Water Sampling with Bayouside Classroom

Jennifer “Murt” Conover, Louisiana Universities Marine Consortium (LUMCON)

Focus/Overview

This lesson prepares students to monitor water quality by conducting Louisiana. To learn how you can participate regularly as a Bayouside Classroom teacher contact the Louisiana Universities Marine Consortium (www.lumcon.edu).

Learning Objective(s)

The learner will . . .

- Collect water samples to test 5 key parameters for determining water quality in an experimental setting.
- Use their data and other data to appraise the water quality in and around their communities.
- Learn how local environments are connected.

Louisiana Grade Level Expectation(s)

Grades 7-12	GLEs are listed on the next page for this lesson.

Materials List

Water quality sampling equipment kits.

- Thermometer (in degrees Celsius)
- pH probe
- Salinity Refractometer
- Dissolved Oxygen Test Kit (all liquid reagents are preferred)
- Color Coded Instruction Sheet (for use with LaMotte D.O. all liquid reagent test kits) – Blackline Master #?
- Transparency Tube (60 cm)
- Rinse Bottle (with deionized or distilled water)
- Waste Container

Safety Gear

- Latex gloves
- Goggles
- Sunscreen (optional)
- Insect repellent (optional)

Sampling Gear

- Clipboard or something hard for student to write on
- Data Sheet (blackline master)
- Pencil
- A 1 Gallon Bucket or Student Sampler
- Rope

Data Analysis Materials

- Completed student datasheets
- Calculators

BTNEP Connection
Water Quality.

Grade Level
7-12

Duration
2or 3 class periods.

Subject Area
Science.

Setting
Field Site and Classroom.

Extension Areas
Graphing.

Vocabulary
None

Original Source

www.lumcon.edu

5-8: GLE-2	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
5-8: GLE-3	Use a variety of sources to answer questions (SI-M-A1)
5-8: GLE-4	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
5-8: GLE-5	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
5-8: GLE-6	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
5-8: GLE-7	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
5-8: GLE-8	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
5-8: GLE-9	Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)
5-8: GLE-19	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
5-8: GLE-21	Distinguish between *observations* and *inferences* (SI-M-A7)
5-8: GLE-22	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
5-8: GLE-23	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
5-8: GLE-27	Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
5-8: GLE-29	Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3)
5-8: GLE-31	Recognize that there is an acceptable range of variation in collected data (SI-M-B3)
5-8: GLE-36	Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5)

9-12: GLE-3	Plan and record step-by-step procedures for a valid investigation, select equipment and materials, and identify variables and controls (SI-H-A2)
9-12: GLE-5	Utilize mathematics, organizational tools, and graphing skills to solve problems (SI-H-A3)
9-12: GLE-6	Use technology when appropriate to enhance laboratory investigations and presentations of findings (SI-H-A3)
9-12: GLE-10	Given a description of an experiment, identify appropriate safety measures (SI-H-A7
9-12: GLE-15	Analyze the conclusion from an investigation by using data to determine its validity (SI-H-B4)

8: GLE-20	Describe how humans' actions and natural processes have modified coastal regions in Louisiana and other locations (ESS-M-A8)
8: GLE-53	Distinguish among several examples of erosion (e.g., stream bank, topsoil, coastal) and describe common preventive measures (SE-M-A10)
9: GLE-1	Measure the physical properties of different forms of matter in metric system units (e.g., length, mass, volume, temperature) (PS-H-A1)
9:GLE-2 PHY SCI	Gather and organize data in charts, tables, and graphs (PS-H-A1)
9:GLE-23 PHY SCI	Classify unknowns as *acidic*, *basic*, or *neutral* using indicators (PS-H-D2)
11-12: GLE -19 ENV. SCI.	Determine the interrelationships of clean water, land, and air to the success of organisms in a given population (SE-H-C1)
11-12: GLE-20 ENV. SCI.	Relate environmental quality to quality of life (SE-H-C2)
11-12: GLE-15 ENV. SCI.	Analyze the risk-benefit ratio for selected environmental situations (SE-H-C4)

7: GLE-33	Analyze discrete and continuous data in real-life applications (D-2-M) (D-6-M)
10: GLE-17	Compare and contrast inductive and deductive reasoning approaches to justify conjectures and solve problems (G-4-H) (G-6-H)

Background Information

The term "water quality" refers to the chemical and physical properties of a given body of water. Environmental scientists are often concerned with the temperature, salinity, or presence of dissolved substances in natural waters because of their effect on animals and plants. These aspects of water quality are also of great importance to community leaders because of our reliance on water for drinking, food production (fisheries and farming), transportation, and industry. With such strong ties to the bayous, marshes, and Gulf of Mexico, water quality is a prime concern for our citizens. The following information can all be found on the LUMCON Bayouside Classroom website (www.lumcon.edu/bayousideclassroom) under the **"What is BC"** link. To get help with the sampling technique for each piece of equipment please review the Water Sampling Technique instructional videos provide by the Barataria-Terrebonne National Estuary Program and LUMCON.

