TEACHER DEMO: **WHERE'S THE OXYGEN?**

OBJECTIVE(s): After completing this demo, students will be able to:

- use thermometers to measure the temperature of water in degrees Celsius (° C) and in degrees Fahrenheit (° F).
- understand that oxygen is dissolved in the water.

MATERIALS:	
18 thermometers	food coloring-assorted colors
2 gallons of water	1 hot plate
20-250 mL plastic beakers	2-600 mL glass beakers
beaker tongs	5 quart sauce pan

BACKGROUND INFORMATION:

DISSOLVED OXYGEN

Dissolved oxygen (DO) refers to the amount of oxygen (O_2) that is dissolved in water. The presence of oxygen in water is essential for the maintenance of healthy lakes, rivers and streams. Most aquatic plants and animals need oxygen to survive. Fish and some aquatic insects have gills to extract oxygen from the water. Some aquatic organisms, like salmon and trout, require medium-to-high levels of dissolved oxygen to live. Other animals, like carp and catfish, thrive in waters with low dissolved oxygen.

The amount of dissolved oxygen can range from high to very low levels. In some cases, the DO is so low that the water is practically devoid of aquatic life. The absence of oxygen is a signal of severe pollution. Waters with consistently high dissolved oxygen are usually considered healthy and provide stable ecosystems capable of supporting many different kinds of aquatic organisms.

Physical Influences

Much of the dissolved oxygen in water comes from the atmosphere. Waves on lakes and tumbling water on fast-moving rivers act to mix atmospheric oxygen with water. Dissolved oxygen can also be affected by the rate of photosynthesis carried on by freshwater plants such as algae and rooted aquatic plants.

The solubility of oxygen varies with both temperature and mineral content of the water. The oxygen content of water decreases with a rise in temperature and density and increases with a decrease in water temperature and density. The rate of flow also affects the DO content of the water. The rate of flow or river discharge is related to the climate of an area. During dry periods, flow may be severely reduced and air and water temperatures are often higher, resulting in reduced DO levels. Wet weather or melting snows increase flow, with a resulting greater mixing of atmospheric oxygen.

Human Influences

Organic waste which consist of anything that was once part of a living plant or animals (food, leaves, feces), is the main factor contributing to changes in dissolved oxygen levels in river systems today. Organic waste can enter rivers in many ways, such as in sewage, urban and agricultural runoff, dairies, meat-packing plants, and other industrial sources. Fertilizers, a significant ingredient in urban and agricultural runoff, stimulate the growth of algae and other aquatic plants in lakes and rivers. As these plants die, aerobic bacteria consume oxygen in the process of decomposition. Many kinds of bacteria also consume oxygen while decomposing sewage and other organic material in the river.

Depletion of dissolved oxygen can cause major shifts in the kinds of aquatic organisms found in lakes, streams, and rivers. Species that cannot tolerate low levels of dissolved oxygen such as beetle larvae, caddisfly larvae, mayfly nymphs, and stonefly nymphs, will be replaced by a few kinds of pollution-tolerant organisms, such as worms and fly larvae. Nuisance algae and anaerobic organisms may also become abundant in water with low levels of dissolved oxygen.

TEMPERATURE

Temperature represents the quantity that tells how warm or cold a body is with respect to some standard. We express the temperature of matter by a number which corresponds to the degree of hotness on some chosen scale. Nearly all materials expand when their temperature is raised, and contract when it is lowered.

A thermometer is a common instrument that measures temperature by means of the expansion and contraction of a liquid, usually mercury or colored alcohol. As the liquid in a thermometer gets warmer, the molecules move faster and farther apart causing the liquid to rise in the tube. As the liquid is cooled, molecules slow down and get closer together causing the liquid to contract and move down the tube.

In the metric system, temperature is measured on the Celsius scale (°C). On this scale the number 0 is assigned to the temperature at which water freezes, and the number 100 to the temperature at which water boils (at standard atmospheric pressure). The space between is divided into 100 equal parts, called degrees. Each Celsius degree represents 1/100 of this temperature range. This scale is called the Celsius scale in honor of the man who first suggested the scale, the Swedish astronomer Anders Celsius (1701 - 1744). (The Celsius scale used to be called the centigrade scale, from centi ("hundredth") and gradus ("degree"). Normal body temperature in humans is 37° C (98.6° F). Comfortable room temperature is 21° C (70° F).

In the English system, 32 is assigned to the temperature at which water freezes, and the number 212 is assigned to the temperature at which water boils. This scale is called the Fahrenheit scale, after the German physicist Gabriel Fahrenheit (1686 - 1736).

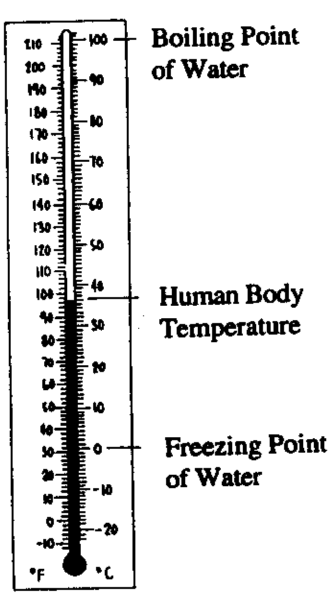
Conversion

To convert degrees Celsius to degrees Fahrenheit, multiply degrees Celsius by 1.8 (or 9/5), then add 32.

$$(°C)\ 1.8 + 32 = °F$$

To convert degrees Fahrenheit to degrees Celsius, subtract 32, then multiply by .555 (or 5/9).

$$(°F - 32)\ .555 = °C$$



PROCEDURE:

1. In this demo, students will observe the process of boiling. Students will observe a liquid changing from a liquid to a gas. They will also use a thermometer to measure and record the temperature of different liquids.
2. Obtain two 600 mL glass beakers (600 mL beakers are used only for demonstration). Fill each beaker half full of water and place them on a hot plate. Use a large pot to boil water for student use.
3. Allow the water in the beakers to boil. Students should make observations about what is going on in the beakers. Instructors should discuss dissolved oxygen and how it affects salmon.
4. Questions that should be asked:

    1. Where do the bubbles come from?
    2. What are the bubbles?
    3. How would water temperature affect the breathing of fish?
    4. Why is the temperature of stream water important to salmon?
    5. List some factors that would increase or decrease the temperature of stream/river water.

5. After the dissolved oxygen discussion, introduce the thermometer as the instrument used to obtain the temperature of a liquid. The following exercise will provide practice in reading the thermometer.
6. Obtain 20-250 mL plastic beakers and group them in sets of four. For each set of beakers, place different amounts of hot water into each beaker (for example: 15 mL, 25 mL, 50 mL, and 75 mL of hot water).. Then add water (at room temperature) to each beaker so that they are all 3/4 full.
7. Add one drop of food coloring to each beaker. Use four different colors of food coloring (blue, green, red, yellow) to distinguish the different beakers (temperatures).
8. A group of 6 students should use a set of four beakers and four thermometers to complete the exercise. Have students record the temperature of each liquid on their Student Activity Sheet-Where's the Oxygen? Use this exercise to familiarize students with the Celsius scale.

TEACHER DEMO: **ACIDS AND BASES**

OBJECTIVE(s): After completing this demo, students will be able to:

- **recognize that all chemicals/substances can be grouped as either an acid, a base, or neutral.**

MATERIALS:	
3-9 oz plastic cups	200 mL of white vinegar solution
200 milliliters (mL) of ammonia solution	200 mL of tap water
Thymol Blue indicator solution	medicine dropper
red and blue litmus paper	

BACKGROUND INFORMATION:

Acids and Bases

A chemical is a substance characterized by definite molecular composition. All chemicals are classified as either being an acid, a base, or neutral. The water molecule (H_2O or HOH) contains two hydrogen atoms and one oxygen atom. The majority of the water molecules that make up a cup of water have this composition (HOH). A certain percentage of the molecules in water are known to dissociate or separate, forming pieces of molecules, such as H+ and OH^-. These electrically charged pieces of molecules are called ions. The hydrogen ion (H^+) has a positive charge and the hydroxyl ion (OH^-) has a negative charge.

The percentage of molecules that are ionized in water at any one time is extremely small--about two ten-millionths of a percent. More importantly, when the number of hydrogen ions present in water is equal to the number of hydroxyl ions (hydrogen-accepting groups), a substance in considered neutral--neither acid nor base. **Acids** are substances that contain a greater number of hydrogen ions (H^+) than hydrogen-accepting groups. **Bases** are substances that contain a greater number of hydrogen-accepting groups (OH^-) than hydrogen ions.

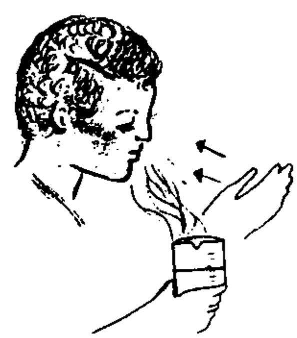
Indicators

There are a variety of chemicals called indicators, whose color depends on the presence of an acid or base. There are natural indicators that can be used, such as red cabbage juice or commercially prepared indicators like Thymol Blue. Scientists use a mixture of indicators dissolved in water and/or alcohol or chemicals absorbed into paper such as litmus paper or pH paper to measure acidity. Litmus paper is made with paper impregnated with a powder made from certain lichens. This dye turns red in acids and blue in bases. It is unchanged in neutral solutions. An easy way to remember this relationship is:

Bases are Blue, aciDs are reD.

PROCEDURE:

1. In this demo, students will observe how an indicator changes color to identify the acidity of certain substances.
2. Obtain three 9 oz plastic cups and label them "A," "B," and "C."
3. Add 100 mL of vinegar to cup "A," and 100 mL of ammonia solution to cup B and add 100 mL of tap water to cup "C."
4. Students should make observations about the contents of each cup. Instructor should remind students that observations are made by using your senses. However, it is **very important** that students **never** taste substances unless specifically told by the instructor.
5. This would be the appropriate time to explain how to smell chemicals. Smelling a chemical can be dangerous because the chemical may react with your body tissue to cause discomfort. You can easily inhale too much of a chemical before your body notices and reacts. See the diagram below for proper smelling technique called wafting.



6. Using visual observations, ask students if the three liquids could be identical? different? Discuss student observations and responses.
7. Add a few drops of thymol blue indicator solution to each of the liquids. Students will note a change in color. Thymol blue indicator solution turns a red/orange color in acidic solutions (vinegar), turns blue in basic solutions (ammonia), and turns yellow in neutral solutions (tap water).

8. Discuss how an indicator distinguishes between acidic, basic, and neutral substances. Generally indicators use color changes to distinguish between acids and bases (pH scale).
9. Introduce the concept that an indicator can be put on strips of paper and used to identify acids and bases. Litmus paper is one example of a paper indicator.
10. Obtain a strip of blue litmus paper. Touch a blue strip of litmus paper to each of the liquids. Students should record results on Student Activity Sheet - Acids and Bases Demo (have students describe results as either blue or red, no other colors).
11. Obtain a strip of red litmus paper. Touch a red strip of litmus paper to each of the liquids. Students should record results on Student Activity Sheet - Acids and Bases Demo.

CONCLUSION:

Instructors should discuss the color changes and their meanings using the following questions:

1. What color does blue litmus paper turn in an acid? in a base? in a neutral solution?
2. What color does red litmus paper turn in a base? in an acid? in a neutral solution?
3. Which cup contains an acid? a base? a neutral solution?

ACTIVITY 2-2: **ACID, BASE, OR NEUTRAL?**

SCIENCE CONCEPTS/PROCESSES: Observe, Classify, Define Operationally, Interpret Data, Communicate, Interactions, Replication

OBJECTIVE(s): After completing the activity, students will be able to:

- identify a common acid.
- identify a common base.
- use an indicator to determine if a solution is an acid, base or neutral.

MATERIALS:	
40 medicine droppers	cabbage indicator solution
20-9 oz plastic cups	20 white plastic ice trays
20 sheets of white paper	24 oz of clear Crystal Pepsi®
24 oz of lemon juice	24 oz of white vinegar
1 can of cream of tartar	40 grams of Ivory Snow®
20 aspirin tablets	100 mL of Milk of Magnesia®
1 box of baking soda	24 oz of tap water
30 grams of Borax®	24 oz of milk
26-250 mL plastic beakers	red and blue litmus paper
24 oz of clear dish washing detergent	24 oz of isopropyl alcohol
20-10 mL graduated cylinders	40 safety goggles

PROCEDURE:

1. In this activity, students will use cabbage indicator solution and litmus paper to test common household substances. They will determine if each substance is an acid, a base, or neutral.
2. Instructors should prepare the following solutions prior to starting the activity.

Acids	
Lemon Juice	Use at full strength, 473 mL (16 oz). (pH~2.1)
Aspirin	Dissolve 20 aspirin tablets with 1 liter of tap water. (pH~2.8)
Pepsi®	Use 473 mL (16 oz) of non-diet cola. (pH~3)
Vinegar	Mix 500 mL of vinegar with 500 mL of tap water. (pH~3)
Cream of Tartar	Dissolve 10 grams of cream of tartar with 1 liter of tap water. (pH~4)

Neutrals	
Milk	Use at full strength, 473 mL (16 oz). (pH~6.9)
Isopropyl Alcohol	Use at full strength, 473 mL (16 oz). (pH~7)
Tap water	Use 473 mL (16 oz). (pH~7)

Bases	
Ivory Snow®	Mix 40 grams of Ivory Snow® with 1 liter of tap water. (pH~8)
Baking Soda	Mix 20 grams of baking soda with 1 liter of tap water. (pH~8.4)
Milk of Magnesia®	Dissolve 150 mL of Milk of Magnesia® in 1 liter of tap water. (pH~9.5)
Detergent	Mix 300 mL of clear dish washing detergent (non-phosphate) with 1 liter of tap water. (pH~8)
Borax®	Mix 30 grams of Borax with 1 liter of tap water. (pH~10)

3. Students should work in groups of two.
4. Each group will need:

    1 white plastic ice tray
    1 sheet of white paper
    2 medicine droppers
    1-9 oz plastic cup
    cabbage indicator solution

5. Each group should place their ice tray on a sheet of white paper. Use pre-made labels for each solution placed on the white sheet of paper. The instructors will pour about 10 mL of each solution into separate compartments in the ice tray.
6. Students will add the same amount (10 mL) of cabbage indicator solution to each of the common household solutions. Gently jiggle the ice tray to mix the two solutions.
7. Students should record their results (use purple, green, and pink for colors) on their data table on Student Activity Sheet 2-2.
8. After completing this section students should test each common household solution with red and blue litmus paper and record their results on their data table.
9. Students should rinse their ice trays out with water and dry them for the next activity.

CONCLUSION:

Instructors should assist groups in determining which common household substances were acids, bases, and neutrals. Students should share their results with the class. Instructors should write class results on chalkboard or a large piece of butcher paper. Questions to ask students:

1. Which substances are acids?
2. Which substances are bases?
3. Which substances are neutral?
4. How did you determine if a substance is an acid, a base, or neutral?---using cabbage indicator solution?---using red and blue litmus paper?
5. What happens if you mix an acid and a base together?

ACTIVITY 2-3: **pH: A COLOR SCALE**

SCIENCE CONCEPTS/PROCESSES: Observe, Classify, Define Operationally, Interpret Data, Communicate, Interactions

OBJECTIVE(s): After completing the activity, students will be able to:

- use pH paper to determine if a solution is an acid, base or neutral.

