The Education Program at the
NJ Marine Sciences Consortium/NJ Sea Grant
22 Magruder Road Fort Hancock, NJ 07732 732-872-1300 njmsc.org

OXYGEN IN WATER

OVERVIEW By sampling and testing a water sample, students will gain an understanding of dissolved oxygen and its importance to life in an aquatic ecosystem.

OBJECTIVES Following completion of this lesson, students will be able to:

- Use a test kit to determine the amount of dissolved oxygen in a water sample;
- Determine if the dissolved oxygen level is reflective of a healthy system;
- Develop an understanding of how oxygen enters and exits water.

GRADE LEVELS 4^{th} -12^{th} grades

NJCC STANDARDS

Science Indicators:
5.1: End of Grade 4: A2, B1, B2, End of Grade 8: A2, B2;
5.3: End of Grade 4: A1, A3, D1, End of Grade 12: B1;
5.4: B1; 5.5: End of Grade 2: B1, End of Grade 4: B1;
5.7: End of Grade 4: A2, B2, End of Grade 8: B2;
5.8: End of Grade 2: B1, End of Grade 6: B1;
5.10: End of Grade 2: A1, End of Grade 6: B1
Mathematics Indicators:
4.1: 6B1, 6C3; **4.2:** 2D1, 2D2, 2D3, 2E1, 4D2, 4D5, 4E2, 6D2, 6E1, 8A5, 8E1, 8E2, 8E3, 8E4, 12A4, 12D2; **4.3:** 12A3, 12D3;
4.4: 2A1, 4A1, 6A1, 12A5; **4.5A:** 1, 2, 3, 4, 5; **4.5B:** 1, 2, 3;
4.5C: 2, 3, 4, 6; **4.5D:** 2, 3, 5

MATERIALS LaMotte Winkler -Titration Oxygen in the Water test kit, thermometer, water sample, chemical waste receptacle.

PROCEDURES Obtain a water sample, ideally one that has just been pulled from the aquatic source under investigation. Follow the procedures as outlined below for the dissolved oxygen test kit:
Instructions for using: **LaMotte Winkler-Titration Test Kit**

I. Collecting the Sample:

1. Take the dissolved oxygen sample bottle and rinse it out a few times with the water you'll be sampling.
2. Fill the bottle by submerging underwater until it is completely full. Make sure no air is in the bottle, tap out any air bubbles. Cap the bottle tightly underwater.
3. Open the cap and add 8 drops of Manganous Sulfate Solution, followed by 8 drops of Alkaline Potassium Iodide Azide. Cap the bottle and very gently invert several times. A precipitate will form. Allow it to settle for two or three minutes.
4. Depending on the particular test kit used, you will either add a 1 gram spoonful of Sulfuric Acid Powder or 8 drops of a 1 M Sulfuric Acid Solution. The result is the same: The precipitate will dissolve and the sample will turn a yellow brown color. Your sample will be fixed.

Note: At this point you can stop--The sample will no longer react to oxygen in the atmosphere. This allows you to take and fix many samples that can later be tested

in the laboratory.

II. Testing the Sample:

1. Fill the titration tube (glass container with a line on it and cap with a hole in it) to the 20 ml line with the fixed sample. If it is already a faint yellow, skip to step three.
2. Fill the direct reading titrator (it resembles a syringe) with Sodium Thiosulfate; make sure there are no air bubbles. Insert the titration tube cap. Add the solution one drop at a time until the yellow-brown color becomes a very faint yellow.
3. When the yellow is very faint, remove the titrator and cap from the titration tube, being careful not to touch the plunger of the titrator. Add 8 drops of Starch Indicator Solution. The sample will turn blue.

Replace the cap with the titrator and continue adding the solution one drop at a time and swirling until the blue disappears. Read the scale on the titrator in parts per million (ppm) at the tip of the plunger, with each minor division equal to .2 ppm. If you run out of Sodium Thiosulfate, you can fill up the titrator again just remember to record the initial 10 ppm.

BACKGROUND

Oxygen is necessary to life for virtually every living creature on this planet. We think of oxygen as being in the air that surrounds us, but what about aquatic organisms like fish, how do they get oxygen?
Just like land-based organisms, aquatic organisms require oxygen for respiration. Aquatic organisms breathe dissolved oxygen (DO) available in water. They access DO by pumping water over their gills or other breathing apparatus, which allow microscopic molecules of DO to be transferred from the water into their blood. Dissolved oxygen is a molecule of oxygen (O_2) within water that cannot interact with the H_2O molecules that make up water. Oxygen can enter into the water by diffusion from the surrounding air and though water movement such as water tumbling over falls, rapids, and waves. More significantly, oxygen is released into water as a bi-product of photosynthesis. Green plants manufacture virtually all the oxygen we breathe. Phytoplankton in the oceans produces a total of three-fourths of the earth's oxygen supply.

Photosynthesis

In the presence of light and chlorophyll

Carbon dioxide + Water •• Oxygen + Sugar

(CO2) (H2O) (O2) (C6H12O6)

Dissolved oxygen levels can be affected in many different ways. Cold water can hold more oxygen than warm water, causing seasonal variations in oxygen levels. **Run-off** of pollution can discharge organic matter into the water that will consume oxygen. **Run-off** may also cause over fertilization from excess nutrients entering the water, which can lead to a high growth of algae. Excess algae smother other aquatic plants and when the plants and the algae die off or decompose, oxygen is consumed and not enough is produced to compensate for this loss. Too many respiring aquatic organisms or bacteria in an area also may lead to oxygen levels being depleted to dangerously low levels.
One of the best methods for determining the health in an aquatic ecosystem is by measuring for dissolved oxygen. Dissolved oxygen is measured in parts per million (ppm) and can range from 0-18 ppm. DO levels of 6-18 ppm will sustain a variety of aquatic life. When DO levels dip down to 4-5 ppm aquatic life becomes under

stress. If oxygen levels in a body of water dip lower than 3 parts per million, even the hardiest of aquatic organisms will die.

VOCABULARY

Photosynthesis - The process by which green plants convert carbon dioxide and water into needed chemical energy.

Run-off - The portion of water from rain or melted snow that flows over the land that ultimately reaches streams.

EXTENSIONS

Obtain a dissolved oxygen meter or readings from a meter and use the test kits to measure for accuracy.
Measure for other indicators of water quality such as pH, turbidity, nitrates or phosphates.

REFERENCES

Cliff Jacobson. 1991. Water, Water, Everywhere - Water Quality Factors Reference Unit. Hach Chemical Company.

Gayla Campbell and Steve Wildberger. 1992 The Monitor's Handbook. LaMotte Chemical Co.

www.ncsu.edu/sciencejunction/depot/experiments/water/lessons/do/dolesson1.html

http://wow.nrri.umn.edu/wow/under/parameters/oxygen.html

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