Environmental monitoring is a type of observational science; we directly observe the conditions in the estuary without changing them. Scientists often conduct observational studies to describe the natural or man-made changes in a system over time. For example, if we are interested in how salinity in the estuary changes over time we might monitor salinity at several locations on a monthly basis. Observational studies can also be used to test how the estuary behaves after a catastrophic event such as a hurricane or oil spill. However, these types of studies are unpredictable, because no one knows when or where the next hurricane will hit.

Observational science stands in contrast to experimental science, in which the scientist deliberately alters the conditions (e.g. temperature) to determine how the system reacts. For example, if we are interested in the growth of oysters in various parts of the marsh we might hypothesize that oysters grow better in low salinity water. To test this hypothesis we might grow oysters in several tanks filled with water of varying salinity. We must be careful to make sure that each oyster gets the same amount of food and that other variables (such as temperature) do not affect our experiment. In order for our experiment to be meaningful we must compare our result to an undisturbed condition (a control treatment). For our oyster experiment we could grow half our oysters in water from the site where they were collected. As you can see, it would be very difficult to conduct experiments on an entire estuary so experiments are usually conducted on a smaller scale than observational studies.

Data collection is common to both observational and experimental studies. The scientist (the student) must record detailed measurements of interesting variables. To determine how the estuary changes in space and time, we must compare several measurements from different areas or time periods. During this field exercise you will be the scientist, collecting data to describe the conditions in the estuary.

When scientists conduct a study they must realize that the environment is constantly changing, and that measurements made on a given day or at a certain location may not apply to every day or every location. That is why we need to collect samples on different days and in different locations. This is known as ***replication***. Ideally, it is best to have several samples from a single site so that we can be sure that the data we report accounts for differences in conditions and errors caused by improper techniques. Proper replication is part of the reason that we have several groups collect samples at each sampling site.

Advance Preparation

- Review each parameter Blackline master to review content and procedure.
- Copy each of the parameter black line masters for each student or group of students.
- Visit the site you have chosen to collect samples without the students to check conditions, space availability, safety concerns, etc.
- Decide how many working groups you will have and how many stations to set up for the equipment introduction activity. Some suggested stations are listed below.
    1. Safety

2. Collecting water samples
3. Temperature
4. pH
5. Salinity
6. Dissolved Oxygen
7. Water Clarity
8. Field Notes/Observations

- Assign all students to a working group. If you have only one kit, it may be best to rotate student groups around parameter stations.
- If available, show instructional videos (website or CD).
- Calibrate equipment if necessary.
- Color code the reagent bottles if they have not already been done. See color coded instructions Blackline Master #?.
- Make sure all equipment is in working properly.
- Introduce students to the equipment and how to use it.
- Introduce units for each parameter.
- Explain the difference between observations and inferences.

Procedure

- Ask the students to tell you why they think water quality is important to them as individuals and to the state of Louisiana. Talk about what kind of water can be fond in Louisiana (e.g. freshwater, saltwater, brackish water).
- Discuss with them how humans use water, and what lives in the water.
- Discuss what water quality is and why we monitor water quality.
- Talk about the scientific method and how water quality data can collected using the scientific method.
- As a class, decide how many times to collect water samples. Talk about the advantages of collecting more than one sample and introduce the term replicate.
- Discuss or describe the site that you have selected and how it is connected to the local area. As a group talk about what the students know about the site (e.g. where does the water come from, is it connected to any other body of water, what events take place that may impact the water quality of the site, how do people use the water from the site).
- Have the student make predictions about the water quality on sampling day.
- Break the students up into their working groups and explain how the water sampling will be done at the site. Make sure to emphasis safety while at the site, the importance of teamwork, and expectations.
- Walk the students out to the site.
- Collect water samples and measure each parameter following the procedures as described in Blackline masters # 2-7
- Before leaving the site, make sure each group has completed the datasheet. See Blackline master #?
- In the classroom, have each group write the data they collected on the board or group recording sheet.
- Take a few minutes to look at all the data that has been collected and as a group discuss the data. Have students point out things that stand out, or about trends they see in the data. Talk about what could have caused one piece of data to be vastly different from the rest (e.g. human error, equipment problems, difference in where the water was collected, etc).
- Ask the students if the data supports what they had predicted for water quality before they went sampling.
- Discuss how the data may be different if had been collected during a different time of day.
- Have the students hypothesize about what the data will look like the next time they sample.
- Have students predict how each parameter is related and how if one parameter changes it affects others.

- Have the students do some basic math calculations using the data (e.g. mean, mode, median, etc).
- Have the students write a short summery explaining if their view or knowledge of site and water quality has changed since completing the sampling.

Blackline Master(s)

1. Safety
2. Parameter Information and Testing Procedure – Temperature
3. Parameter Information and Testing Procedure – Salinity
4. Parameter Information and Testing Procedure – Dissolved Oxygen
5. Parameter Information and Testing Procedure – pH
6. Parameter Information and Testing Procedure – Water Clarity
7. Observations and Field Notes
8. Datasheet
9. Water Quality Quiz
10. Water Quality Quiz Answer Key

Assessment(s)

- If you have chosen a site that most students are familiar with, have them write a short summery of what they know about the site before and again after sampling water quality. Compare the before and after summaries to assess if knowledge or impressions of the site has changed.
- Ask the students to write a short summery about their attitudes about science and the scientific process before and after sampling water quality. Compare to assess whether student attitudes have changes.
- Give the students the Water Quality Quiz (Blackline Master #?) to assess student knowledge.

