Lesson Seven
(Surface and Ground Water)

DISSOLVED OXYGEN
(D.O.)

Dissolved oxygen (DO) is the oxygen in the water that is used by fish and plants. In fresh waters you might find 12 ppm of DO. Cold waters (oligotrophic) hold more DO than warm waters (eutrophic). There should be lower levels in your ground water (est. 2 ppm – temperature dependent). DO oxidizes organic matter (like iron – rust).

$$Fe^{0} \text{ consumes } O_2 \rightarrow Fe^{+2}_{\text{solution}} \text{ or } Fe^{+3}_{\text{in solution (ppt)}}$$

The oxidation of the iron is surface rust.

It can roughly tell how closely the groundwater is connected to the surface. This is what causes staining in sinks, tubs, and toilets.

When comparing your groundwater studies to surface water bodies in the same watershed this parameter should be included.

VOCABULARY

Dissolved Oxygen- the amount of oxygen dissolved in a body of water as an indication of the degree of health of the water and its ability to support a balanced aquatic ecosystem; also, the amount of free (not chemically combined) oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation; abbr. *DO*

Oligotrophic- Lacking in plant nutrients and having a large amount of dissolved oxygen throughout. Used of a pond or lake.

Eutrophic- Having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the extinction of other organisms. Used of a lake or pond.

Turbidity- Having sediment or foreign particles stirred up or suspended; muddy: *turbid water*.

Oxidize- to dehydrogenate (take away a hydrogen or positive charge) especially by the action of oxygen

Boyant- the tendency of an object to float or rise when submerged in a fluid.

Convection- (a fluid being heated) the warmer part of the mass will rise and the cooler portions will sink

ACTIVITY #1

Glass beakers (cooking pans)

Thermometers

Heating sources:

- Bunsen burners
- stove tops (gas or electric)

hot plates
Teachers may wish to observe this effect first at home by putting tap water, 2 - 4 cm (0.8 - 1.6 in) deep, in a cooking pan or large frying pan. Use a low heat so that the water temperature rises about 10°C (18°F) every minute. Very small dissolved air bubbles will begin to form on the bottom at about 35°C (95°F), usually around the edge of the pan. They will gradually expand and then rise to the surface and pop. At about 90°C (194°F) water vapor bubbles will form but collapse before reaching the surface. After the water starts to boil, turn off the heat and let the water cool to room temperature. Reheat the water and observe the lack of dissolved air.

Try again the next day with the same water: no air bubbles should appear. Cool the water and with the pan covered, vigorously shake the water for about ten seconds. Reheat the water to see if air has been dissolved. Different heat sources will produce different bubble patterns depending on where the thermal energy is transferred.
This activity can be done individually at home by the students, with reports afterward, or in the classroom in small groups.

ACTIVITY #2
Bring a cooking pan from home or use a school beaker.
Pour tap water into your container to a depth of two to four centimeters (0.8 - 1.6 in).
(Alternative: Let two beakers of cold water sit overnight or a couple of days. Put an aquatic plant in one of the beakers. This plant's photosynthesis will add more oxygen to alter the initial condition of this beaker.)

Place your container over the heat source. (If using the alternative method, remove plant from beaker. Note which beaker had the plant in it. Heat both beakers side by side.) Activate your heat source at a low setting. Time the temperature change (if using a thermometer) to give about 10°C (18°F) increases each minute. Observe the air bubbles formed on the container bottom, noting size and distribution. Estimate the total number of bubbles formed (hundreds, thousands) and their approximate diameters in mm.

Just before boiling, about 90°C (194°F), notice the different bubbles being formed on the bottom. Do they rise to the surface as the air bubbles did? Continue heating the water until boiling occurs, then turn off the heat source. Cool the water to room temperature by placing the pan in a sink containing a few centimeters of water at room temperature or cooler.

Reheat the water and look for air bubbles. How are your observations similar to or different from your observations the first time you heated the water. (If using the alternate method with two beakers, put both side-by-side on a hot plate. Note any differences between the beaker with and the beaker without the plant.)
(Optional) If time permits, cool the water again to room temperature. After it is cool, place a cover over the pan and vigorously shake the water for about ten seconds. Reheat the water and again look for air bubbles.

EXPLANATION

Dissolved air in the water will expand on heating, forming bubbles at the bottom surface. When the buoyant force on a bubble overcomes surface tension, it will rise to the surface and pop. With time, convection currents in the water will cause all of the dissolved air to coalesce and form bubbles near the warm bottom and side surfaces.
The second set of bubbles that form near the boiling point are water vapor bubbles. These rise to the surface once their internal pressure exceeds atmospheric pressure. At higher elevations where atmospheric pressure is lower, boiling occurs at lower temperatures.

Activity #3
Supplies per group:

3 Glass Beakers	3 steel nails (8 or 10 penny)
Freezer	saran wrap
Heat source	

Each of the three beakers will be of different temperatures. One should be cold, one hot and one room temperature. Place one nail in each beaker. Cover the beakers with saran wrap. Allow all of the beakers to reach room temperature and observe which nail was oxidized the most (rust). The cold water should hold the most oxygen at the time the nail is placed in it and should produce more rust. The hot water should contain the least amount of oxygen and should produce the least amount of rust.

HOMEWORK

Investigate whether there is a connection between adding large amounts of heat to rivers and the loss of fish due to oxygen depletion.

1. What type of natural or human-caused processes could add significant amount of heat to rivers or seas?
2. Are there rules and regulations that limit the input of heat into rivers, streams, and oceans? Why or why not?
3. Should there be such limitations?

SOURCE
"Visit to an Ocean Planet" educational CD-ROM

Adapted from the San Juan Institute Activity Series, 1997.