MATERIALS:	**(use the solutions from Activity 2-2)**
35 medicine droppers	pH paper/color charts
18-9 oz plastic cups	18 plastic ice trays
18 sheets of white paper	1-16 oz bottle of Crystal Pepsi®
1-16 oz bottle of lemon juice	1-16 oz bottle of white vinegar
16 oz of cream of tartar solution	1-16 oz bottle of ammonia
40 aspirin tablets	40 antacid tablets (Tums®)
1 box of baking soda	16 oz of tap water
8 oz of sea salt	16 oz of milk
1-16 oz bottle of clear dish washing detergent	24-250 mL plastic beakers
18-10 mL graduated cylinders	1-16 oz bottle of isopropyl alcohol
35 safety goggles	

BACKGROUND INFORMATION:

pH

Acidity is measured in terms of pH (the **p**(ower) of **H**(ydrogen)) and is a measure of the number of hydrogen ions in a given volume of a substance. The pH scale ranges between zero and fourteen. The number in the middle, 7, describes neutrals, neither an acid nor a base. Numbers less than 7 are used to quantify acids. The lower the number the "more acidic" the acid. Numbers greater than 7 are used to quantify bases. The higher the number the "more basic" the base.

The pH scale is logarithmic scale, like the Richter scale used to measure the extent of ground movement in earthquakes. Each whole number on the pH scale represents an increase or decrease by a factor of 10. This means that a substance of pH 6.0 is ten times more acidic than a substance of pH 7.0, and so on.

APPROXIMATE pH OF SOME COMMON SOLUTIONS

	pH	SOLUTIONS
↑	0	
		battery acid
	1	
		stomach acid (1.3-3.0)
	2	lemon juice (2.1) acid fog (2-3.5) aspirin (2.9)
increasing acidity	3	vinegar, wine, beer, soft drinks orange juice cream of tartar
	4	tomatoes
	5	black coffee pH-balanced shampoo (4.0-6.0) distilled water (5.0-5.5)
	6	saliva (6.3-7.5) milk (6.9)
Neutral	7	tap water, rubbing alcohol egg white (7.6-9.5)
increasing *basicity*	8	sea water (7.8-8.3) non pH-balanced shampoo baking soda (8.4)
	9	phosphate detergents antacids
	10	milk of magnesia (9.9-10.1)
	11	household ammonia (10.5-11.9) non phosphate detergents
	12	
		hair remover
	13	
		oven cleaner
↓	14	

PROCEDURE:

1. In this activity, students will use pH paper as an indicator to test common household substances. Instructors should discuss the pH color scale.
2. Students should work in groups of two.
3. Each group will need:

   1 plastic ice tray
   1 pre-labeled sheet of white paper
   2 medicine droppers
   pH paper and color chart

4. Each group should place their ice tray on the pre-labeled sheet of white paper. Place each solution next to the correct label on the white sheet of paper. The instructors will pour about 10 mL of each solution into separate compartments in the ice tray.
5. Students should test each solution with pH paper and compare the color change with the pH color chart. Record their results on their data table on Student Activity Sheet 2-3.

CONCLUSION:

Instructors should discuss the relationship between the colors and the pH numbers, in general terms. For example, numbers 1-6 represents an acidic solution, 1 being a "stronger" acid than 6. Number 7 represents a neutral solution. Numbers 8-14 represent a basic solution, 14 being a "stronger" base than an 8.

Instructors should set up a large sheet of butcher paper with a pH scale on it.

←0----1----2----3----4----5----6----7----8----9----10----11----12----13----14→
↑
←Acidic **Neutral** **Basic→**

Have students add their common household solution's pH to the scale as part of the discussion.

Story Time: Journey of the *Oncorhynchus*-Chapter Three. Each student will need their Journey of the *Oncorhynchus* story book. Before starting the story, set up either the Journey of the *Oncorhynchus* mural by adding **section three** or the poster. Call attention to the mural/poster by having the students search for the hidden salmon in section three. The first student to find the hidden salmon will be awarded a prize.

Activity Sheet 2-1

WHERE'S THE OXYGEN?

1. List observations of the liquid being heated on the hot plate.

2. Fill in the table below.

LIQUID COLOR	TEMPERATURE °C
BLUE	
RED	
YELLOW	
GREEN	

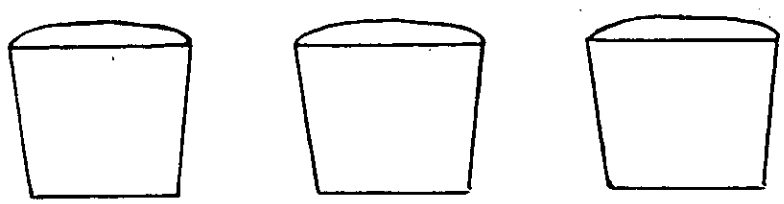
Student Activity Sheet

ACID AND BASE DEMO

1. Make three observations about the contents in each cup: A, B, and C.

Cup A	1. 2. 3.
Cup B	1. 2. 3.
Cup C	1. 2. 3.

2. What happened to each solution when the indicator was added to the cup?
(use crayons to show the color of each solution below)



A. B. C.

3. Explain how to properly smell a chemical solution.

4. Fill in the table below.

Cup	Blue Litmus turns...	Red Litmus turns...
A		
B		
C		

Student Activity Sheet 2-2

ACID, BASE, OR NEUTRAL?

1. Fill in the data table below.

Name of Chemical	Color it turns Cabbage Juice	Litmus Paper Test Turns blue paper...	Litmus Paper Test Turns red paper...	Acid (**A**), Base (**B**), or Neutral (**N**)
Rubbing Alcohol				
Lemon Juice				
Vinegar				
Milk of Magnesia®				
Tap water				
Baking Soda				
Crystal Pepsi®				
Borax®				
Ivory Snow®				
Aspirin				

2. Which substances are acids?

3. Which substances are bases?

4. Which substances are neutral?

5. How did you determine if a substance is an acid, a base, or neutral---using cabbage indicator solution? using red and blue litmus paper?

Student Activity 2-3A **pH: A COLOR SCALE**

1. Fill in the table below.

SUBSTANCES	pH
Cream of Tartar	
Milk of Magnesia®	
Milk	
Lemon Juice	
Coke®	
Vinegar	
Isopropyl Alcohol	
Detergent	
Borax®	
Ivory Snow®	
Baking Soda	
Tap Water	
Aspirin	

2. List the acids from strongest to weakest?

3. List the bases from strongest to weakest?

4. Which substances were neutral?

CHEMISTRY
WORD SEARCH

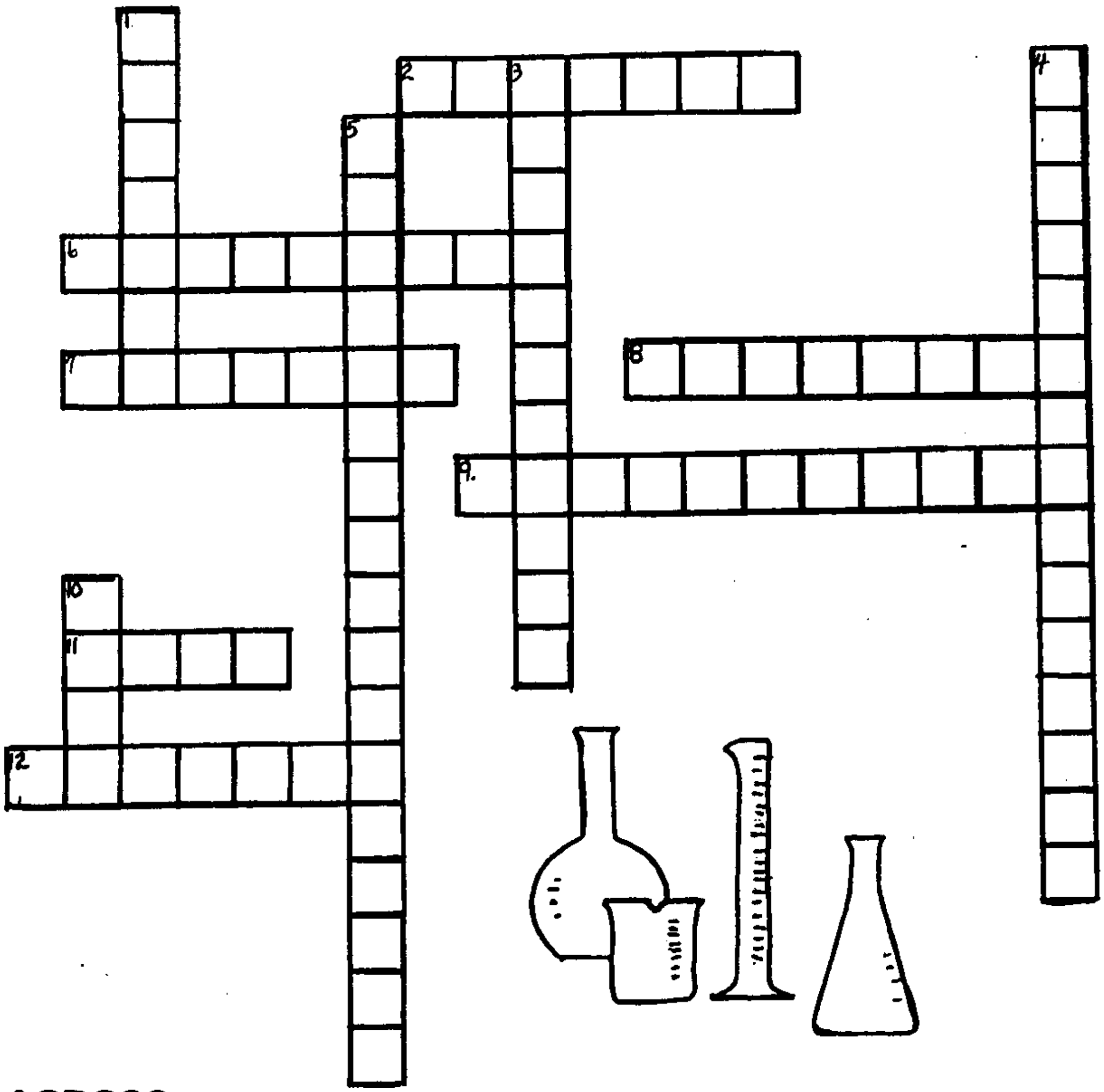
D	I	S	S	O	L	V	E	D	O	X	Y	G	E	N
C	P	I	V	U	G	A	T	Z	E	U	I	L	H	T
U	F	N	A	B	R	W	E	C	X	B	N	J	I	H
M	C	D	M	Y	D	S	M	I	A	D	F	V	G	E
T	H	I	Q	T	E	X	P	S	W	C	E	O	J	R
D	E	C	T	N	S	Y	E	Z	N	E	Y	A	K	M
G	M	A	B	V	E	H	R	I	X	L	P	H	R	O
R	I	T	B	G	T	U	A	E	P	C	L	F	J	M
A	C	O	C	A	E	P	T	F	J	I	A	M	O	E
D	A	R	U	X	Q	R	U	R	Y	U	B	S	I	T
U	L	W	L	R	O	H	R	Q	A	S	K	F	O	E
A	C	R	B	V	G	J	E	D	O	L	V	K	C	R
T	S	B	E	A	K	E	R	X	Z	N	P	E	H	Q
E	L	M	E	T	R	I	C	S	K	D	I	C	A	D
D	C	Y	L	I	N	D	E	R	H	M	W	N	Z	G

Temperature
Base
Neutral
pH
Graduated Cylinder

Beaker
Dissolved Oxygen
Celsius
Thermometer
Chemical

Metrics
Vortex
Acid
Indicator

CHEMISTRY CROSSWORD



ACROSS

2. System of measurement used by scientists.
6. Chemicals used to determine if substances are acidic, basic, or neutral.
7. Temperature scale used the metric system.
8. Unscramble hecmlaci to get this word.
9. Measurement of how hot or cold something is.
11. Turns blue litmus paper red.
12. pH of seven. Not acidic or basic.

DOWN

1. Instrument used to measure mass in the metric system.
3. Instrument used to measure temperature.
4. For of oxygen found in water.
5. Instrument used to measure liquid volume in the metric system.
10. Turns red litmus paper blue.

Day 2 Teacher's Guide

9:00 a.m. Serve Breakfast to campers in their groups.

Activity 9 **How much is a drip?**

Skills: Estimation, Measurement, Observation, Evaluation, Calculation

Objective: Students will be able to estimate, measure, and use basic lab equipment. Students will understand the concepts of volume and water conservation.

Materials: 10 mL graduated cylinders, eyedroppers, graph paper, colored pencils, beakers, containers of water

Vocabulary: **Volume, Liter, Millimeter, Graduated Cylinder**

Procedure:

Begin this activity by asking students to estimate how many drips of water they think it would take to fill up the 10 mL graduated cylinder they are holding. After each student has written down their estimate, have them work with a partner to count the number of drips required to reach the 10 mL mark. Explain that 25 mL is a little less than one ounce of water. Provide a small container (1000 mL or 1 quart) to hold the water supply, a graduated cylinder, and an eyedropper for students to do the activity.

Have students try to calculate how much water is contained in one drip of water. Use the Activity 9 Student Activity Sheet provided in the Teacher Materials section for students to record their answers. Finally, have students make a graph on their worksheet to calculate how much water would be wasted from a dripping faucet over a one year period using the results from the activity.

Conclusion: At the end of this activity the following closure activities are suggested:

1. Award the students with the closest estimate.
2. Ask how much water is in one drip and how they figured it out.
3. Ask if they can think of a simpler way to calculate the amount water in a drip rather than counting.
4. Ask students to imagine the volume of water wasted each year from dripping faucets.
6. Have students explain why we need to keep from wasting water in places such as the faucets in our homes and schools.
7. Review vocabulary terms on Student Activity Sheet

Activity 10 Water Cycle Hexaflexagon

Skills: Construction, Description, Observation, Modeling, Writing

Objective(s): Students will be able to describe the water cycle and provide examples of different phases making it up.

Materials: Water Cycle Poster, Water Cycle Hexaflexagons, Rulers, Scissors, Clear Tape, Paper, Pencils, Meter Stick

Procedure:

Start the activity by displaying the Water Cycle Poster and explaining what makes the water cycle and how it is important to us. The water cycle is a continuous cycling of water in our environment which shapes the earth, provides the basis for life, and is responsible for our weather. All water occupies one of the three phases at all times which are liquid, solid, and gas. Temperature and location primarily determine which phase of the cycle water exists in.

Nearly three fourths of the earth's surface is covered by water but a considerable amount of water is contained in glaciers and within the upper crust of the earth. The table below shows the approximate distribution of earth's water. A meter stick can be used to depict the different percentages of water on earth.

Water on Earth

Oceans	97.2%
All icecaps/glaciers	2.0%
Groundwater	0.62%
Freshwater Lakes	0.009%
Inland Seas/Salt Lakes	0.008%
Atmosphere	0.001%
All Rivers	0.0001%
All other sources	0.1618%
total	100%

source: Project Aquatic WILD, WREEC, 1992

Provide students with the Water Cycle Hexaflexagon, rulers, scissors, and clear tape to make the flexagon devices. Have students follow the instructions that are on the hexaflexagon sheets. A sample device should be demonstrated and available for students to look at as they make their own. When they have succeeded and can use their device, have them think about a drop of water that drips from a faucet. Ask students to write a short story in their lab books describing the travels their drop could have made, considering all of the parts of the water cycle shown on their flexagon. The writing exercise can be completed as other students are finishing their flexagons. Ask students to share their stories, if they like, once everyone is done.