Extension(s)

- Have students start to make graphs that can be displayed in the classroom. New data can be added after each sampling trip.
- Have the student predict relationships between parameters based on what they already know about the parameters. Then have students monitor the parameters over time. Use the data collected to test the student's predictions. Have them write a short summery tell report whether their predictions were rejected or supported by the data. Summaries should include why think their predictions rejected or supported.

Resource(s)

- Louisiana Universities Marine Consortium: Bayouside Classroom website www.lumcon.edu/bayousideclassroom

Blackline Master #1a

Safety

Field and lab safety are critical to conducting a successful scientific expedition, and we must always be on the lookout for potential hazards.

Field Safety

Before leaving for the field be sure to include a first aid kit in your field supplies, and know the location of the nearest medical facility. It is a good idea to keep a portable phone with you (if available) in case of emergency. If you will be using chemicals in the field, make sure you pack gloves and goggles to protect your skin and eyes.

Dress appropriately for the field. It is always a good idea to where long pants, long sleeved shirts, and boots or sneakers when going to the field. A broad brimmed hat will help with the sun. Use bug spray and sunscreen as needed.

Be aware of your surroundings at all times. Avoid areas that are spoiled with trash; broken glass, sharp metal, or other hazards that may be present. Also avoid thick brush or tall grass where biting insects or other biological hazards (e.g. poison ivy) are likely.

Whenever you are working near water, be mindful of slick surfaces or steep banks. Never run along the bank or on a dock! Floatation aids (e.g. life jackets) are a good idea. Also keep an eye out for dangerous animals. Alligators, snakes, crabs, and even oysters can cause serious injuries.

When planning to use chemicals in the field, be sure to bring an appropriate container for any waste that is created. All waste should be properly disposed of after returning from the field.

Lab Safety

Safety in the lab is just as important as in the field. Make sure your lab is equipped with a first aid kit and a source of running water for washing chemicals from skin or eyes. An eyewash bottle (or eyewash station) and safety shower are the best means of keeping safe around chemicals. Be sure you know the location of all safety equipment.

Never run in the lab!

Always wear goggles and gloves when handling chemicals.

If you don’t know what something is or how it works, ask before handling it.

Use caution and common sense whenever using chemicals, sharp instruments, or unfamiliar equipment.

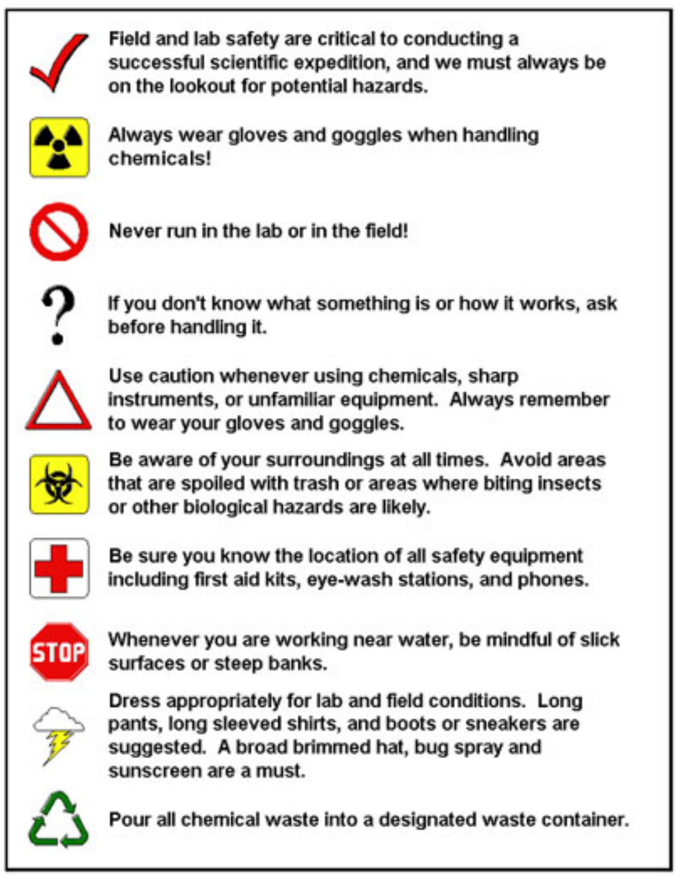
Blackline Master #1b

Chemical safety
Always wear gloves and goggles when handling chemicals!

Use extreme caution when pouring or measuring chemicals to avoid spills, and avoid using powdered chemicals under windy conditions (outside or near an open window).

Always pour all chemical waste into a designated waste container, even in the lab. Dispose of the waste properly according to manufacturers instructions and local laws.

