

READING THE RIVER

SUMMER 2002

“All the water in the world”

GRADES 9 – 10

INTEGRATED SCIENCES – EARTH SCIENCE

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"All the Water in the World"

Grade Level: 9 – 10

Objectives

Upon completion of this lesson, the students will be able to:

1. Describe the never-ending journey of water [hydrologic cycle]
2. Explain the sequential physical and chemical changes occurring during the water cycle
3. Justify the importance of protecting our limited supply of fresh water [visualization and computation exercises]
4. Calculate the pore space and drainage rate of various materials
5. Compare the porosity and permeability of various materials
6. Determine the factors influencing various critical water quality parameters
7. Explain how those parameters affect the environment in our watershed

Program of Studies

Scientific Inquiry

- Identify and refine questions and identify scientific concepts to guide the design of scientific investigations.
- Use equipment [e.g. LaMotte water test kit], tools [e.g. beakers, graduated cylinders], techniques [e.g. collecting data, charting], and mathematics to improve investigations and communication.
- Communicate results of scientific investigations

Conceptual Understandings

- Structure and properties of Matter
- Chemical reactions
- Motions and Forces
- Energy in the Earth system
- Geochemical Cycles

Applications/Connections

- Demonstrate how science is used to solve problems [environmental quality], and how science concepts can be used in real life situation
- Analyze scientific data to acquire better conceptual understandings.

Core Content

Physical Science

SC-H-1.2.5 → Solids, liquids, and gases differ in the distances between molecules or atoms and therefore the energy that binds them together. In solids, the structure is nearly rigid; in liquids, molecules or atoms move around each other but do not move apart; and in gases, molecules or atoms move almost independently of each other and are relatively far apart.

SC-H-1.3.1 → Chemical reactions occur all around us (...) Reaction rates vary and depend on concentration, temperature, and properties of reactants.

SC-H-1.4.1 → Objects change their motion only when a net force is applied. Laws of motion are used to describe the effects of forces on the motion of objects.

SC-H-1.4.2 → Gravity is a universal force that each mass exerts on every other mass.

Earth and Space Science

SC-H-2.1.3 → Heating of Earth's surface and atmosphere by the Sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

SC-H-2.1.4 → Global climate is determined by energy transfer from the Sun at and near the Earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the Earth's rotation and static conditions such as the position of mountain ranges and oceans.

SC-H-2.2.1 → Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different reservoirs. Each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles.

SC-H-2.2.2 → Movement of matter between reservoirs ... are often accompanied by a change in physical and chemical properties. Carbon, for example, occurs in carbonate rock such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.

Materials

various size graduated cylinders and beakers [1 liter, 10, 100, 250, 500 ml]
pipettes, small Petri dish 45mm
food coloring, salt
paper, pencils, crayons, markers, etc...
plastic wrap, coffee filter
large plastic cups, plastic funnels
gravel, sand, clay
stopwatch, calculator
LaMotte water testing kit

Activities

- Investigation, research, and presentation of the Water Cycle.
- Demonstrations of evaporation, condensation, and fresh water production from salt water.
- "All the water in the World" demonstration and handout sheet
- Lecture on watershed – particularly Linking river watershed –
- Differentiation between Porosity and Permeability
- Some critical parameters defining water quality [temperature, turbidity, pH, dissolved oxygen, flow rate]
 - Testing
 - Research

- Presentation of findings

Activity Procedure

Day one The Water Cycle

Using classroom materials [including teacher's computer], research and draw a diagram of the water cycle, properly labeling each part.

Be ready to present your findings and answer appropriate questions.

Day two Evaporation, Condensation, Desalination

With the students' help, the teacher is setting up materials to demonstrate evaporation, condensation, and desalination.

1. Place a 100ml beaker [right side up] in the bottom of a 1000ml beaker
2. Pour water into the 1000ml beaker so the water surrounds the smaller beaker BUT not enough to make it float
3. Mark the water level
4. Cover the 1000ml beaker with plastic wrap and place a small weight in the center of the wrap over the smaller beaker.
5. Place the setup in a sunny area
6. Observe changes over time
7. For desalination, repeat steps 1 thru 5 but add salt to the water

Discuss with the students what can be expected. Can you predict or hypothesize on what will happen? To the water in the large beaker, in the small beaker, to the salt, and the taste of the water in the small beaker....

Link with how to gather water from plant transpiration in a "survival" scenario.

Day three "All the Water in the World"

1. Fill a 1 liter beaker with water. This represents the global quantity of water
2. Ask a student to pour out 50ml. This represent the total amount of fresh water, while the remaining 950ml represents all salt water. Add a few drops of food coloring to the latter [green]
3. Ask another student to pour 8ml out of the fresh water beaker into a graduated cylinder. The remaining 42ml represents the amount of fresh water trapped in glaciers and ice caps; this water is NOT readily available. Add a few drops of food coloring [blue]
The 8ml is the world's available fresh water.
4. From the 8ml, take out 1ml. This represents the amount of water held in the world's fresh water lakes and river [surface water].
The remaining 7ml represents the amount of fresh water trapped in the pores space of soil and fractures of bedrock [groundwater]. Add a few drops of food coloring to the latter [red].
5. Ask the students to make a pie chart showing the world's water distribution.
6. Ask the students to answer the following questions on their worksheet
 - a. Are you surprised by those numbers? Did you realize that such a small percentage of the water in the world is fresh?
 - b. Why isn't all fresh water usable?
 - c. Why do we need to take care of the surface water / groundwater?