Conclusion: Bring closure to the activity by considering the following questions:

1. Why do you think earth is called the water planet?
2. What would earth be like if there were no water?
3. Is there an unlimited amount of water on earth?
4. What would happen to earth's water if the average temperature went up?
5. How does pollution affect the water cycle?
6. What could cause the water cycle to end?
7. Describe some ways we benefit from the water cycle.

10:45 a.m. Snack Break

Activity 11 Watershed Runoff

Skills: Mapping, Observation, Prediction, Small Group Work, Interpretation

Objective(s): Students will be able to relate the water cycle to the runoff in the rivers and streams which produce our hydroelectric power. Students will be able to make a map that shows the major rivers and streams that flow into the Columbia River.

Materials: Maps of the Pacific Northwest Watersheds, Blue, Green, Yellow, and Red colored pencils, river flow data, scissors, clear tape, and regional watershed maps (**maps and data sheet are included in Teachers Materials section**)

Procedure:

Explain that runoff is one part of the water cycle and it is required to produce hydroelectric power. Refer to Columbia River Watershed poster, which depicts the watershed, and describe how the water flows downhill from the mountains to collect in many rivers and streams. These in turn flow into the Columbia River. Explain that it is this flowing water that provides us with electricity for our homes, schools, and businesses in the Northwest.

Working in groups, students are each assigned one portion of the entire Columbia watershed to show stream flows. When the sections are done they are fit together to make a large map of the Columbia River Watershed (posters depict the same area).

Step 1. Each student selects one part of the 5 available parts of the watershed.

Step 2. Explain the watershed data table provided to each student.

Step 3. Have each student color and size-code the different rivers by using four different colored pencils to trace over the line representing each river listed. The watershed data is used to determine a large, medium, or low flowing river.

Step 4. The students in each group then cut out their watersheds and put them together like a puzzle to show the entire region's watershed.

Step 5. Group awards are provided for the completed maps.

Step 6. Provide each student with a Columbia River Watershed poster and explain the rules for those that would like to enter the writing contest.

Conclusion: To provide closure to this activity, provide the following or similar observations and questions:

1. Which region appears to provide the most water to the Columbia?
2. Do you think that the region with the most water flow provides the most hydroelectric power?
3. What could explain lower electricity production from a high water flow region?
4. A region's water flow changes from year to year. What could cause this?
5. How come the largest region does not provide the most water?
6. If you were a fish, which region appears to provide the most reliable water supply?

~12:15 p.m. **Lunch Break**

1:00 p.m. **Roll On Columbia, Roll On -** ***Sing Along***

Directions:

Hand out copies of Woody Guthrie's "Roll on Columbia, Roll On" to students (reproducible masters are located in Teachers Materials section). Model song by singing or playing tape so students can learn the melody. Read the lyrics and then sing the verse(s) that you choose. If students are enthusiastic, have the campers sing the song all the way through the nine verses.

Native American Legends Story Telling Part 1

Select a Native American legend to read to students from those compiled in the Appendix . All of the legends listed relate to the Pacific Northwest and tribes in the region. Provide background on the historic locations of area tribes by showing the map provided in the Teacher's Materials.

Activity 9 **How Much Is A Drip?** **Student Worksheet**___________________
(your name)

Background:

You have probably seen water dripping from a faucet, droplets of rain, or dew drops on a blade of grass. You will be finding out exactly how much water is contained in a single drip by counting the number of drops to fill a small graduated cylinder. Before you start counting drops, record your estimate of how many it will take to fill a 10 milliliter cylinder. One milliliter (mL) equals one thousandth of a liter (a liter is a little more than a large pop container).

Vocabulary: Graduated cylinder, liter, milliliter, volume

Directions: Work with one partner

Step 1. Record your estimate of number of drips in 10 mL here: ___________

Step 2. Get an eyedropper, a small container of water, and a graduated cylinder

Step 3. Fill the eyedropper with water and have your partner count drops as you fill the cylinder to the 10 mL line.

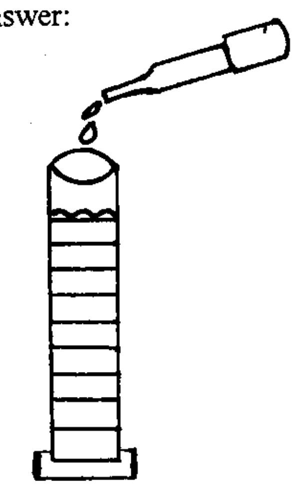
Step 4. Record the number of drops needed to make 10 mL here: ___________

Step 5. Calculate the volume of one drip by dividing the number of mL in the cylinder (10) by the number of drops from Step 4. Record your answer:
(volume is the amount of space something takes up)

____

Optional:

Step 6. Calculate the amount of water wasted per 24 hour day if you had a dripping faucet where one drop fell every second (hint: Multiply the volume of water contained in one drip x 60 seconds in a minute x 60 minutes in an hour x 24 hours in a day). Record your answer:



____

Great Job!

The Water Cycle Hexaflexagon

The water cycle is an endless circulation of water from one phase to the next. Water occurs in all three phases on earth; the water in rain, sea water, lakes, streams, clouds, the ground, and in living th[illegible]akes up the **liquid phase** of water. **Solid** water comes in the f[illegible] snow, ice, and glaciers where the temperature is below freezing. Water in the **gas** phase is found primarily in our atmosphere and in the air we breathe. Most, if not all of the water found on or in the earth has been here since the earth was formed, perhaps some 4.6 billion years ago.

Over 97 percent of earth's water is contained in oceans and seas. All icecaps and glaciers contain about 2 percent of all water. Little more than one half of one percent of earth's water is contained in the ground. Each of the remaining sources of water — lakes, inland seas, rivers, and the atmosphere — contain less than one hundredth of one percent of earth's water. Even so, water travels from one source to another in an endless cycle. The same molecule of water that fell from the mouth of a dinosaur 100 million years ago may be in the water you drink from a fountain today.

Water moves from one part of the cycle to another by the processes of evaporation, condensation, precipitation, and melting. When water **evaporates** it changes from a liquid to an invisible gas. Rapid evaporation takes place when you boil water on a stove, while slower evaporation takes place when you perspire or leave a glass of water in the open air. The rate of evaporation depends on temperature and something called humidity which is the amount of water vapor (gas) that is found in the air. **Condensation** is what takes place when water vapor changes from a gas back to a liquid. Water can condense at any temperature below boiling. The lower the temperature the faster the rate of condensation that can take place. **Precipitation** is when water falls from the air in the form of rain, sleet, snow, hail, or dew. **Melting** is when water changes from the solid phase to the liquid phase.

Sometimes water is stored or locked up for thousands of years. Water that has evaporated, condensed, and fallen as solid snow or ice in cold climates may remain that way for a very long time before it either melts or evaporates and rejoins the cycle. Water that percolates into the ground may also remain in the liquid phase if it is stored in an underground reservoir or bound up within mineral or rock crystals. In other circumstances water may go through the cycle over and over again very quickly. In the tropics for example, water evaporates from the ocean, condenses, and falls back to the ocean as rain on a daily basis. The water cycle can be very interesting to think about if you consider the possible journeys and history of the water we all use every day. The next time you take a drink of anything, think about the places the water in it may have been.

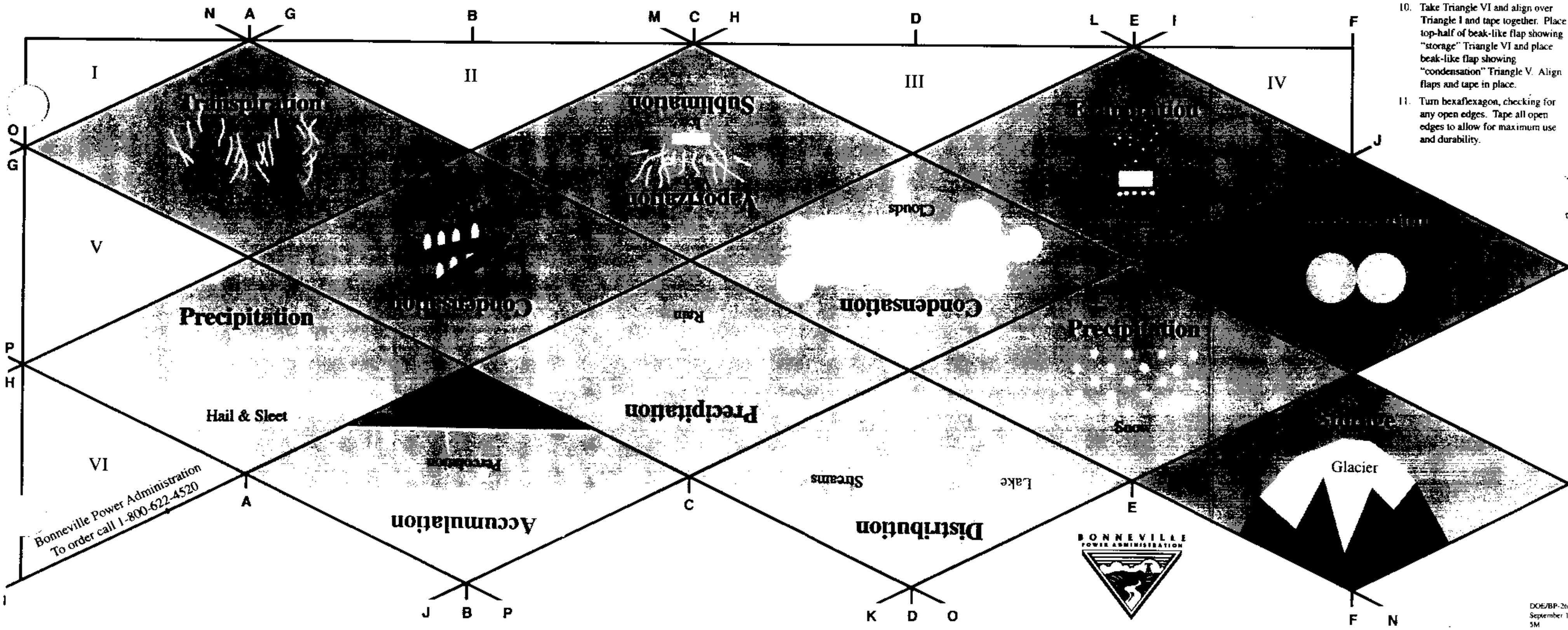
The Bonneville Power Administration (BPA) depends on the water cycle to provide enough water for generating the region's electricity. The future of fish and other wildlife habitat in the Columbia River's watershed is also dependent on the water cycle to provide a suitable environment for all to enjoy and use. Future generations depend on the preservation of our region's water resources and BPA is committed to helping preserve and educate people about our cycle of water. This hexaflexagon uses a special geometric form to show the phases of the water cycle and how they effect us.

For additional information, please call 503-230-3478 in Portland, or toll free 1-800-622-4519 outside of Portland.

To Assemble the Water Cycle Hexaflexagon:

Items Needed to Assemble: ruler, scissors, clear tape

1. Place drawing with printed side up on a table. Place ruler on paper to connect Point A to point A. Using the long edge of one scissors blade, press the scissor on paper and move along the line from point-to-point to make an indent/mark (This is known as scoring.) Be careful not to cut through paper. Accurate scoring and folding is essential for easy manipulation of the finished hexaflexagon.
2. Repeat Step #1 for point B to point B, C-C, through point F-F. When done, A-A through F-F will be vertically scored.
3. Repeat Step #1 for point G-G, H-H, I-I, through P-P. These lines are diagonally placed.
4. Cut out the hexaflexagon along the far OUTSIDE border.
5. With the printed side up, fold all vertically scored lines face-to-face. (A-A through F-F). Then, straighten out each fold.
6. Fold all diagonally scored lines (G-G through P-P) so they are back-to-back. Then straighten out each fold.
7. Hold the hexaflexagon with the printed side down and the beak-like flap pointed towards you. Bring the "Accumulation" section to fit over Triangle II. Align an tape open edge.
8. Bring the "distribution" section over Triangle III. Align and tape.
9. Bring the "storage" section over Triangle IV. Align and only tape upper one-hal of section. Leave two beak-like flaps free.
10. Take Triangle VI and align over Triangle I and tape together. Place top-half of beak-like flap showing "storage" Triangle VI and place beak-like flap showing "condensation" Triangle V. Align flaps and tape in place.
11. Turn hexaflexagon, checking for any open edges. Tape all open edges to allow for maximum use and durability.



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Activity 11 **Watershed Runoff** **Student Activity Sheet** _______________
(your name)

Background:

A watershed is the drainage area of a certain river, stream or system of rivers and streams. In a watershed, much of the water that runs off the land from rain or melting snow collects and flows to a main river or stream. The collection of streams that carry the water often looks like branches on a tree, the main branches are often called tributaries which in turn connect into a main trunk or river.

The Columbia River is the main trunk for the watershed that is supplied water by major tributaries like the Snake, Willamette, and Clearwater rivers. If precipitation (rain and snow) is low in a watershed, the runoff will also be low. In years of drought, most rivers have large reductions in water flow. This affects the amount of habitat available for fish and reduces the amount of water that can be used to generate electricity.

In the Columbia River watershed, some parts get more water than others because of their location and elevation. The amount of water also varies from year to year so that you might have abundant water in one basin and not enough in another because of drought. In this activity you will be finding streamflow information for major tributaries and color coding the different them, based on the amount of water that flowed . When you are done you will fit your part of the Columbia's watershed with the others to make a picture of the entire area.

Vocabulary: Watershed, Drainage Basin, Precipitation, Streamflow, Tributary, Drought

Directions:

Step 1. Get blue, green, red, and yellow color pencils and your assigned watershed basin map.

Step 2. Make sure that you have a stream flow data sheet that matches the rivers and streams that you have on your map.

Step 3. Use the stream flow data to color the entire length of each stream listed on your map using the following colors:

Blue if stream flow is over 100
Green if stream flow is between 10 and 100
Yellow if stream flow is between 1 and 9
Red if stream flow is below 1

(numbers represent millions of acre feet of water per year)

Step 4. Use a scissors to cut out your watershed along the outside boundary.

Step 5. Fit your watershed together with the watershed areas done by other members of your group to assemble the Columbia River watershed.

Step 6. Glue or tape the pieces together and ask your instructor to display your results with those from other groups.

Step 7. Compare your completed watershed map with the map of precipitation for the same area and describe what you observe in the space below.