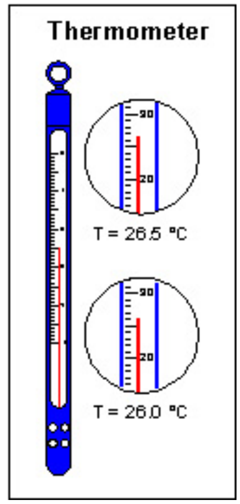
The chemicals used in the dissolved oxygen measurement are designed to be poured down the sink with lots of water. Remember, sinks are connected to sewage treatment facilities that can handle such chemicals in small quantities. Do not dump in storm drains and other sewers that dump directly into the bayou. Never put wastes into the storm drain.



Blackline Master #2

Temperature

Temperature is a measure of heat content of a sample; specifically it is a measurement of the kinetic energy of the molecules in the sample. The temperature of a given body of water is determined by the local climate (air temperature, solar radiation), by the volume of water, and by other processes that can add heat (e.g. industry) to the system.



Temperature influences a variety of biological and physical processes such as photosynthesis and respiration, the solubility of dissolved gases, and the sensitivity of aquatic organisms to disease, pathogens or parasites. Temperature dictates the life history of aquatic animals by controlling metabolic rates and reproductive timing. For example, many organisms are adapted to live within a certain range of temperatures. If the temperature varies outside of this range for prolonged periods, then certain organisms may not survive.

Use a simple glass thermometer to measure water temperature in the study area. The temperature of the sample will start to change as soon as it is collected, so make sure to measure and record the temperature reading as quickly as possible.

Procedure

- Once the sample is collected, immediately immerse the thermometer in the sample for 30-60 seconds. It is important not to let the thermometer touch the sides or the bottom of your bucket or sampler while you wait.

- Read the temperature directly from the thermometer (match the top of the red line to the nearest 0.5 degree C) while it is still in the water, this ensures that the temperature reading reflects the temperature of the sample site, not the air temperature. To obtain the most accurate reading possible, get as close to eye level as you can manage to read the thermometer. If you read the thermometer at an angle, the scale will look different; this is called parallax error.

- Recored the temperature in degrees C on the datasheet (Blackline Master #?).

- Thermometers do not need to be rinsed unless you are sampling in a saltwater area.

Note: Thermometers are fragile and should be handled gently. Because they can break, it is preferable to use thermometers filled with alcohol or kerosene (usually dyed red), rather than mercury (silver liquid metal), which is highly toxic.

Blackline Master #3a

Salinity

Salinity is the total of all the salts dissolved in the water, measured in parts per thousand (ppt). If a sample of water were divided evenly into 1,000 buckets, one of those buckets would be 1 ppt. So if one of our sites has a salinity of about 5 ppt, that means of the 1,000 buckets, 5 would be filled with salt, and the remainder would be water and other chemicals. Salinity will vary from place to place and from time to time. In an estuary freshwater from rain, runoff and ground water seepage combines with the salty water of the ocean brought in by tides, wind, and currents. Ocean salinity is approximately 35 ppt, while freshwater is 0 ppt.

The amount of salt dissolved in the water controls which types of organisms can live in the estuary, and also affects its ability to be used for drinking and industry. Salinity controls the types of plants and animals able to inhabit a given environment. Most animals and plants are adapted to either freshwater or saltwater. In an **estuary**, however, with a wide range of salinities plants and animals have special adaptations that allow them to survive in both low and high salinity water.

Natural and **anthropogenic** (man-made) factors can affect the salinity of water. Saltwater intrusion is the movement of salt water into a freshwater environment, such as our freshwater marshes. This intrusion may be the result of a natural process such as a storm surge from a hurricane. Man-made navigation channels or pipeline canals can result in saltwater intrusion because these canals provide straight, deep channels that allow salt water to move more freely into freshwater marshes than natural meandering channels. Irrigation runoff can raise also raise the salinity in fresh waterways, as can municipal and industrial effluents, sewage effluent and urban runoff.

You will be using a refractometer to measure salinity. A refractometer takes advantage of the fact that light bends as it passes through different materials. In water, the amount of bending (refraction) is related to how much salt is dissolved in the water. When using a refractometer, a sample is placed on an optical prism. As light shines through the sample, it is bent according to the salinity of the water, and casts a shadow on the scale that is visible through the eyepiece. Prior to using the refractometer it should be checked to make sure that it is reading properly. It should be calibrated if it is not. Follow the manufacturer’s instructions to calibrate your refractometer. If no calibration is necessary, you are ready to measure the salinity of your sample.

Procedure

- Using water from your collected sample, rinse disposable pipette by filling and emptying the pipette 3 to 4 times. Do not contaminate your sample by putting water back into the sample. All rinse water should be emptied on the ground.

- Next, rinse the optical prism (the blue oval) and the plastic flap on top of the refractometer using water from the sample 3 times.

Blackline Master #3b

- Once both the pipette and prism are rinsed three times each, fill the pipette with water from your sample one more time. Holding the refractometer place several drops of sample on the prism. Make sure the water does not run off the prism while you add the water. Keep adding drops until you have a large puddle of water covering the prism.

- Close the plastic flap over the puddle of water, removing all air bubbles.

