DAY TWO

OVERVIEW OR SUMMARY OF LESSON

This class period involves an exploration of the nature of water. What makes water unique? Why is water so easily contaminated? The class will be divided into 5 groups. Each group will study one characteristic of water, prepare visuals and/or a demonstration, and then teach the rest of the class what they have learned. Following each presentation, the teacher can correct misconceptions, see that everyone understands what was presented, and discuss additional facts and concepts. Ideally, students will make journal entries after each group presentation, in which they describe water properties and significance. Journal entries could include diagrams, pictures or questions**.** (Very likely, presentations will spill over into Day 3!)

PROCEDURES

To study the properties of water, divide the class into five groups. Pass out **Handouts #4 (a-e)**, one per group. Group 1 will study the *three states of water*; Group 2 ***density***; Group 3 ***surface tension,*** Group 4 ***capillary action*** and Group 5 ***solvency***. Each group, after completing their specified task, will be responsible for teaching the rest of the class what they have learned. Students will make journal entries including (A) a brief description of what was entailed in the experiment or activity and (B) the results of what was learned by each group.

(Note: If the class is going to spend an extended period of time on this study, each group could perform each of the experiments or fields of study and make journal entries. This could be done in learning stations with small groups rotating tasks.)

ALTERNATIVE OR SUPPLEMENTAL ACTIVITIES:

The group lesson provided here is basic. Although we have chosen to accentuate those properties of water which most closely relate to the rest of "The River" curriculum, you may wish to introduce more extensive water studies. For example, your class could examine surface or ground water samples from your community under a microscope.

CONTENT DISCUSSION

Water is a singular substance and the basis for life as we know it. All living things contain water. The human body is approximately 65% water. On average, the body needs 1-1/2 quarts of water every day to replace the moisture lost to essential body functions. The group activities examine 5 properties which make water unique.

THE 3 STATES OF WATER: Since the 3 states of water are determined within a narrow temperature range, humans and other life forms are vulnerable to surrounding temperatures. For starters, we need to keep our bodies from freezing or over-heating (which can result in heat stroke). Additionally, many natural dynamics are affected by water changing from one state to another. For example, water freezing and then thawing will crack rock -- which can create boulders and cause sand or soil to form. Colder temperatures and freezing soil is an essential aspect of the life cycle for many plants and animals. Humans use ice to preserve foods; we harness steam to power machines and heat our homes.

Boiling does not always mean hot. The actual temperature at which water freezes or boils is determined by pressure. The boiling point drops one degree for every 300 meters (about 1000 feet) in elevation. Therefore, water which boils at 95 degrees C in Albuquerque boils at 74 degrees C on top of Mount Everest. Nine miles up in the atmosphere, water boils at 37 C. If not insulated by a pressurized suit or cabin, an astronaut's body fluids would come to a boil.

DENSITY: Although density may not seem like an essential property of water, in river and lake ecologies density is life-giving. If water were a typical liquid, ice would form from the bottom up -- since colder liquid sinks to the bottom as it becomes denser. But since water has the unique quality of becoming less dense below 39.2 F (or 4 C), colder water floats upward, and ice forms first on the surface. If this were not the case, aquatic life forms could not survive a winter. Furthermore, there would be insufficient heat in the summer to melt the bottom ice, and gradually seas and lakes would freeze solid -- so that eventually the water cycle would come to a standstill and life on earth would perish.

SURFACE TENSION: Surface tension is the ability of a substance to stick to itself and pull itself together. The surface tension of water is very high: a film is formed over the face of the water. Many organisms are able to live just below or above this surface tension. Water surface tension is so strong that any small organisms which break through the surface tension in either direction will either drown or dry up if they can't break through it once again. Rain drops are also held together by surface tension. A diver breaks the surface tension of water by entering with the hands. Soaps and detergents clean by reducing surface tension, as do rolling and tumbling water.

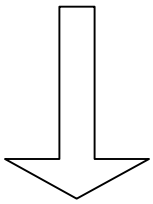
CAPILLARY ACTION: Plants are dependent upon the spread of water through capillary action. A related phenomenon is adhesion. This is when water molecules are attracted to a substance without dissolving it. This is the "wetting action" of water. A wet towel is an example of this. Adhesion and capillary action are processes which allow water to creep from rivers and other bodies of water into adjacent areas, extending the life-sustaining zone. There are certain substances to which water is not attracted. Wax is an example. Water neither dissolves wax nor is attracted to it. Rather, it forms beads on the surface.

SOLVENCY: Solvency may be the most critical property of water for students to understand in the study of "The River." Although water does not dissolve every

substance, it dissolves so many gases and other substances that it is often thought of as the closest thing to a universal solvent. Rivers pick up salts and a variety of minerals in solution as they flow through an area. This process can be cleansing for soils and beneficial for living organisms which are dependent on minerals for growth. As water dissolves compounds, it does not change them. This means that living organisms can assimilate necessary compounds from the water.