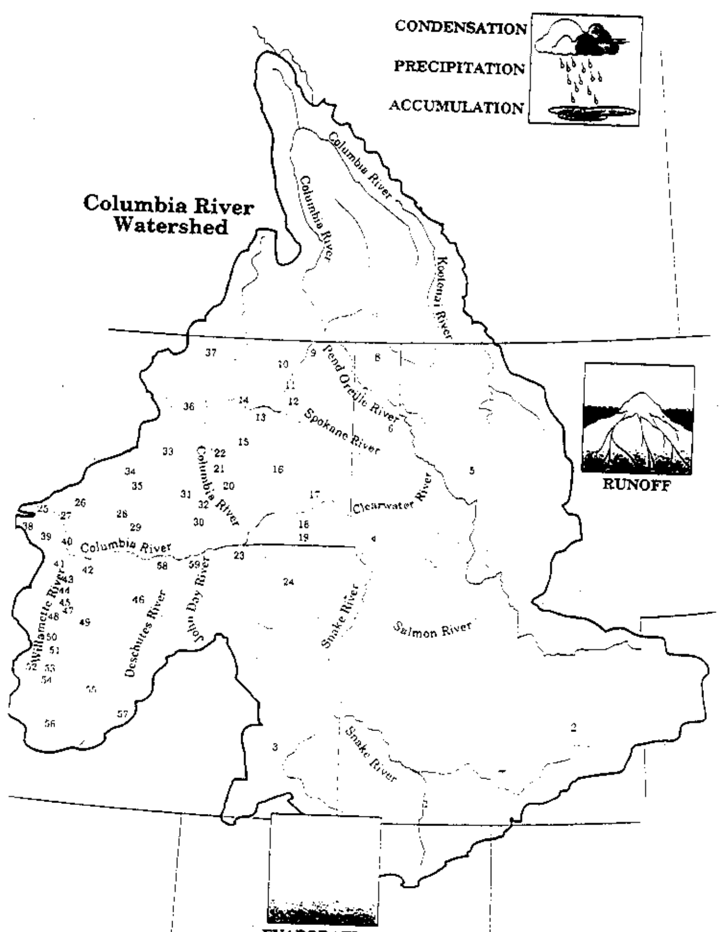
____

____

____

____

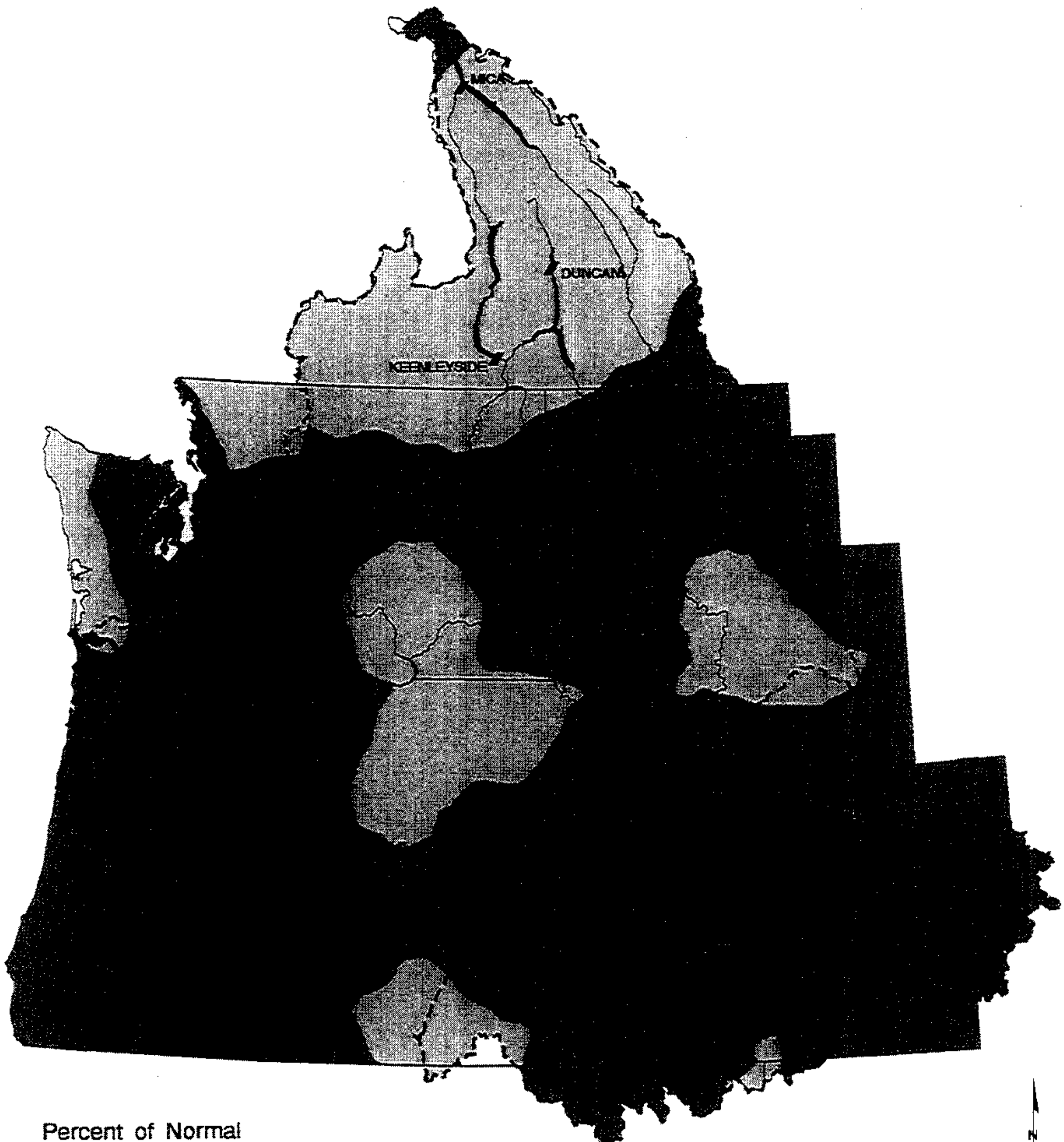
____



Activity 11 Watershed Data Sheet (numbers represent millions of acre feet annually)

Watersheds	Average Annual Flow (000,000)
Upper Columbia	
Kootenai River	20.1
Mid Columbia	
Okanaogan River	2.04
Spokane River	5.52
Yakima River	2.52
Wenatchee River	2.16
Methow River	1.08
Lower Columbia	
Columbia River	170.9
Willamette River	24.9
Clackamas River	1.92
McKenzie River	3.0
South Santiam River	2.16
North Santiam River	2.46
Deschutes River	4.2
Crooked River	0.24
John Day River	3.72
Umatilla River	0.36
Lewis River	3.6
Cowlitz River	6.72
Pend Oreille Watershed	
Flathead River	8.4
South Fork Flathead River	2.64
North Fork Flathead River	2.16
Blackfoot River	1.2
Clark Fork	14.4
Bitterroot River	1.8
St. Joe River	1.7
Pend Oreille River	18.9
Couer d' Alene River	1.32
Snake Watershed	
Snake River	37.8
Clearwater River	11.04
Grande Ronde River	2.16
Salmon River	8.52
Payette River	3.12
Boise River	2.04
Malheur River	0.14
Owyhee River	0.84
Bruneau River	0.29
Blackfoot River	0.18
Selway River	2.76

Northwest Seasonal Precipitation
October 1,1993 to October 1, 1994

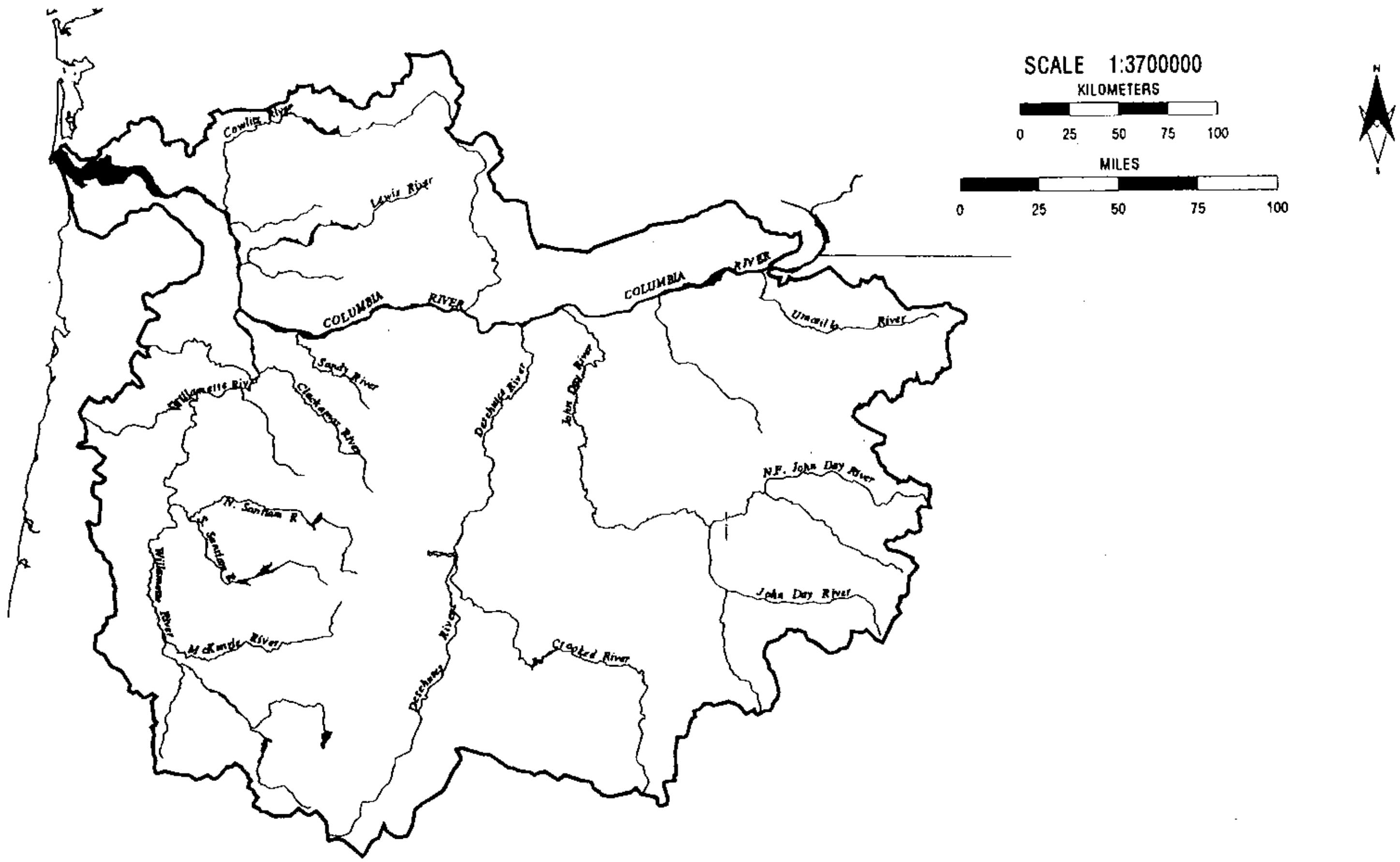


Percent of Normal

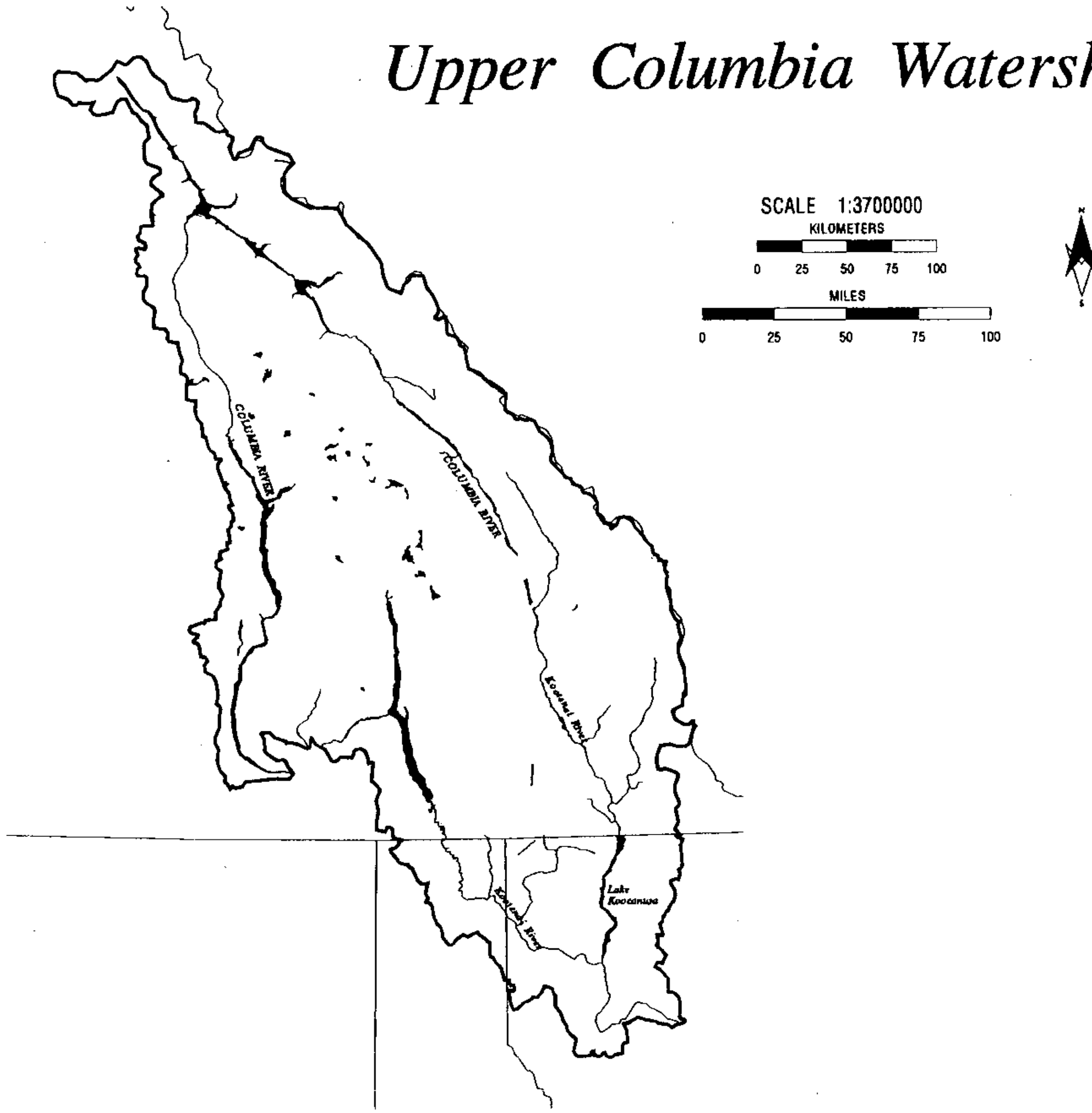
■	< 60%	■	120 - 140%
■	60 - 80%	■	140 - 160%
■	80 - 100%	■	160 - 180%
■	100 - 120%	■	> 180%