- Hold refractometer upright in the direction of a strong light source (e.g. the sun) and look through the eyepiece. Never look directly into the sun!

- Turn the focus ring until the scale is clearly visible. There will be two scales, make sure that you read the scale on the right hand side of the circle. This scale will be 0-100 in whole numbers. Care should be used in reading the result as the lines on the scale are very small. The number 0-100 represent the salinity.

- Read salinity in parts per thousand (ppt, the scale on the right) where the horizon created by the blue section (top) and the white section (bottom) crosses the scale.

- Record the salinity measurement on the data sheet (blackline Master #?).

- Rinse the prism and the plastic flap with fresh water three times, and gently wipe sample window with soft tissue or lens paper.

Blackline Master #4a

Dissolved Oxygen

The following instructions and procedures are for the LaMotte dissolved oxygen all liquid reagent test kit. If you are using another type of dissolved oxygen test kit make sure to follow the manufactor's instructions for that kit.

Dissolved oxygen is oxygen gas (O2) that is dissolved in water. Oxygen enters the water from the air and through photosynthesis. It is an important parameter to measure because most aquatic plants and animals need oxygen in order to survive. Access to plentiful oxygen is usually not a factor on land where oxygen concentration in air does not change from about 21%. However, oxygen concentration in aquatic habitats varies in space and time. For example, cold water can hold more dissolved oxygen than warm water. Areas with plentiful plant life may have higher concentrations of oxygen because of photosynthesis. However, under some conditions too many plants can lead to low oxygen conditions, known as hypoxia, as the plants die and decompose.

The amount of oxygen dissolved in water depends on temperature, turbidity, photosynthetic rates and respiration rates. In general, as water temperature rises, dissolved oxygen levels decrease because high temperatures lower the saturation point of oxygen and increase respiration rates. Turbidity, or cloudiness of the water, reduces the amount of sunlight that aquatic plants receive, thus limiting the amount of oxygen produced by photosynthesis. Microbes and fungi use oxygen to decompose organic material, so waters with high organic loads can have low oxygen.

We will be using a technique called a **Winkler titration** to measure the concentration of dissolved oxygen in our study sites. The Winkler titration involves a series of chemical reactions, where the O_2 combines with iodine to form a golden yellow chemical. Each oxygen molecule in the sample becomes associated with one iodine molecule, therefore it is possible measure the oxygen indirectly by measuring the iodine. To measure the iodine it is neutralized it by adding sodium thiosulfate, this makes the golden color disappear. By measuring the amount of thiosulfate it took to remove color from the sample the amount of iodine (hence oxygen) was in the sample is determined. (Note: Some oxygen test kits use a starch indicator that turns the iodine solution from yellow to a deep blue color to make it easier to distinguish the color change.)

Many of the following methods and techniques are designed specifically to avoid contamination of our samples and chemicals. For example, rinsing the sample containers thoroughly before collecting a sample is critical to avoid contaminating the sample with residues from previous samples. Just as important is the proper handling of chemicals to ensure that the reagents don't become contaminated with sample water or with other reagents. This is important for two reasons. First, the methods used are based on having pure chemical reagents. If the reagents are contaminated, the data will not be useful and will not be reproducible by others. Second, reagents are expensive and should be preserved for future samples. It is possible to ruin a whole bottle of reagent with a single drop of contaminant.

Blackline Master #4b

Following these simple steps should eliminate the majority of contamination problems.

1) Open only one reagent at a time, and immediately recap the bottles with the same cap when done.
2) Never touch the tip of a dropper bottle or pipette to the sample or the sample container.
3) Rinse and dry sample containers thoroughly after each use.

Dissolved Oxygen: Sample Collection

Procedure

- To make sure that your sample bottle is clean, rinse the bottle 3 times using water from your collected water sample. There is no need to completely fill your bottle all three times to rinse it. A small amount of water is adequate as long as you make sure to rinse the entire inside of the bottle. Place all of the rinse water into the waste container as it may have chemicals in it from the last time the bottle was used.

- Fill and cap the glass sample bottle. The presence of air bubbles can add more oxygen to the sample; be very careful not to have any air bubbles in the sample bottle. If using an open top sampler, such as a bucket, hold the glass bottle underwater until all air is removed. Invert the cap underwater to remove the trapped air and then put the cap on the bottle while the bottle is still submerged, remove the bottle from the sample. To ensure that no air bubbles are trapped inside tighten the cap and turn the bottle upside down. If air bubbles are visible in the bottle while it is upside down, turn the bottle right side up and put it back in the water sample. Uncap the bottle while it is under water and repeat the capping procedure. Check for air bubbles again.

Make sure you are wearing gloves and safety goggles before proceeding.

Dissolved Oxygen: Important things to Remember
The following instructions and procedures are for the LaMotte dissolved oxygen all liquid reagent test kit. If you are using another type of dissolved oxygen test kit make sure to follow the manufacture's instructions for that kit.

There are a few things that are very important to remember when doing the titration. Listed below are the 6 most important things to remember. Please be sure to emphasis each one of these things when teaching students how to do the titrations.

- Always wear latex gloves and safety goggles while doing the titration.