Day four Watershed and Porosity vs. Permeability

1. Lecture introducing the term watershed, the Licking River watershed, and the concept of porosity and permeability

Day five Small-scale investigation Porosity / Permeability

1. Porosity

- a. Measure and mark the level of 500ml in 3 large plastic cups
- b. Discard the water and dry the cups
- c. Fill each cup to that mark with sand, pebbles, and clay respectively
- d. Fill a 500 ml graduated cylinder with water
- e. Slowly pour water in the first cup [for example sand] until the sand is just covered.
- f. Repeat steps b. and c. for the pebbles and the clay.
- g. The amount of water used to saturate the materials represents the pore space [500 – water remaining in the graduated cylinder].
- h. Calculate the percentage of pore space [pore space divided by 500] and record as the porosity of the specific materials.

2. Permeability

- a. Place a plastic funnel on top of a 500ml graduated cylinder.
- b. Fold a coffee filter into quarters, open it into a cone and place it into the funnel
- c. Fill the funnels to the same level with sand, pebbles, and clay
- d. Pour 200 ml of water into the funnel. Time and record how long it takes for the water to drain through each funnel.
- e. Calculate the rate of drainage for each funnel by dividing the amount of water that drained by the time it took the water to drain.

3. Answer the following questions:

- a. Which material holds the most water? Why?
- b. Which funnel had the highest drainage rate? Why?
- c. What is the relationship between porosity and permeability?

Day six through eight Water Quality Parameters

1. Background information on pH, temperature, salinity, dissolved oxygen, and flow will be discussed.
 - a. Teacher will demonstrate the colorimetric method for pH determination, the use of a handheld conductivity meter, dissolved oxygen assessment, and flow rate calculation.
 - b. Students will have the opportunity to familiarize themselves with the various procedures.
2. The class will be divided in 5 groups [one per parameter]. Each group will be required to investigate, research, and report on the questions pertaining to the parameter that they were assigned:
 - a. pH
 - i. What factors influence the pH of water?
 - ii. What is the optimal pH for most of the aquatic plants and animals?
 - iii. What factors are affected by your watershed's pH?

- b. Temperature
 - i. What factors influence the temperature of water?
 - ii. What is the optimal temperature for most aquatic plants and animals?
 - iii. What factors are affected by your watershed's temperature?
- c. Salinity
 - i. What factors influence the salinity of water?
 - ii. What is the optimal amount of salinity in your watershed?
 - iii. What factors are affected by the salinity of your watershed?
- d. Dissolved oxygen
 - i. What factors influence the amount of DO in water?
 - ii. What is the minimal amount of DO needed for most aquatic plants and animals to survive?
- e. Flow
 - i. What factors influence stream velocity in your watershed?
 - ii. What factors influence stream volume in your watershed?
 - iii. What is the optimal stream flow in a watershed?
 - iv. What factors are affected by stream flow in a watershed?

Definition / Explanation of Concepts

Earth is often referred as the “water planet”. It is a well-recognized fact that water covers between 2/3 and 3/4 of the entire surface of the globe. Water is abundant, but it is not always clearly understood that first, all the water currently available on the planet Earth is the same as it has always been, and that it will likely remain unchanged for the future. The water cycle [or hydrologic cycle] is essentially a closed loop within which water is continuously on the move between the earth and the sky, and therefore constantly recycled and reused.

Second the amount of readily usable fresh water is miniscule [app. 1%] compared to the entire earth's supply. Depending on where it lands, the water may be held as “surface” water in lakes and/or rivers, or may seep into the ground and become “stored” as groundwater.

The users of fresh water -people, animals, and plants- require clean water. Various easily measurable parameters have a direct impact on the environment, which we are obviously part of.

Protection of, and furthermore proper management of our water system is vital for the “lasting good of men.” Such endeavors begin at home and in our community. The lesson unit is intended to have students visualize the importance of protecting and preserving our natural environment for today and future generations, and recognize their own ability to make a difference in personally participating and in promoting the conservation and protection of our limited water resources.

Assessment

Students will be assessed on the following criteria:

1. Accuracy and originality/creativity in the water cycle representation
2. Extent of use of proper scientific methods to answer aforementioned questions
3. Extent of support required while getting acquainted with the various water parameters testing [pH colorimetry, conductivity meter, DO evaluation]
4. Overall participation during class discussion and group activities/projects

Lesson Context

The lessons are incorporated within a larger unit named “Reshaping the Crust” in which the forces that have shaped and continue to shape the earth are being discussed: erosion due to weathering, water, groundwater, glaciers, winds, and waves.

References

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