Data source: National Weather Service
416 of 422 recording stations reporting

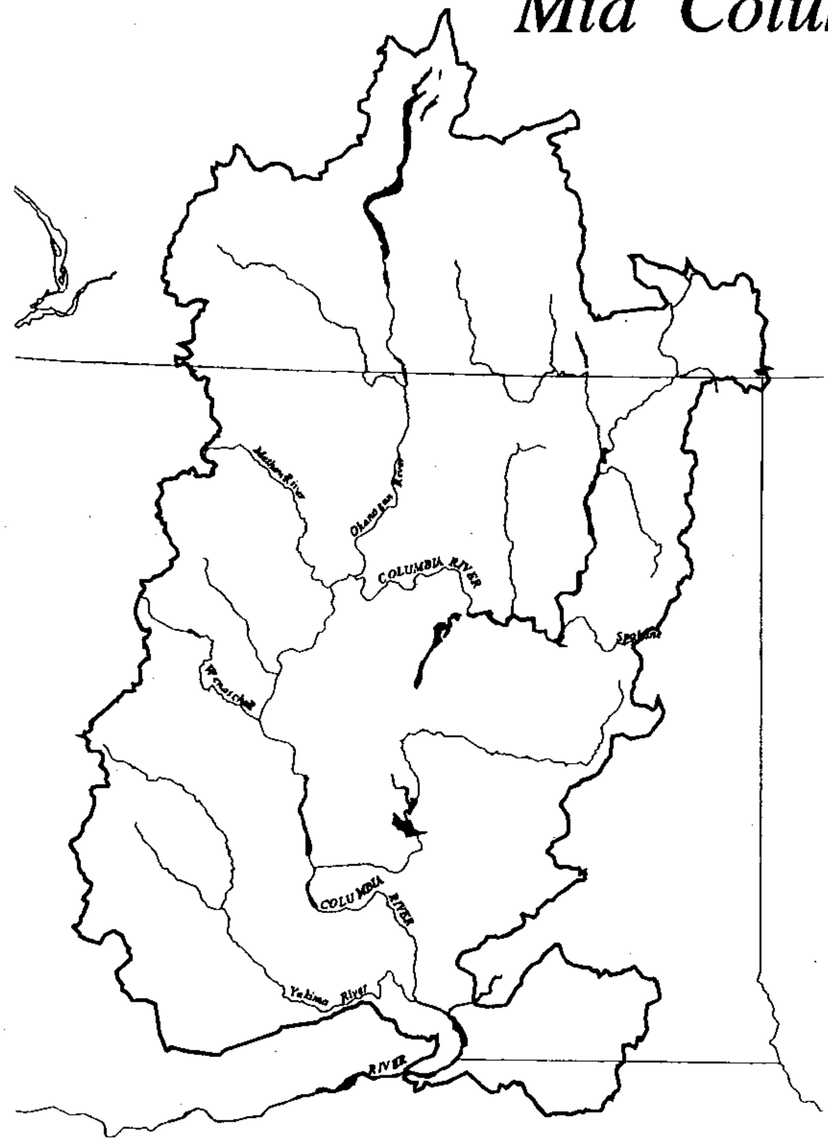
Lower Columbia Watershed

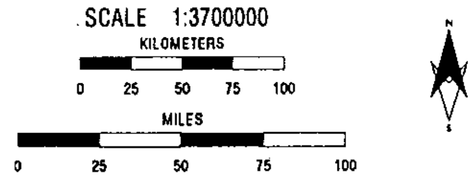


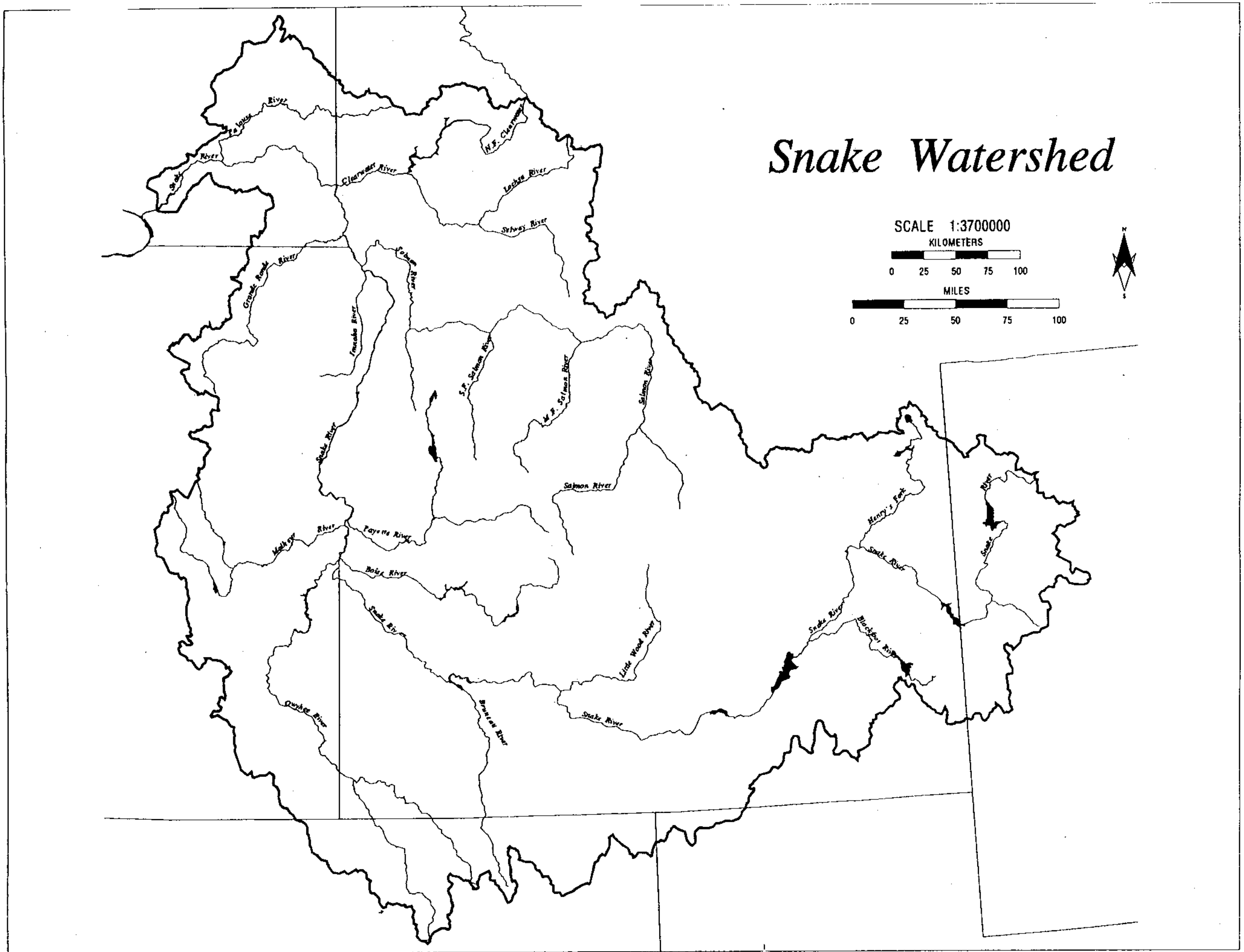
Upper Columbia Watershed



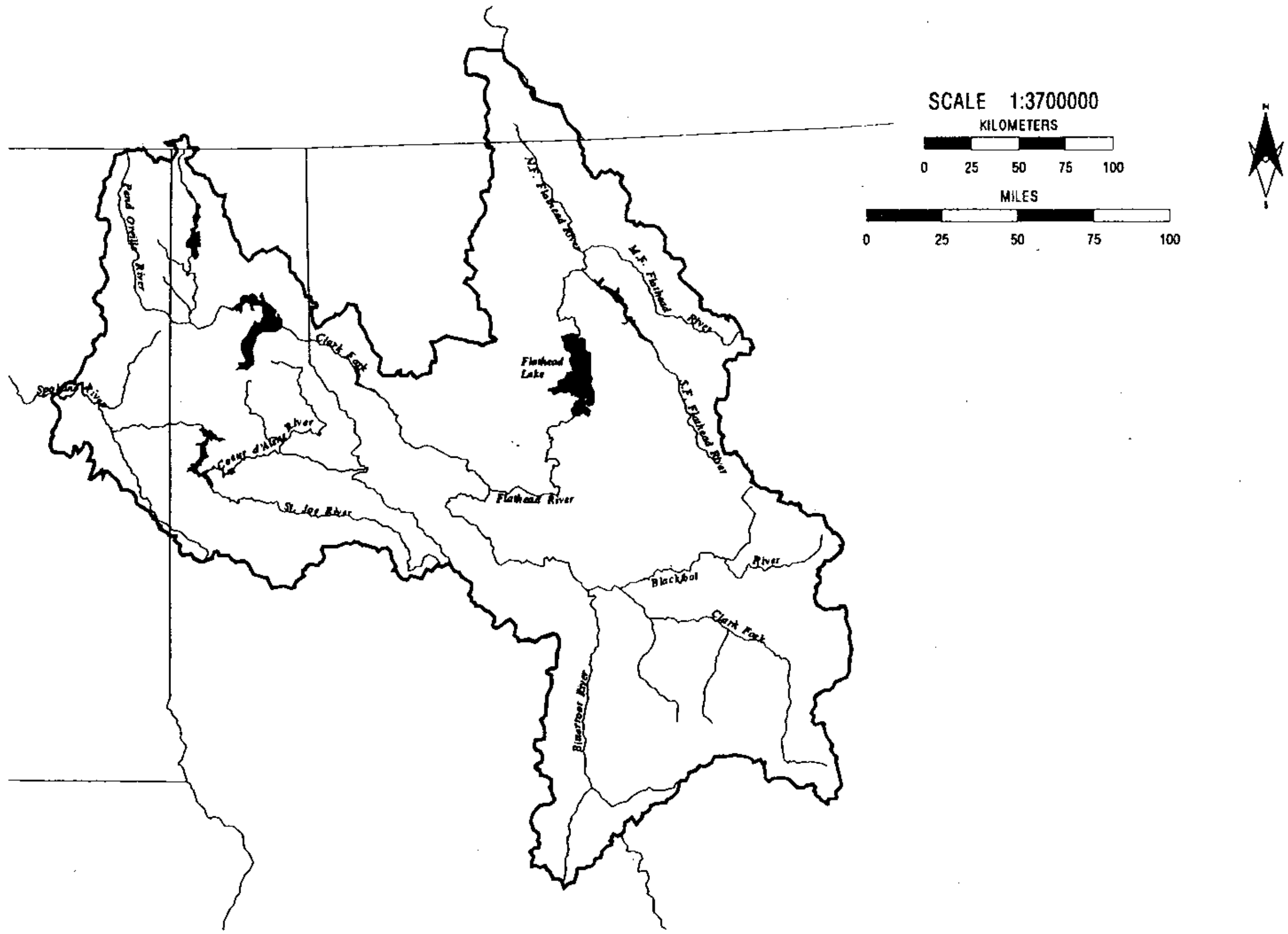
Mid Columbia Watershed






Snake Watershed
SCALE 1:3700000
KILOMETERS
0 25 50 75 100
MILES
0 25 50 75 100
N
S
Palouse River
Snake River
Clearwater River
N.F. Clearwater
Lochsa River
Selway River
Grande Ronde River
Imnaha River
Salmon River
S.F. Salmon River
M.F. Salmon River
Salmon River
Salmon River
Snake River
Malheur River
Payette River
Boise River
Snake River
Little Wood River
Owyhee River
Bruneau River
Snake River
Henry's Fork
Snake River
Snake River
Blackfoot River
Snake River

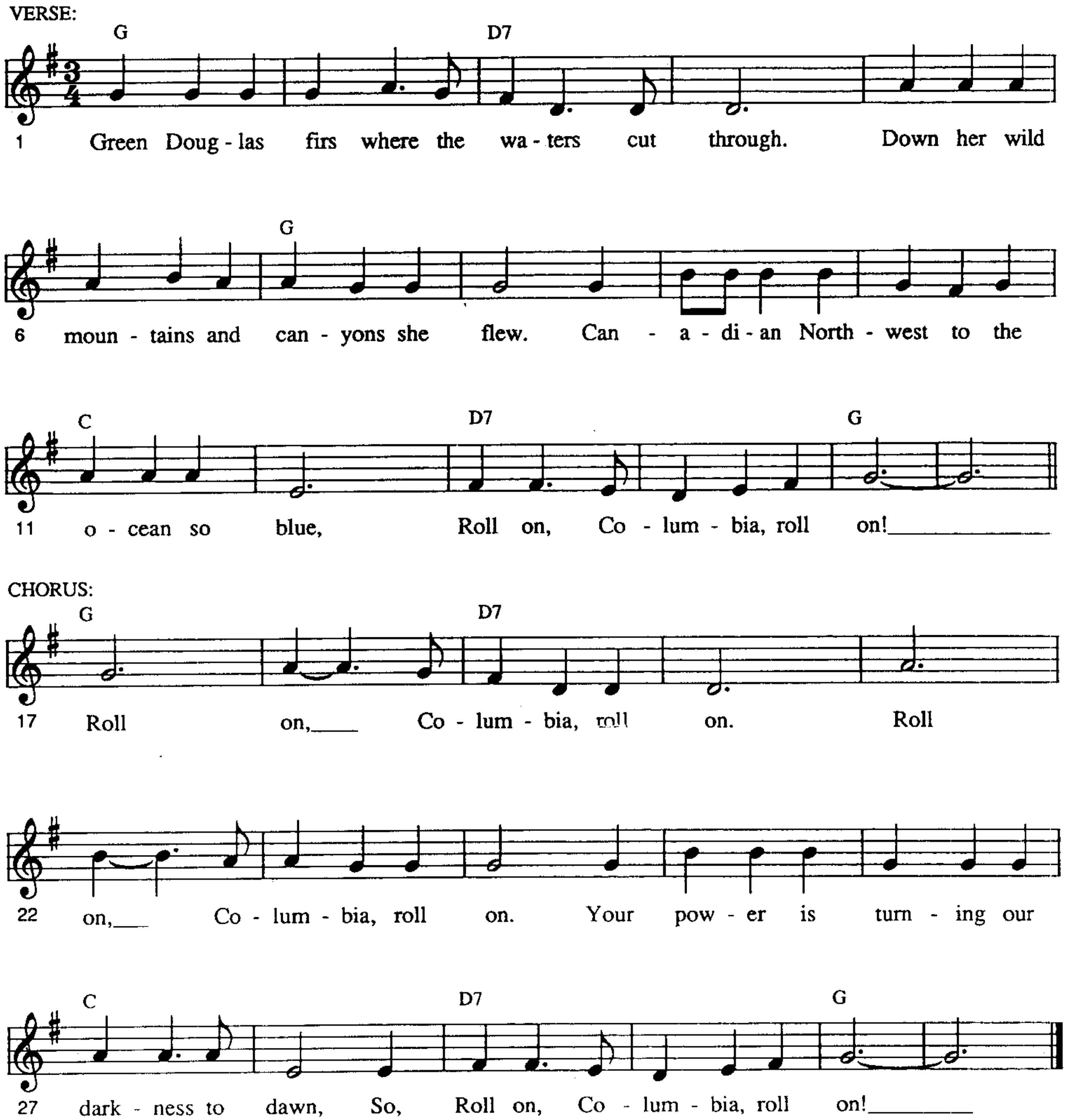
Pend Oreille Watershed



ROLL ON COLUMBIA, ROLL ON

By Woody Guthrie

Music based on "Goodnight Irene"
by Huddie Ledbetter and John Lomax



Other great rivers add power to you,
Yakima, Snake, and the Klickitat, too,
Sandy, Willamette, and Hood River, too;
Roll on Columbia, roll on!

Chorus if desired

Editor's Note:
This verse was added later by Michael Loring, BPA, 1947.

Tom Jefferson's vision would not let him rest,
An empire he saw in the Pacific Northwest.
Sent Lewis and Clark and they did the rest;
Roll on, Columbia, Roll On!

Chorus if desired

It's there on your banks that we fought many a fight,
Sheridan's boys in the block house that night,
They saw us in death, but never in flight;
Roll on, Columbia, Roll On!

Chorus if desired

Our loved ones we lost there at Coe's little store,
By fireball and rifle, a dozen or more,
We won by the Mary and soldiers she bore;
Roll on, Columbia, Roll On!