Blackline Master #4c

- Never touch the tip of the reagent bottle to the water in the sample bottle. Contamination of the reagent will occur if the tip touches the water.

- Always hold the reagent bottle straight up and down. All the drops need to be the same size and the position of the reagent bottle will have an impact on drop size.

- Recap all bottles and waste container after every use. **Make sure that the right cap goes on the right bottle otherwise contamination will occur.**

- Never work with chemicals over your legs, or near anyone else.

- Treat any area, even outside, as a lab when chemicals are being used. All lab safety procedures should be followed while chemicals are being used.

Reminder: Never touch the reagent bottle to the water. Make sure the reagent bottle is straight up and down when adding reagent to the sample.

Dissolved Oxygen: Fixing the Sample

Procedure

- Carefully add 8 drops of the Manganous Sulfate Solution (green).

- Similarly, add 8 drops of Alkaline Potassium Iodide Azide (blue).

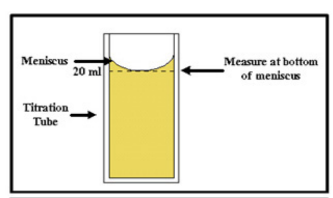
- Recap the bottle and mix the contents by tipping the bottle over and back several times with a "rocker shake". A pale precipitate will form.

- Allow the precipitate to settle to below the shoulder of the bottle, about one-third to one-half way to the bottom of the bottle.

- Once the precipitate has settled, carefully open the bottle and add Sulfuric Acid (red) to dissolve the precipitate. Once again, make sure the bottle is straight up and down and not touching the water.

- Recap the bottle and gently mix the contents by inverting the bottle several times like we did before. At this point all of the precipitate should dissolve, and if oxygen is present the solution will turn golden yellow. The sample is now fixed and ready to be analyzed.

Dissolved Oxygen: Analysis of the sample



Proper Technique for reading a meniscus

Procedure

- Open the sample bottle and fill the titration tube (glass tube) to the 20 ml line. Water in the tube will form a *meniscus*; a concave curved surface that is higher around the edges and lower in the center. The tube should be filled so that the bottom of the meniscus is level with the 20ml graduation line.

- Cap the tube and set aside.

- Fill the titrator. Making sure the plunger on the titrator is completely depressed, insert the titrator into the bottle of Sodium Thiosulfate (yellow). Invert the bottle

  and titrator, and slowly withdraw the plunger until the indicator on the plunger is on the zero mark. If air bubbles are present in the titrator, completely depress the plunger and refill the titrator. Once the titrator is full and free of air bubbles, turn the bottle upright and remove the titrator.

- Insert the tip of the Titrator into the cap on the titration tube. Slowly depress the plunger, adding Thiosulfate to the sample one drop at a time. Be sure to swirl the tube in between adding drops of Thiosulfate. Do not shake the tube, you want to mix the sample and the Thiosulfate without getting water on the cap.

- Continue adding Thiosulfate until the solution turns pale yellow.

- Remove the titrator and set aside without moving the plunger. Use of the titrator will continue later.

- Uncap the tube. Add 8 drops of Starch Indicator (black). The solution should turn a dark blue color which aids in seeing the color change. Swirl the tube to make the entire sample dark blue.

- Recap the tube and replace the titrator. Add thiosulfate one drop at a time until the solution turns from blue to colorless. Again, be sure to swirl the tube between drops. If the Thiosulfate is depleted, refill the titrator completely and continue adding drops and swirling until the sample is clear.

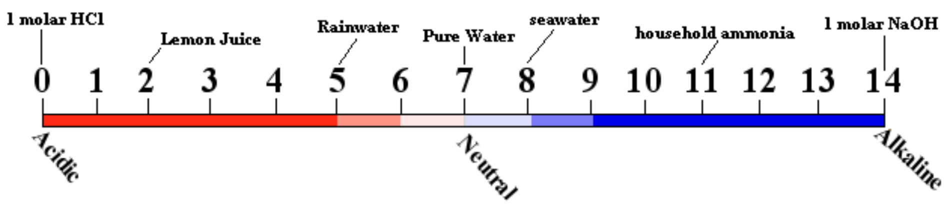
- Now read the scale on the titrator. Each line represents 0.2 mg/L. If you had to refill the titrator, remember to add 10 mg/L to your final result.

- Record the total amount of Thiosulfate that was used in mg/L. The amount of Thiosulfate used is **directly** related to the total dissolved oxygen in the sample.

Blackline Master #5a

pH

pH is a measure of the concentration of hydrogen ions in a solution. Measured on a scale from 0 to 14, pH varies due to variables including temperature, dissolved gases, and pollution. Marine scientists use pH as an indicator of water quality. The marine biologist is interested in pH and its changes, since they may reflect biological activity and changes in natural chemistry of waters, as well as pollution. Most marine organisms can tolerate only a narrow range of pH and depend on the natural buffering system of saltwater to maintain pH readings between 7.5 and 8.4. As a pH reading gets closer to 0, the hydrogen ion concentration $[H^+]$ gets higher, the hydroxide ion $[OH^-]$ concentration goes down and the solution becomes more **acidic**. As a pH reading gets closer to 14, the hydrogen ion concentration $[H^+]$ goes down while the hydroxide ion $[OH^-]$ concentration goes up and causes the solution to become more **basic (alkaline)**. A pH reading of 7 means the $[H^+]$ concentration and the $[OH^-]$ concentration are equal and the solution is considered to be neutral, being neither acidic nor basic.