However, certain substances in solution can be detrimental to life. If a river picks up minute quantities of arsenic or mercury, for example, the quality of the water for human consumption is greatly diminished. Herbicides dissolved in water can prove destructive to riparian habitats.

Note: You may also want to discuss the phenomenon of sublimation. This is the process wherein a substance changes from a solid to a gas or from a gas to a solid without going through the liquid phase. An example of this is ice crystals formed on a windshield on a cold morning. Or when dry ice turns to gas, or ice turning to water vapor over a glacier.



HANDOUT #4a

THE NATURE OF WATER: *THE 3 STATES OF WATER*

Two hydrogen atoms combine with one oxygen atom to form a molecule of water. Water is the basis for life on earth. Although it is plentiful, we can't take it for granted. We are going to think about what makes water unique and life-supporting, and also vulnerable to contamination. Each group in your class will study one property of water and then teach the rest of the class about it.

INSTRUCTIONS

Your group will be responsible for teaching about the 3 states of water. After you've read the material below, talk about it in your group to be sure that everyone understands it. Then choose a way to communicate the information to the rest of the class. You might make diagrams, pictures, or cartoons, or choose to demonstrate it. (Just be sure to record the process in your journal!)

WHAT ARE THE 3 STATES OF WATER?

Within a very short temperature range, water can be a solid, a liquid or a gas. No other substance is like water in this respect.

Water molecules are always moving or vibrating. But the movement is not always at the same speed. Heat energy changes the speed. When water warms, the molecules move faster. Some of the molecules escape from liquid form and become a gas called water vapor. This process is called evaporation. When water boils at 212 F or 100 C, the rate of evaporation increases dramatically.

If, however, the water molecules are cooled, the heat energy is removed and the molecules slow down. At 32 F or 0 C, the molecules are hardly moving at all. The liquid state changes to a solid state called ice.

HOW COULD WE DEMONSTRATE THE 3 STATES OF WATER?

If you have access to a burner and a freezer, put a thermometer in each of two vials of water. Put one vial in a freezer and the other over a low flame. Carefully observe what happens to the water. (Do not allow the water to freeze completely or to boil too rapidly.)

WHY IS THIS IMPORTANT?

The 3 states of water are essential to life forms. Since a high percentage of living things are composed of water, they are sensitive to surrounding temperatures. Plants and animals can freeze to death, or die from high temperatures.

HANDOUT #4b

THE NATURE OF WATER: *DENSITY*

Two hydrogen atoms combine with one oxygen atom to form a molecule of water. Water is the basis for life on earth. Although it is plentiful, we can't take it for granted. We are going to think about what makes water unique and life-supporting, and also vulnerable to contamination. Each group in your class will study one property of water and then teach the rest of the class about it.

INSTRUCTIONS

Your group will be responsible for teaching about the density of water. After you've read the material below, talk about it in your group to be sure that everyone understands it. Then think of a way to communicate the information to the rest of the class -- you might make diagrams, pictures, or cartoons, or choose to demonstrate it. (Just be sure to record the process in your journal!)

WHAT DOES 'DENSITY OF WATER' MEAN?

As liquid water cools, it contracts (takes up less space). Most other liquids do the same. However, when the temperature of the water reaches 39.2 F (4 C), it does just the opposite -- it begins to expand. When liquid water changes to solid ice, it takes up 9% more room than the same weight of liquid water. Because the ice expands and takes up more room, it weighs less than an equal amount of liquid water. Ice is less dense than liquid water, so it contracts in volume as it melts.

HOW COULD WE DEMONSTRATE THE DENSITY OF WATER?

Fill two equal plastic, uncovered measuring cups or beakers to the same level with water. Weigh both containers. Allow the water in one container to freeze. Observe the level of the water in both containers. Weigh each container once again. Do they weigh the same? Is the level of the ice and the liquid water the same?

WHY IS THIS IMPORTANT?

Since ice is less dense than liquid water, ice will float to the top of a pond or river. This allows fish and other life forms to stay alive under the ice.

When surface water warms to 39.2 F, the water becomes denser and sinks toward the bottom. This action moves the water around, and, in the process, oxygen enters the water. This allows fish and other life forms to live.

HANDOUT #4c

THE NATURE OF WATER: *SURFACE TENSION*

Two hydrogen atoms combine with one oxygen atom to form a molecule of water. Water is the basis for life on earth. Although water seems plentiful, we can't take it for granted. We are going to think about what makes water unique and life-supporting -- and also what makes it vulnerable to contamination. Each group in your class will study one property of water and then teach the rest of the class about it.