Chorus if desired

Remember the trial when the battle was won,
The wild Indian warriors to the tall timber run,
We hung every Indian with smoke in his gun;
Roll on, Columbia, Roll On!

Chorus if desired

Year after year we had tedious trials,
Fighting the rapids at Cascades and Dalles.
The Injuns rest peaceful on Memaloose Isle;
Roll on, Columbia, Roll On!

Chorus if desired

At Bonneville now there are ships in the locks,
The waters have risen and cleared all the rocks,
Ship loads of plenty will steam past the docks,
So, Roll on, Columbia, Roll On!

Chorus if desired

And on up the river at Grand Coulee dam,
The mightiest thing ever built by a man,
To run the great factories for old Uncle Sam;
It's roll on, Columbia, roll on!

Note: The chorus of this song can be sung after every verse, or after every two or three verses, as you like. This song was wrote up by an Oakie passing through your country, and I'm pretty certain that everybody just first a coming into this country has got some such similar song in his or her head, but times is such that they just can't sing it out loud so you might not hear it.

Woody Guthrie, outskirts of Portland, Oregon, 5-12-1941.

Day 3	Teacher's Guide
8:30 a.m.	**Check-in and board buses for Fishing Field Trip**
Materials:	Fishing Equipment, Sample Containers, SOLV Bags, Sun Protection, Lunch & Snacks
8:45 a.m.	Depart camp for Cathlapotle/Battle Ground Lake. Students eat breakfast on the bus.
9:15 a.m.	Arrive at Battle Ground Lake or Ridgefield
9:20 a.m./ 1:20 p.m.	**Group 1** Go over fishing safety rules with students and provide for all participants. Distribute fishing gear and demonstrate fishing methods and baiting hooks. Catch and release techniques should also be demonstrated. **Group 2** Introduce Ridgfield Wildlife Refuge History and historical settlement (USFWS) and then board shuttle bus to Cathlapotle site.
9:40 a.m./ 1:30 p.m.	**Student fishing/bus to Cathlapotle Ancient Indian campground**
10:00 a.m./ 2:40 p.m.	**Native American Legend Part 2 (Select Native American legend to read to students who are on Cathlapotle hike).**
10:45 a.m./ 2:45 p.m.	**Snack Break**
11:00 a.m./ 3:00 p.m.	**Activity 16 - Water Sampling**
Skills:	Application, Analysis, Classification, Description, Synthesis, Handle Materials, Observe, and Measure
Objective(s)	Students will be able to collect and test samples of water using common analytical techniques.
Materials:	Plastic film canisters, thermometers, pH paper, dissolved oxygen tester, student worksheets, magnifying glasses, pencils, pH color chart

Procedure: Begin activity by explaining that water can be very different from place to place because of materials that are in the water. A healthy habitat for fish requires a certain level of oxygen, the right acidity (pH), a limited amount of dissolved and suspended materials, and not too much toxic material. By testing the water, you can tell if the habitat is healthy or not. Have students work in their groups. The samples they collect will be saved and used back at camp the next day.

Step 1. Provide plastic film canisters for students to take a water sample from the surface to use in lab the next day. Ask students to use their magnifying glasses to look at their water sample and describe on their worksheets what they see.

Step 2. Demonstrate the use of the dissolved oxygen testing equipment to measure DO. Have each group select one member to make and record the measurements for their entire group.

Conclusion: Bring closure to the activity by directing students to do the following:

1. Seal and label your samples with your name and give to your counselor for safekeeping.

2. Ask students to tell what they think could affect dissolved oxygen and acid levels in the water.

3. Have students describe the things they would expect to be suspended or floating in their water sample.

4. Ask students to evaluate the quality of the habitat where they took their sample.

Activity 16 **Water Sampling** **Student Activity Sheet** ____________________
(your name)

Background:

Creatures who live in the water need food, water, shelter, and space (habitat) just like those who live on land. If the water is too warm or too cold, has too many things in it, there is not enough oxygen, or it is too acid, plants and animals in the water will not be able to survive. Simple tests can be used to find out if water habitat is good to live in. In this activity you will be taking a water sample to test in the lab and measuring the temperature and acidity of the water where you are fishing.

Vocabulary: pH, dissolved oxygen, toxic

Directions:

Step 1. Take surface water temperature by holding the thermometer in the water for 30 seconds and recording the temperature here:

____

Step 2. Take a second temperature reading at a depth of 8 - 10 feet for 30 seconds and record the temperature here:

____

Step 3. Test the acidity of the water by wetting pH paper and comparing to the pH color chart provided. Write the pH of the water here:

____

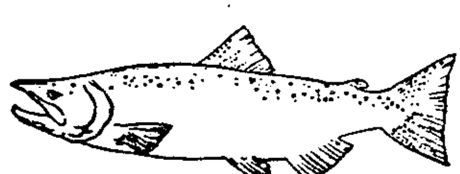
Step 4. Next, Test the acidity of your saliva and write down which is more acid, the lake water or your saliva:

____

Step 5. Have one person in your group measure the amount of dissolved oxygen in the water using the electronic meter and write down the meter reading here:

____

Step 6. Use the container provided to take a lake water sample back to the lab. Write your name on the container, where the sample from, and give it to your teacher or counselor to save for you to test later.



Chinook

Activity 18 **Water Critters**

Skills: Handle Materials, Observe, Classify, Reporting, Application, Synthesis, Describe, Measure, Identify

Objective(s) Students will be able to use common laboratory equipment to find and identify living organisms found in stream or pond water.

Materials: Identification Keys, Microscopes, Slides, Droppers, Activity Sheets, Probes

Background: *Water samples taken from ponds, lakes, and rivers normally contain a large variety of aquatic plant and animal life forms. These living things make up an important part of the food chain which is necessary to maintain life on earth. Looking at samples of water under the microscope tells us how many and what types of living things use a particular water source as their habitat. In this activity students look for microscopic life in water samples collected in the field. Identification keys which show the appearance of common plants and animals will help them identify the different organisms.*

Procedure: Begin activity by asking students to look at the water sample they collected the previous day. Hand out the student activity sheets. Ask students to describe what they can see or what kind of living things they think are contained in their sample. Make sure that your samples come from a source with abundant microscopic life (stagnant water with visible organic growth will work well). Have students perform the following operations:

1. Use the identification key to find the names of living things in their samples.
2. Set-up a microscope and slide to observe the contents of samples.
3. Identify macroscopic and microscopic life within their samples.

4. Find the main organic structures of the resident life forms.
5. Explain how the aquatic life relates to fish habitat.

Conclusion: Ask the following types of questions to bring closure to this activity:

⇒ Describe or name some living things whose habitat is water.
⇒ What would you predict would happen to fish if there was no other aquatic life in the lakes, rivers, and streams?
⇒ What do you think the microscopic animals eat?
⇒ Where do the microscopic plants get their food?
⇒ Besides the living things you found in your sample, what other living things did you observe in and around the water hole where you got your sample?
⇒ Describe some things that could affect water habitat.

Activity 21 **Oxygen in Water**

Skills: Observation, Synthesis, Recording Data, Analysis, Handling Materials

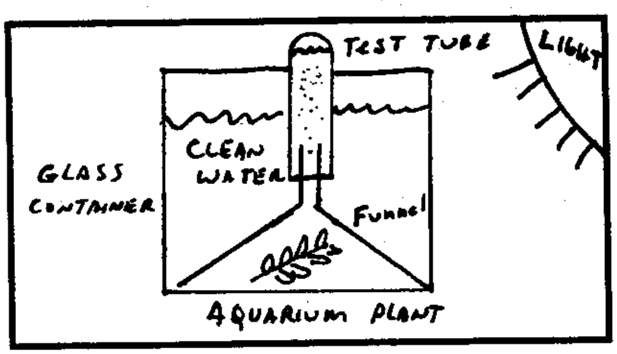
Objective(s): Students will be able to observe the production of oxygen by photosynthesis, describe how oxygen can dissolve in water, and test for dissolved oxygen(DO).

Materials: Transparent Glass Funnel, Test Tube, Test Tube Clamps, 250 mL Beaker, Dissolved Oxygen Testing Kits, Elodea (aquarium plant), Pure Water, Wood Splints, Matches, Hot Plates, 100 mL beakers

Procedure: Begin activity by asking students to explain how they think fish breathe. Explain that they take in the oxygen through their gills in the same manner that we use our lungs. The oxygen that fish breathe is dissolved in the water that they live in. The oxygen in the water comes from two primary sources: the atmosphere and from plants living in the water. Explain that they will be watching a plant produce oxygen in water and test water for oxygen which is dissolved in it. Have students follow the steps below:

Part 1 Demonstration

Step 1. Set up a collection apparatus as shown in the diagram below in to collect oxygen from an elodea plant inside the clear glass funnel. Make sure that the test tube is filled with unchlorinated pure water before sealing with your finger and inverting it over the funnel. The apparatus needs to be placed in direct sunlight.



Step 2. Have students observe and record what happens inside the test tube after they complete the DO tests in Part 2.

Part 2. Testing for Dissolved Oxygen

Goggles and gloves should be used for this experiment

Step 1. Have students completely fill a stoppered glass bottle with tapwater and follow the directions on their lab sheets to test for dissolved oxygen.

Step 2. Students then boil 100 mL of fresh tapwater for three minutes and test again for DO to see if there is a difference.

Step 3. **(optional)** Ask students to take the remaining boiled sample they just tested for oxygen and pour it back and forth between two beakers for 3-5 minutes to dissolve oxygen from the air back into the water. Once again, have students test the water for DO and record their observations on their activity sheets.

Step 4. After students have completed the DO tests, return to the apparatus in Part One and have them observe the results. If sufficient oxygen has been collected to displace about an inch of water from the test tube, remove it and test with a glowing splint.

Conclusion: Bring closure to this activity by having students focus on questions similar to those below:

1. What would happen to fish in water that contained little oxygen?
2. How does oxygen get used up in water?
3. Where does oxygen in water come from?
4. Would stagnant water or moving water be normally better for fish?
5. What kind of conditions do you think provide a healthy habitat for fish?
6. Describe some ways we could restore good water conditions for fish in areas of distress.

Activity 22 **Finding pH** (adapted from Lakes and pH in The Stream Scene)

Skills: Analysis, Application, Observation, Measurement, Handling Materials, Generalization, Reading Graphs

Objective(s): Students will be able to explain the difference between acids and bases on the pH scale and determine suitable pH levels for different fish.

Materials: Wide Range pH Indicator Solution, Aquatic Life Charts from Stream Scene, Baking Soda Solution, Beakers, pH paper, Vinegar, Activity Sheets

Background

The number of hydrogen ions (positive charged hydrogen protons combined with single molecules of water -H_3O^+) in a solution is called ***pH*** *and determines whether a solution is* ***acidic*** *or* ***basic****. The pH scale ranges from 1 (very acidic) to 14 (very basic) with 7 as neutral. Each change of one number on the scale is a 10 fold change in the number of hydrogen ions present. A change from 7 to 6, for example, represents 10 times more hydrogen ions; 7 to 5, 100 times, and so forth.*

Most living things have a narrow pH range in which they can live (Figure 22). Some fish for instance, can live in a range of 5 to 9, others cannot survive a change of even one pH unit. Because of this narrow range of tolerance, pH limits where many living things can survive and the makeup of the population.

Pure water has a pH of about 7, but dissolved materials and chemicals in the water can change the pH. Materials can be dissolved from a streambed, the soil in a watershed, sediments washed into a stream, or from the air.

In this activity you will be testing some common household items to find their pH by using pH paper which changes color depending on how acidic or basic a solution is.

Procedure: Begin activity with a short introductory lesson on acids and bases and how pH is a measure of the amount of hydrogen ion present in a material. A good demonstration is to use a strong acid like HCl and a strong base like NaOH to demonstrate the effect of acids and bases on materials. Then neutralize the acid with the base to form a neutral compound. Explain that when you test for pH you are measuring how much Hydrogen ion is available to combine with other elements. After the demonstration, have students follow the steps below:

Step 1. Ask students to use water from the sample collected in the field for their analyses.

Step 2. Have students compare the pH of their water sample with that of 1) vinegar and 2) a baking soda solution, by using pH paper and color indicator charts. Students record their answers on their lab sheets.

Step 3. Let students find the actual pH of their water sample by chemically testing it with Wide Range pH Indicator.

Step 4. Ask students to compare their stream water pH with their chart showing the pH requirements for different fish.

Step 5. Have students complete their lab sheets by recording the names of fish that could live in the water they sampled and the pH levels where all fish die.

Conclusion: Bring closure to the activity by focusing on the following types of questions:

1. What will happen to the fish that live in lakes and streams if we pollute them with too much acid or base?
2. How might rain, that is acidic, affect fish habitat?
3. If a lake was too acid or basic for fish, how could you change it into the desired pH range?
4. Where do you think the acids and bases that get into our lakes and streams comes from?
5. Which pH level do you think supports the most aquatic life in our waterways?
6. Even though fish can live in water of pH of 4 or 5, why would they be unlikely to survive?

Snack Break

Read the Next Native American Story from the Available Selections in Appendix

Journal Writing Activity - Students write in their journals about what they learned in camp on Day 4.

Day Four Awards **All students who have done all their entries in their journals up to date receive Junior Scientist Certificates. Those that accumulate all of the certificates for the camp earn special hats and prizes awarded during Day 9 Celebration.**

3:00 p.m. Camp Ends for Students

Activity 18 **Water Critters** **Student Activity Sheet** ________________
(your name)

Background:

Water samples taken from ponds, lakes, and rivers normally contain a large variety of aquatic plant and animal life forms. These living things make up an important part of the food chain which is necessary to maintain life on earth. Looking at samples of water under the microscope tells us how many and what types of living things use a particular water source as their habitat. In this activity you will be looking for microscopic life in water samples that you have collected. Identification keys showing the appearance of common plants and animals will assist you in identifying the different organisms.

Vocabulary: Habitat, Food Chain, Macroscopic, Microscopic, Organism

Directions:

Step 1. Find the parts labeled on the microscope diagram. You will need to use these parts in order to see the microscopic organisms in your sample.

Step 2. Look at the water sample provided by your instructor with your unaided eyes to see if you can find anything that looks alive. Things that you can see without a microscope are called macroscopic. Did you see anything?

____

Step 3. Take a glass slide and place a single drop of the water on the slide using an eyedropper. Place a coverslip over the water droplet and set the slide on your microscope stage.

Step 4. Look through the eyepiece and use the coarse adjustment to bring the view into rough focus. Make the final focusing adjustments using the fine focus knob on the microscope you are using.