Most living organisms can tolerate only slight pH fluctuations near the neutral region of the pH scale. Under open ocean conditions an effective pH buffering system limits seawater pH values to a narrow range between 7.5 and 8.4. However, dissolved gases such as CO_2, H_2S, and NH_3 can also have a significant effect.

When recording data it is important to also record the units the parameter was measured in so there is no doubt about the measurement. pH has no units so no units are recorded.

Note: Handheld portable probes makes measuring pH in the field easy and accurate. pH probes should be calibrated regularly. Read all of the manufacturer's instructions about how often and instructions to calibrate your pH probe. After the probe is calibrated it is ready to take pH measurements.

Procedure

- Simply turn the probe on by pressing the 'On/Off' button once and wait for 'PH' to clear from the display.
- Take the protective cap off of the electrode end of the probe and place into the sample and stir **gently** for a few seconds.

Blackline Master #5b

- Give the probe time to settle on one reading; this may take a few minutes, but usually occurs quickly. Probes that take longer may need to be recalibrated. Read the pH measurement while the probe is still in the water, do not take it out of the water to read it.

- Record the pH measurement on the data sheet (Blackline Master #?)

- When the sampling procedure is over, rinse the electrode area of the probe with clean water and replace the cap. Make sure to turn off the probe before packing it away to preserve battery life.

Blackline Master #6a

Water Clarity

Water clarity measures the clearness or the transparency of water. The transparency of water will indicate how far light is able to travel through the water column. Transparency can be used as an indicator the turbidity of a body of water. Turbidity is the cloudy appearance of water caused by suspended particles in the water. Suspended particles include things like sediment, minerals, microorganisms, and chemicals. Keep in mind that transparency and turbidity are very different water quality parameters and should not be used as interchangeable terms.

Measuring the transparency of a body of water will indicate the depth of the **photic zone**; the zone of water that is exposed to enough sunlight to support photosynthesis, on a given day. The depth of the photic zone varies with the turbidity of the water. In highly turbid lakes the photic zone can be as little as 1-2 centimeters, while in the open ocean it can extend to 200 meters.

Scientists are concerned with water clarity because high turbidity can cause problems. The suspended solids in a water body can absorb heat and cause dissolved oxygen levels to drop. It also lowers dissolved oxygen levels by decreasing the amount of photosynthesis by aquatic plants and algae by limiting the sunlight available. Lower levels of photosynthesis will lower the amount of dissolved oxygen required by cellar respiration. High levels of suspended solids can also have devastating affects on other aquatic life. Large amounts of suspended material can settle out of the water column destroying habitat for macroinvertebates, fish eggs, and fish fry. High turbidity can cause problems by choking filter feeders, clogging the gills of aquatic animals, and reducing their ability to feed and fight infections. Humans are also susceptible to hazards presented by high turbidity. Suspended material can make it easier for viruses, bacteria, and protozoa to survive chemical disinfection of water treatment.

Measure water clarity by using a transparency tube. A transparency tube is a clear tube with a Secchi disk pattern located on the bottom and a centimeter scale on the side. The tube should also have a drainage hose and a clamp on the bottom. Make sure that the clamp is functioning properly and that the tube does not leak before going to the field.

Procedure:

- With a bucket tied to a rope or student sampler collect a water sample. It is important to use a **new** sample of water for measuring water clarity since suspended solids will fall out of suspension rather quickly.

- Rinse your bucket three times with water from the site. Make sure not to stir up the water so more suspended material is in the water. To avoid this, collect your rinse water away and downstream of where you intend to collect your sample. Always pour the water out of the bucket away from the edge of the water body.

Blackline Master #6b

- Collect the water sample.

- Making sure that the hose is clamped shut; pour 10 cm of water in the tube. With one hand over the opening and the other on the bottom, rock the tube back and forth to rinse the tube. Do this at least 3 times.

- Make sure the clamp is still pinched tight. With the rest of the collected sample, fill the tube completely to the top.

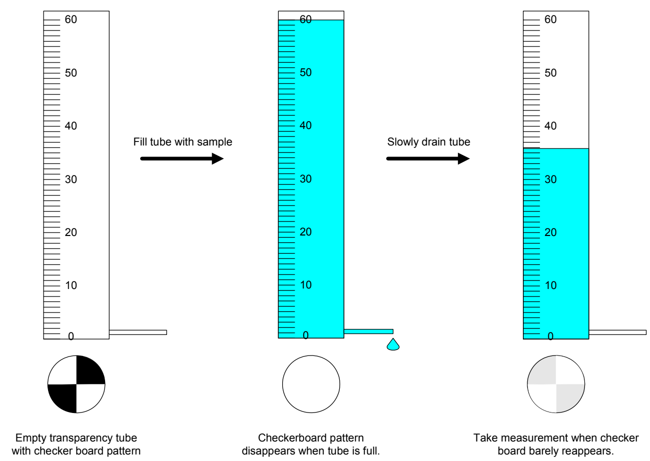
- Turn your body away from the sun so that the only thing that is shading the tube is your body.

