gravel and soil
- containers to hold water
- measuring cups or beakers
- moss and small plants
- gravel (pea sized)
- potting soil
- rulers
- lamp with incandescent light bulb
- permanent marking pens
- wide transparent tape
- paper towels

Treatments:

1. Incandescent light source
2. Students select another treatment: _____

Hypothesis:

Before making your hypothesis, it helps to start with a question or make observations and then ask a question. Think about the segments of the water cycle that you think will occur inside the terrarium after 1 day of incubation. Use your prior knowledge of the water cycle to help you predict what you think will happen.

How will incubation conditions affect the inside and outside surfaces of the plastic bottles after terrariums are incubated for 1 day?

Initial hypothesis:

A second Hypothesis can be made after observations are recorded after 1 day of incubation.

How will incubation conditions affect the inside and outside surfaces of the plastic bottles after terrariums are incubated for 4 days?

Second hypothesis:

Methods:

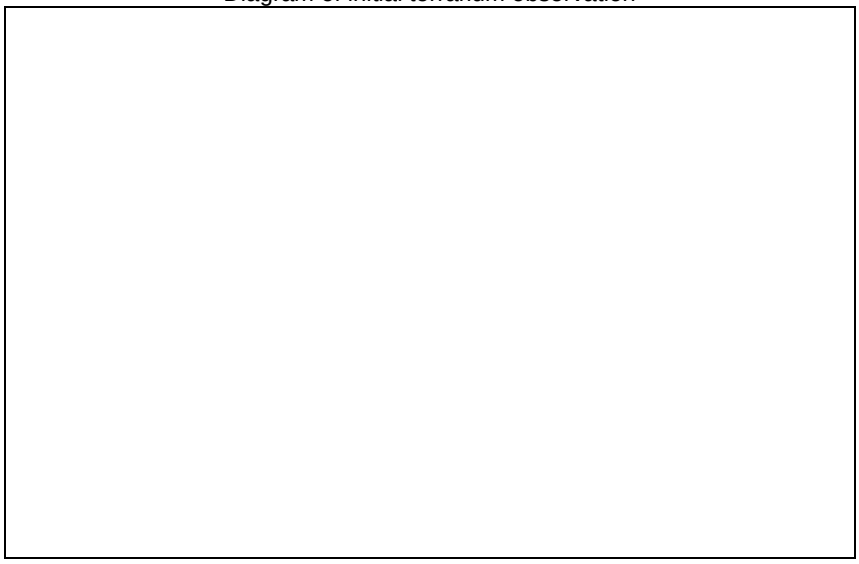
1. Add gravel to fill the bottom 2 cm of the bottle.
2. Cover the gravel with potting soil until the level of the soil is 8 cm from the base of the bottle.
3. Slowly and gently water the surface of the soil with 125 ml until the soil and gravel become moist. Add more soil to bring the soil level to the 8 cm mark.
4. Carefully plant the moss and a small plant in the soil.
5. Place the top section of the bottle on top of the bottom section of the bottle using the vertical line as a guide. Tape the top securely in place and cover all cut surfaces with tape.

Observations:

Describe the outside and inside surfaces of the bottles placed under treatment one and two

Initial observation:

Diagram of initial terrarium observation



After one day, describe the outside and inside surfaces of each of the bottles placed under treatment one and two. Were there any differences between the two bottles?

Second observation:

Diagram of second terrarium observation

treatment 1	treatment 2

After four days, describe the outside and inside surfaces of each of the bottles placed under treatment one and two. Were there any differences between the two bottles?

Third observation:

Diagram of third terrarium observation

treatment 1	treatment 2

Conclusion:

From your three observations of a miniature water cycle in the terrarium, write your conclusions about what happened to the water.

My conclusion:

A Condensation Experiment
Is there water in the air?
Water Experiment #2

Name of Scientist: _____

Purpose: to use water in its three states to experiment with condensation.

Materials:

- clear plastic cups
- water
- ice cubes

Treatments:

1. Empty cup (control treatment)
2. Cup containing room temperature water (control treatment)
3. Cup containing room temperature water and ice

Hypothesis:

Before making your hypothesis, it helps to start with a question or make observations and then ask a question. Use your prior knowledge of condensation to help you predict what you think will happen if ice water is placed inside a plastic cup.

How will ice water affect the inside and outside surfaces of the plastic cup?

Hypothesis:

Methods:

1. Keep one cup empty and pour the same volume of room temperature water into the other 2 cups so that the cups are 2/3 full.
2. Add 3 ice cubes to one of the cups containing water.
3. Record observations of the inside and outside surfaces of the cup and the contents of the cup for each treatment immediately after the experiment is set up.
4. Record observations of the inside and outside surfaces of the cup and the contents of the cup for each treatment after 20 minutes of incubation at room temperature.

Observations:

Initial observations of the cups' surfaces:
Initial observations of the cups' contents:

Second observation of the cups' surfaces (20 minutes later):
Second observation of the cups' contents (20 minutes later):

Diagram of each cup after 20 minutes

treatment 1	treatment 2	treatment 3

Conclusion:

What happens to water vapour as it hits the surface of a cool plastic cup?