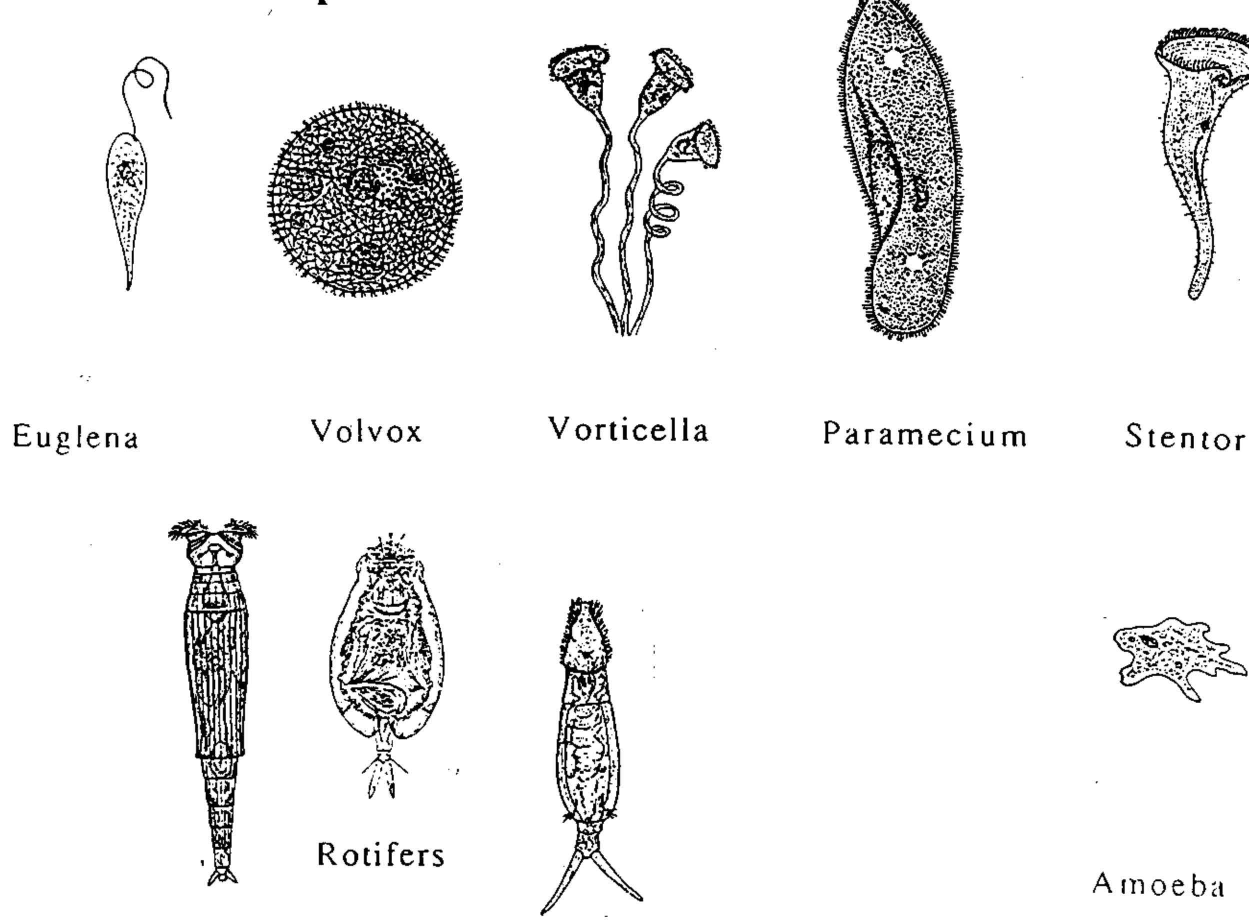
Step 5. Pick three organisms that you can see clearly and make a simple drawing of each in the three circles below.

Optional. Using the picture key provided, identify the living things that you find in your sample and write their names in the spaces below.

Animal Life	**Plant Life**
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

Question: How are microscopic plants different from microscopic animals?

Common Microscopic ANIMALS



Common Microscopic PLANTS

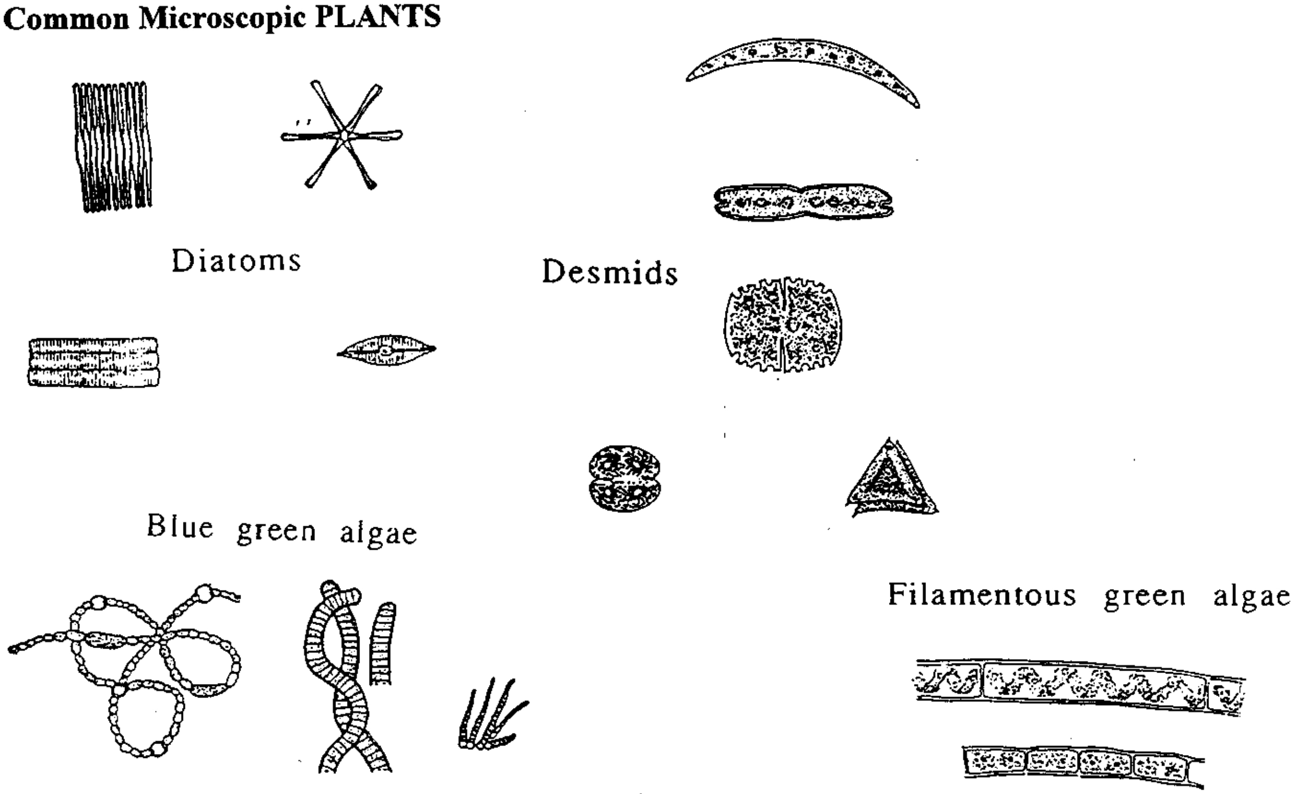
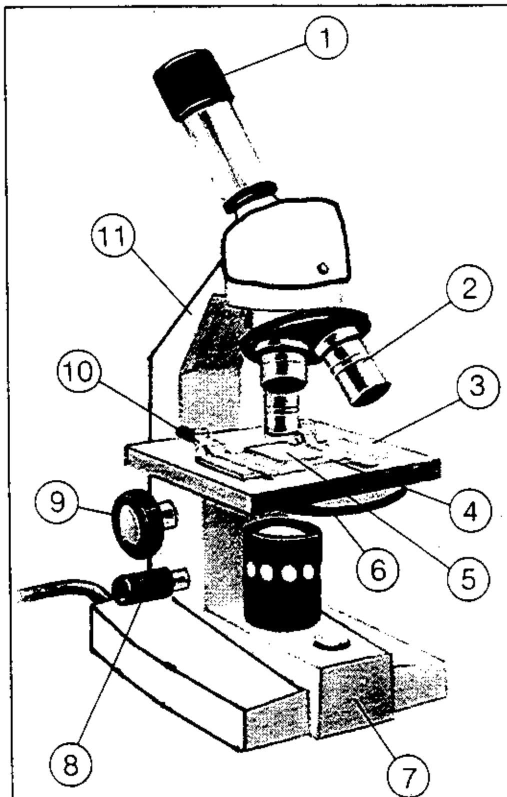


Diagram of a common microscope



Compound Light Microscope

1. Ocular lens (eyepiece)
2. Objective lens 3. Stage
4. Glass slide 5. Coverslip
6. Diaphragm (regulates light intensity)
7. Base
8. Fine adjustment knob
9. Coarse adjustment knob
10. Stage clips
11. Arm

Activity 21 **Oxygen in Water** **Student Activity Sheet** ____________________
(your name)

Background: You probably know that water can contain a lot of things. Some things you can see, other things are microscopic or invisible. All fish live in water and are able to breathe by removing oxygen that is dissolved in the water by drawing it through their gills. The oxygen in the water actually passes (diffuses) through the gill tissue directly into the blood. The oxygen in water comes from two primary sources: From the air and from plants living in the water. If there is not enough oxygen in the water, fish and other organisms that use gills will not be able to survive there. Cold water can hold more oxygen than warm water.

A water body which has reduced dissolved oxygen is called "eutrophic." Plants can live in such a place, but fish and other animal life generally cannot. The term "oligotrophic" is used to describe water bodies with abundant oxygen for animal life. There are simple measurements which can be taken to find out the how much dissolved oxygen (DO) is contained in a water body. In this activity you will add oxygen to water, take it out, and measure the amounts of dissolved oxygen present.

Vocabulary: Eutrophic, Diffusion, Dissolved, Oligotrophic, De-oxygenated, Precipitate

Directions: **Part 1. Demonstration**. Your instructor will set up a device to collect oxygen from a plant as shown in the diagram. It will take 30-60 minutes for this to work, so proceed to step 2.

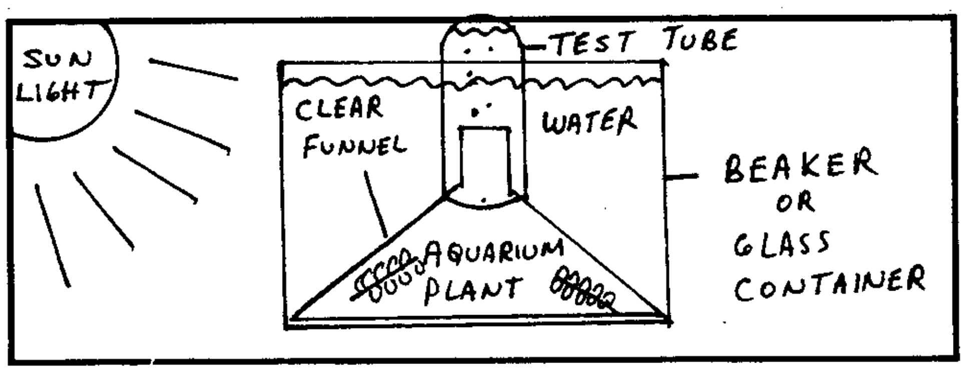


Diagram 21-1

Part 2. Experiment

Step 1. Completely fill a glass-stoppered dissolved oxygen bottle with tap water and make certain that no air bubbles are trapped inside. **** Be very careful of the poisonous chemicals used in steps 3-6. Use protective gloves and goggles.**

Step 2. Add the contents of the Dissolved Oxygen One and Two Reagent packets (Reagant One is manganese sulfate $MnSO_4$ and Reagent Two is lithium hydroxide LiOH). Stopper and shake well.

Describe what happened in Step 2.

Step 3. Allow the precipitate to settle on the bottom of the bottle and shake once again. When the precipitate has settled from the upper half of the bottle, add one packet of Dissolved Oxygen 3 Reagent (sulfamic acid $C_6H_{13}NO_3S$), stopper and shake again until the precipitate disappears.

Step 4. Next pour the solution into a dissolved oxygen measuring tube (5.83 mL) filling it to the top. Pour into a mixing bottle.

Step 5. Add one drop at a time of Sodium Thiosulfate counting drops until the sample changes from yellow to colorless. Each drop added equals one milligram of DO (1 milligram = 1/1000 gram).

Step 6. Figure out the DO content of the tapwater and write the result below (number of drops needed to make the solution clear).

Dissolved oxygen amount:

The number of drops equals the milligrams of DO dissolved in a liter of water.

Step 7. Add 100 mL to a large beaker and boil the water for about 3 minutes.

Step 8. Test this sample for dissolved oxygen repeating the same procedure in steps 2-6 and write down what you find:

Why do you think the boiled tapwater had different DO than the plain tapwater?

Step 9. Go back to the demonstration in Part 1 and ask your instructor to test the gas collected in the test tube with a glowing splint.

Good Job!

Activity 22 **Finding pH** **Student Activity Sheet** ____________________
(your name)

Background

The number of hydrogen ions (positive charged hydrogen protons combined with single molecules of water -H3 O+) in a solution is called **pH** and determines whether a solution is **acidic** or **basic**. The pH scale ranges from 1 (very acidic) to 14 (very basic) with 7 as neutral. Each change of one number on the scale is a 10 fold change in the number of hydrogen ions present. A change from 7 to 6, for example, represents 10 times more hydrogen ions; 7 to 5, 100 times and so forth.

Most living things have a narrow pH range in which they can live (Figure 22). Some fish for instance, can live in a range of 5 to 9, others cannot survive a change of even one pH unit. Because of this narrow range of tolerance, pH limits where many living things can survive and the makeup of the population.

Pure water has a pH of about 7, but dissolved materials and chemicals in the water can change the pH. Materials can be dissolved from a streambed, the soil in a watershed, sediments washed into a stream, or from the air.

In this activity you will be testing some common household items to find their pH by using pH paper which changes color depending on how acidic or basic a solution is.

Vocabulary: pH, Acid, Base, Solution, Population, Dissolved, Ion, Proton, Tolerance

Directions:

Step 1. Take a strip of pH paper and dip it into one of the solutions provided.

Step 2. Compare the resulting color of the pH paper to the chart on the paper container.

Step 3. Find the pH of the solution by writing the number of the color that most closely matches the color of your strip. Record the pH of the solution below.

Step 4. Repeat steps 1-3 with the other solutions.

________	________	________	________	________
Lemon Juice	Soft Drink	Bleach	Tapwater	Vinegar

Step 5. Look at Figure 22 and write down which of the items you tested above have a survivable pH for fish to live in.