- Take of sunglasses if you are wearing them.

- Look down the center of the tube.

- If the black and white pattern of the Secchi disk is visible, the clarity measurement is +60 cm.

- If you can not see the Secchi disk, start to slowly drain water from the tube through the hose. You can use the clamp to slow the rate at which water is drained. Drain the water out of the tube until the difference between the black triangles and the while triangles of the Secchi disk is just barely visible.



- Stop draining the water.

- Using the centimeter scale on the side of the tube measure how much water is left in the tube.

- Record the clarity reading on the data sheet in centimeters (Blackline Master #?)

Blackline Master #7a

Field Notes

Field notes are observations made while collecting samples. These should include information about the weather, since weather plays a big role in what kind of water quality data that is collected on a given day. The notes should also include observations about things going on in the environment. For instance, make notes about plants and animals in the area, or if there are grass clippings in the water.

Most people have a hard time thinking about field notes as being data, but these notes are data. In fact, without these data others would have a have hard time interpreting data. Good field notes are essential for people who intend to use the data years from when it was collected. When taking field notes it is important for people to know the difference between observations and inferences.

- Observations are facts about what you see, touch, smell, and hear.
- Inferences, on the other hand, are interpretations based on our knowledge, past experiences, or opinions.

Below are examples of observations and inferences.
Observations:

- The sky is blue.
- The water is high.
- The marsh smells like sulfur.

Inferences:

- The sky is blue and all white things in the sky are clouds.
- The water is high, tide is high.
- No birds are present, the water quality is bad.

The field notes should also include any notes about problems with the equipment and procedure. Be sure to make a note of anything that could have an impact on the reported data. Mistakes in sample procedure should be corrected by starting the procedure over if time permits. Students should report the errors and if they were able to start over or if they continued with the procedure.

If the same problem persists even after following procedure there is probably something wrong with the equipment. It could be that the equipment needs to be recalibrated. Try recalibrating (according to manufacturer instructions) to see if that solves the problem. Problems with the dissolved oxygen test could indicate contamination of the reagents.

Blackline Master #8

Water Quality Data Sheet

Group Members: ______________________ ______________________

______________________ ______________________

______________________ ______________________

Location: ____

Date: ______________________ Time: ______________________

Temperature: ____________________

pH: ____________________

Salinity: ____________________

Dissolved Oxygen: ____________________

Water Clarity: ____________________

Field Notes/Observations

Blackline Master #9

Water Quality Quiz

1. Why do we care about water quality?

2. Indentify 3 ways we avoid contamination during water sampling?

3. When is it most important to wear gloves and goggles during water sampling?

4. Which of the 5 parameters most affects the biological and chemical processes of organisms that live in water?

5. Describe the proper technique for adding chemicals to the sample bottle during the dissolved oxygen test?

6. In the space below, draw the pH scale. Include on the scale the range for acids, and bases, and where neutral are located.

7. What property of water does a refactometer use to measure the salinity of a water sample?

8. How is observational science different from experimental science?

Blackline Master #10

Water Quality Quiz Teacher Key

1. Why do we care about water quality? **Water quality affects plants and animals that live in the water. Humans depend on water for drinking, food production, transportation and, industry.**

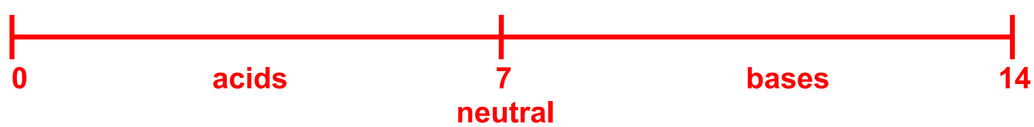
2. Indentify 3 ways we avoid contamination during water sampling?
   - **Never put any thing back into a bottle or sample once it has been taken out.**
   - **Never allow the tip of a reagent bottle to touch the water sample.**
   - **Never fill the titrator with anything but thiosulfate,**
   - **Always make sure the right cap goes on the right bottle.**
   - **Always rinse the bucket, pipette, or bottle 3 times before collecting a sample.**
   - **Rinse containers well are every use.**

3. When is it most important to wear gloves and goggles during water sampling? **When working with chemicals.**

4. Which of the 5 parameters most affects the biological and chemical processes of organisms that live in water? **Temperature**

5. Describe the proper technique for adding chemicals to the sample bottle during the dissolved oxygen test? **With the chemical (reagent) bottle straight up and down and never letting the tip touch the water.**

6. In the space below, draw the pH scale. Include on the scale the range for acids, and bases, and where neutral are located.



7. What property of water does a refactometer use to measure the salinity of a water sample? **How water bends light as it travels through water or refraction**

8. How is observational science different from experimental science? **In observational science we observe conditions without changing any of them. In experimental science we deliberately change conditions to see how other processes change.**