INSTRUCTIONS

Your group will be responsible for teaching about surface tension of water. After you've read the material below, talk about it in your group to be sure that everyone understands it. Then think of a way to communicate the information to the rest of the class -- you might make diagrams, pictures or cartoons, or choose to demonstrate it with a science experiment. (Just be sure to record the process in your journal!)

WHAT IS 'SURFACE TENSION' OF WATER?

Water molecules tend to cohere (form a bond) with other water molecules. On the surface of water the molecules form a connecting layer that resists being pulled apart. This is called surface tension. Other liquids, such as alcohol, do not have this characteristic.

HOW COULD WE DEMONSTRATE SURFACE TENSION?

To get an idea of what surface tension looks like, get a bowl of water, a fork and a needle. Put the needle on the fork and slowly lower the fork into the water. (Be sure to keep the needle totally horizontal, so that it doesn't break the surface tension.) The needle will actually float on the water -- although you might have to try this several times to get it to work! Now try adding a drop of detergent to the water, and see if the needle will float.

WHY IS SURFACE TENSION IMPORTANT?

Surface tension allows light-weight insects to skim along the tops of bodies of water. Many small organisms live just above or below the "film" of water formed by surface tension. These organisms are an essential part of the food chain of a river or pond. Surface tension also holds raindrops together.

HANDOUT #4d

THE NATURE OF WATER: *CAPILLARY ACTION*

Two hydrogen atoms combine with one oxygen atom to form a molecule of water. Water is the basis for life on earth. Although water seems plentiful, we can't take it for granted. We are going to think about what makes water unique and life-supporting, and also vulnerable to contamination. Each group in your class will study one property of water and then teach the rest of the class about it.

INSTRUCTIONS

Your group will be responsible for teaching about capillary action of water. After you've read the material below, talk about it in your group to be sure that everyone understands it. Then think of a way to communicate the information to the rest of the class -- you might make diagrams, pictures or cartoons, or choose to demonstrate it. (Just be sure to record your information and ideas in your journal!)

WHAT IS 'CAPILLARY ACTION'?

Molecules of water are attracted to each other. This is why a quantity of water holds together. Sometimes water molecules are even more attracted to molecules of other substances. This attraction allows water to make the other materials "wet." Water can even defy gravity: It can crawl up the sides of a tube, soak a paper towel, or help a plant get water to the top of its growth. The ability of water to climb against the pull of gravity is called capillarity or capillary action.

HOW COULD WE DEMONSTRATE 'CAPILLARY ACTION'?

One simple way to show capillary action is to fill a bowl with water dyed with food coloring; then put one end of a string in the water and one end over the side of a bowl. Water will begin climbing up and over the side of the bowl and then drip from the end of the string. Try putting other tubular objects in the water bowl and see which ones demonstrate capillary action.

WHY IS THIS IMPORTANT?

Capillary action is life-supporting because it helps living things get the water they need. Capillary action circulates water. For instance, every day a 40-foot tree draws about 50 gallons of dissolved nutrients from the soil and carries it up to the leaves -- this is capillary action at work!

HANDOUT #4e

THE NATURE OF WATER: *SOLVENCY*

Two hydrogen atoms combine with one oxygen atom to form a molecule of water. Water is the basis for life on earth. Although it seems plentiful, we can't take it for granted. We are going to think about what makes water unique and life-supporting, and also vulnerable to contamination. Each group in your class will study one property of water and then teach the rest of the class about it.

INSTRUCTIONS

Your group will be responsible for teaching about solvency of water. After you've read the material below, talk about it in your group to be sure that everyone understands it. Then think of a way to communicate the information to the rest of the class -- you might make diagrams, pictures, cartoons, or choose to demonstrate it. Just be sure to record your process in your journal!)

WHAT IS '*SOLVENCY*' OF WATER?

Water molecules are attracted to the atoms and molecules of some other substances.

They can move in between these atoms and molecules and dissolve that substance. This

makes water an excellent solvent. Many substances, including gases, will dissolve in

water. Moving water can carry dissolved substances great distances.

HOW COULD WE DEMONSTRATE WATER SOLVENCY?

Line up several jars of water. To each one add salt, sugar, a drop of food coloring, a drop of oil, or some other substance. What do you observe? Do you think there is a way of making the substances dissolve faster or more completely? Test your theories and see if they are correct.

WHY IS WATER SOLVENCY IMPORTANT?

As you have just seen, when water comes into contact with certain substances, the substance dissolves. Water will dissolve a substance without changing its chemical composition. This is beneficial to life, because water transports many minerals that are necessary for living things to grow and be healthy. However, water can also dissolve and transport harmful substances. For instance, if too much salt gets into the water, plants and animals can sicken or die from an overdose of salinity.