____

____

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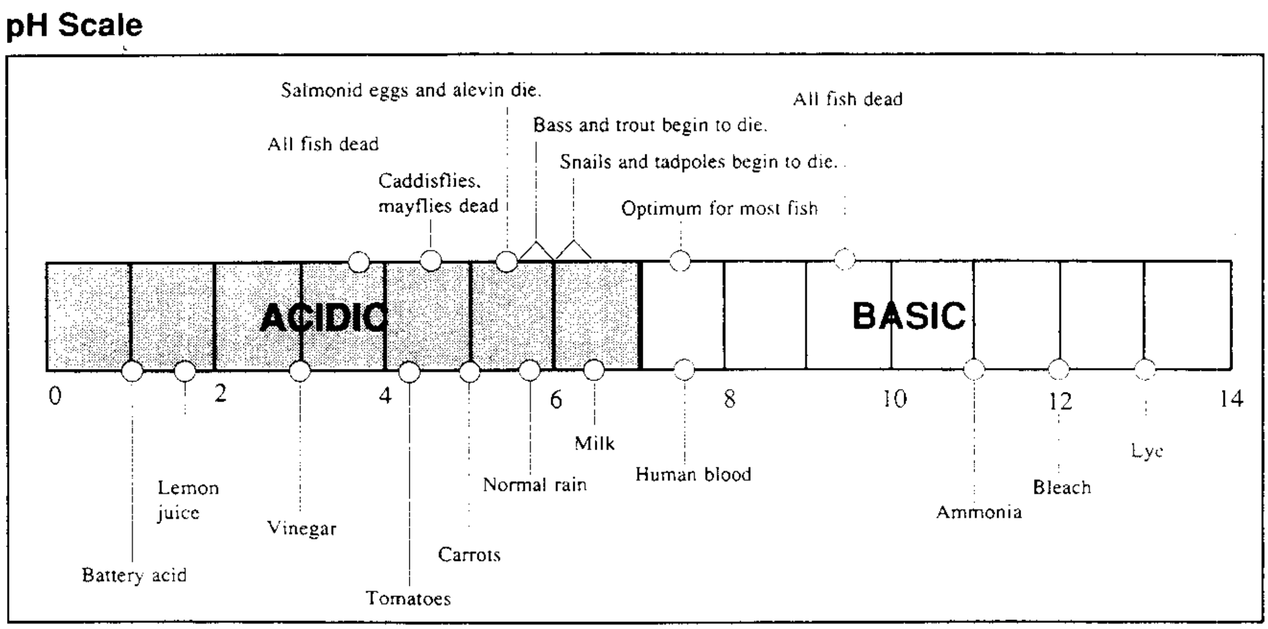


Figure 22

Activity 25 **Water Cycle Relay** (**from Teacher's Guide to Bonneville Dam, U.S. Army Corps of Engineers**)

Skills: Analysis, Application, Discussion, Evaluation, Generalization, Observation, Problem-solving, Synthesis

Objective(s): Students will be able to relate the water cycle and conservation to energy generation.

Materials: Small Cups or Large Spoons, Water

Background: *Everybody knows that water flows downhill but not everyone realizes that hydroelectricity is made possible by gravity. As the water falls through a powerhouse, the gravity energy is changed to mechanical energy. This takes place when water strikes the turbine blades causing rotation of the turbines. The turning turbines are attached to generators. Therefore, as the turbine spins, so does the generator. The mechanical energy of the turbine is changed to electrical energy as the magnets of the rotor are spun past the coils of copper wire in the stator. The transformer increases the voltage so electricity may be sent more efficiently through transmission lines. The transmission lines usually take it to another transformer which decreases voltage again and it is then sent to homes and businesses for people to use.*

Procedure: Begin activity by asking students to relate the water cycle to hydroelectric production. Good focus questions include: Where does the energy come from which powers the water cycle? (sun, gravity) What makes water evaporate? (the sun) Where does the water go? (it changes to a gas and eventually condenses to fall back to earth) How does it get to the river? (run-off from the land) What makes the water flow in the river and through the powerhouse? (gravity) Follow the steps below to conduct the activity:

Step 1. Divide the students into even teams of 6 or 7. Any "leftover" students can help judge.

Step 2. Label each of the team members as 1) river, 2) turbine, 3) generator, 4) dam transformer, 5) transmission line, 6) neighborhood transformer, and 7) light bulb. (omit the transformers if using 5 or 6 student teams)

Step 3. Provide each player with an identical container such as a small cup, bowl, or measuring spoon.

Step 4. Line the teams up in starting position and fill the first team member's container as full as possible with water. (the water represents energy)

Step 5. Explain that each team member must run the relay course (whatever is chosen) trying not to spill the water and then transfer the water to their next team member's container.

Step 6. Measure the water left after the last team member crosses the finish line. The team with the most water (energy) remaining in their container wins.

Conclusion: Bring closure to this activity by doing the following:

1. Discussing how energy is lost in the form of heat every time it is transferred.
2. Noting that the Water Cycle Relay illustrates the second law of thermodynamics which, simply stated, says that whenever energy is transferred, some is lost in the form of heat.
3. Explaining that heat radiates away from the earth and approximately equals what comes in from the sun.
4. Discuss the need for conserving energy

Snack Break

Activity 32 **Columbia River Watershed Poster Contest**

Skills: Computation, Application, Measurement, Classification, Observation, Writing, Problem Solving, Estimation

Objective(s) Students will be able to identify and measure the 10 longest tributaries to the Columbia River. Students will be able to rank order the tributaries and explain in writing about elements of the water cycle.

Materials: Watershed Posters, Direction Sheets, Pencils, String, Rulers, Writing Paper

Procedure: Explain to students that they will be using a piece of string about 24 inches long to lay out along the course of the 10 largest tributaries to the Columbia River. Explain that a tributary is a river or stream which flows into a larger river. When students have measured each of the tributaries including the Columbia itself, have them order from 1-10, the longest to the shortest in length. Students desiring to enter the contest can then take the first letter from the name of each tributary in the correct 1-10 order and write a ten sentence story about the water cycle. The beginning letter of each story sentence must correspond to the first letter of the respective tributary river. Have students follow the steps below.

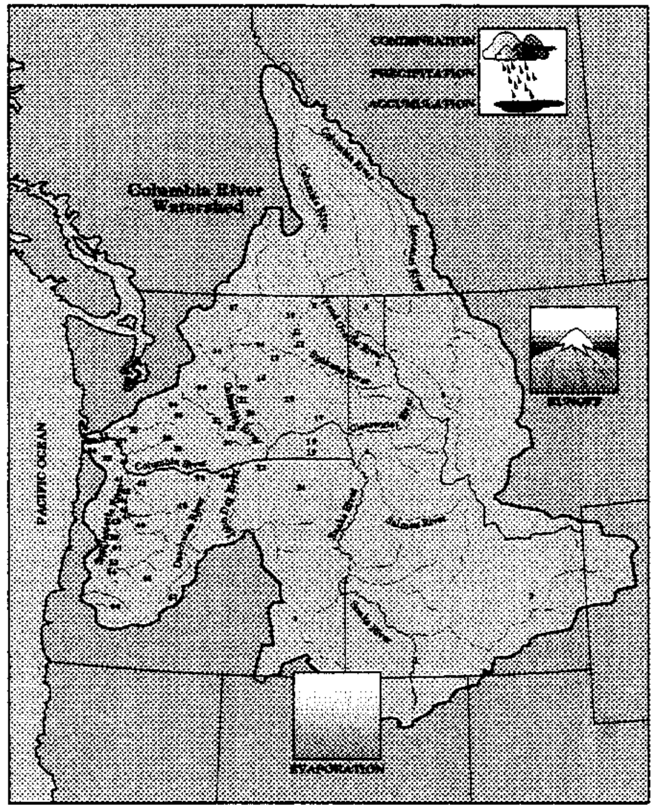
- **Step 1.** Write the names of the 10 largest Columbia River tributaries in any order: (Columbia, Snake, Kootenai, Spokane, Salmon, John Day, Deschutes, Clearwater, Willamette, and Pend Oreille)
- **Step 2.** Using a 24 inch piece of string, measure the length of each tributary starting at the longest branch and laying it along the river's course until it reaches the Pacific Ocean. The course may include other rivers as necessary.
- **Step 3.** Mark or measure the length of each string segment and record the distance next to the corresponding river.
- **Step 4.** Order the tributaries from longest to shortest; 1 being longest and 10 being shortest.
- **Step 5.** Optional. Write a 10-sentence story about the water cycle using the first letter of each of the 10 tributaries in their correct order from longest to shortest. Number the sentences. Prizes will be awarded to those entering.

Conclusion: Bring closure to this activity by providing the students with the correct order of length (measure yourself) and provide your parameters for students entering the water cycle writing contest.

Lunch Break

Learn the Columbia River Watershed Contest

Contest Rules:

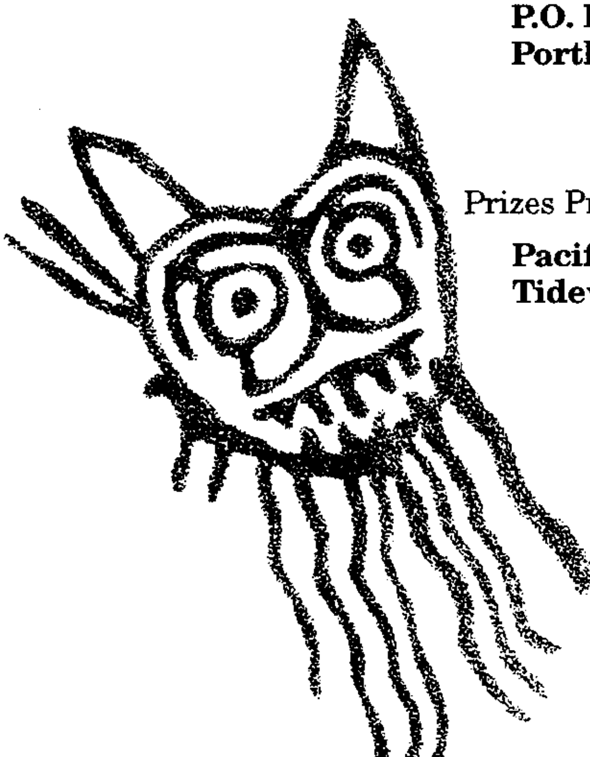


List the 10 major rivers named on the poster in order from longest to shortest in length measured from their *begining* to where they reach the Pacific Ocean. Use the first letter of each river in order to create a 10-sentence story about the water cycle. The *beginning* letter of each sentence needs to correspond with the first letter of each river in the correct order of length. **Sentences must be numbered 1 to 10.** When measuring the river, start with the longest branch and follow it until it reaches the Pacific Ocean. This path will include parts of the Columbia and possibly other rivers.

Entries will be judged in two division: Grades 4-8 and Grades 9-12. The top three qualifying stories selected by the judges in each division will each receive a $100 Savings Bond. **Deadline for entry is March 1, 1996. Winners will be notified by May 1, 1996.**

Please send entries on standard notebook paper to:

Poster Contest - TEB/4
Bonneville Power Administration
P.O. Box 3621
Portland , Oregon 97208-3621

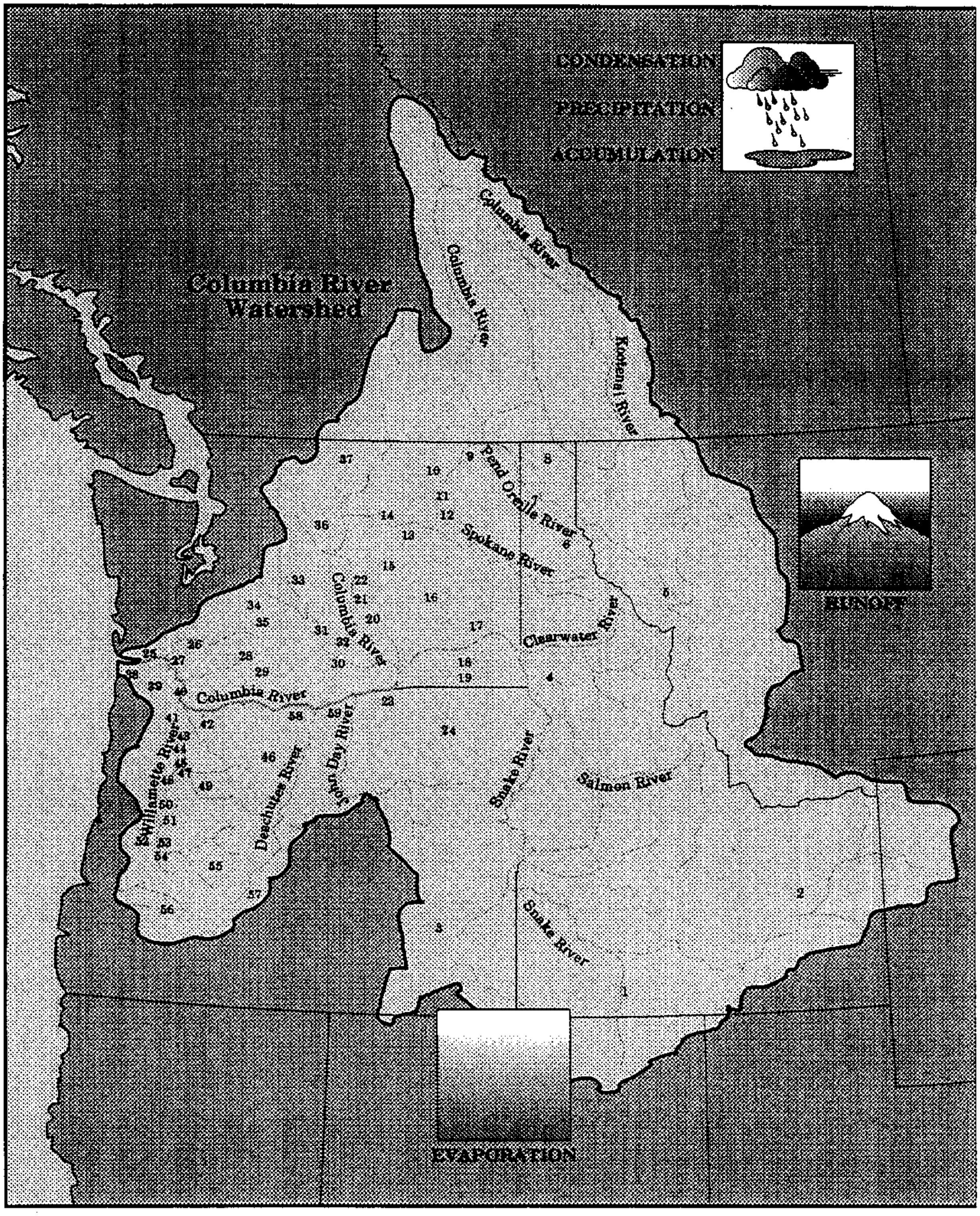


Prizes Provided by:

Pacific Power & Light Company
Tidewater Barge Lines

BONNEVILLE
POWER ADMINISTRATION

Learn the Columbia River Watershed



Contest:

List the 10 major rivers on the poster in order from longest to shortest in length measured from their begining to where they reach the Pacific Ocean. Use the first letter of each river in order to create a 10-sentence story about the water cycle. The begining letter of each sentence needs to correspond with the first letter of each river. Number your sentences.

First Prize:
Second Prize:
Third Prize:

BONNEVILLE POWER ADMINISTRATION

Historic Indian Tribes within the watershed Boundaries

1. Bannock
2. Shoshoni
3. Northern Paiute
4. Nez Perce
5. Flathead
6. Coeur d' Alene
7. Kalispel
8. Kutenai
9. Seniextee
10. Sinkaietk
11. Nespelem
12. Sanpoil
13. Sinkiuse
14. Methow
15. Chelan
16. Sinkiuse
17. Palouse
18. Wauyukma
19. Wallawalla
20. Wanapam
21. Wenatchie
22. Entiat
23. Umatilla
24. Cayuse
25. Chinook
26. Kwaihiqua
27. Wakiakum
28. Cowlitz
29. Klickitat
30. Yakima
31. Mical
32. Pshwanwapam
33. Snoqualmie
34. Nisqually
35. Taitnapam
36. Skyomish
37. Upper Skagit
38. Clatsop
39. Cathlamet
40. Clatskanie Skilloot
41. Multnomah
42. Clackamas
43. Clowwewalla
44. Alfalah
45. Ahantchuyuk
46. Nothern Molal
47. Yamel
48. Luckiamutte
49. Santiam
50. Chepenefa
51. Chelamela
52. Upper Umpqua
53. Calapooya
54. Yoncalla
55. Southern Molal
56. Coquille
57. Klamath
58. Wasco
59. Tenino