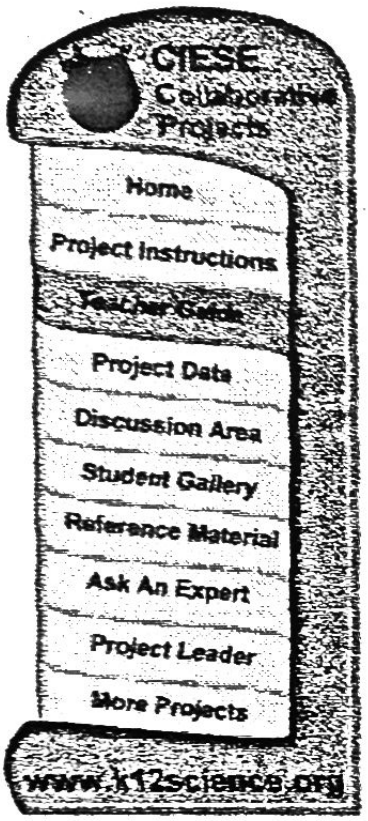

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An Investigation of Water Quality

Dissolved Oxygen

When doing any water sampling test, it is important to record certain

Background Information

Dissolved oxygen (DO) is essential to healthy streams and lakes. The dissolved oxygen level can be an indication of how polluted the water is and how well the water can support aquatic plant and animal life. Generally, a higher dissolved oxygen level indicates better water quality. If dissolved oxygen levels are too low, some fish and other organisms may not be able to survive. Much of the dissolved oxygen in water comes from oxygen in the air that has dissolved in the water. Some of the dissolved oxygen in the water is a result of photosynthesis of aquatic plants. On sunny days, high DO levels occur in areas of dense algae or plants due to photosynthesis. Stream turbulence may also increase DO levels because air is trapped under rapidly moving water and the oxygen from the air will dissolve in the water.

Water temperature also affects DO levels. Colder water can hold more oxygen in it than warmer water. A difference in DO levels may be seen at the test site if tested early in the morning when the water is cool and then later in the afternoon on a sunny day when the water temperature has risen. A difference in DO levels may be seen between winter water temperatures and summer water temperatures. Similarly, a difference in DO levels may be apparent at different depths of the water if there is a significant change in water temperature.

Species such as sludge worms, blackfly larvae, and leeches are more tolerant of low dissolved oxygen levels so those species are more likely to be found in warm waters. Species that need high levels of dissolved oxygen include pike, trout, bass, salmon, mayfly nymphs, stonefly nymphs, and caddisfly larvae so those will be more likely found in colder waters.

Low DO levels may be found in areas where organic material (dead plant and animal matter) is decaying. Bacteria require oxygen to decompose organic waste, thus, deplete the water of oxygen. Areas near sewage discharges sometimes have low DO levels due to this effect. DO levels will also be low in warm, slow

moving waters.

Dissolved oxygen levels are often measured in parts per million (ppm) but sometimes are given in terms of Percent Saturation. Percent Saturation is the amount of oxygen dissolved in the water sample compared to the maximum amount that could be present at the same temperature. For example, water is said to be 100 % saturated if contains maximum amount of oxygen at that temperature. A water sample that is 50 % saturated only has half the amount of oxygen that it could potentially hold at that temperature. For this project, results will be reported in ppm but if you wish to determine the Percent Saturation, you can use this DO Percent Saturation chart. Sometimes water can become supersaturated with oxygen because of rapidly tumbling water. This usually lasts for a short period of time but can be harmful to fish and other aquatic organisms.

Test Procedure

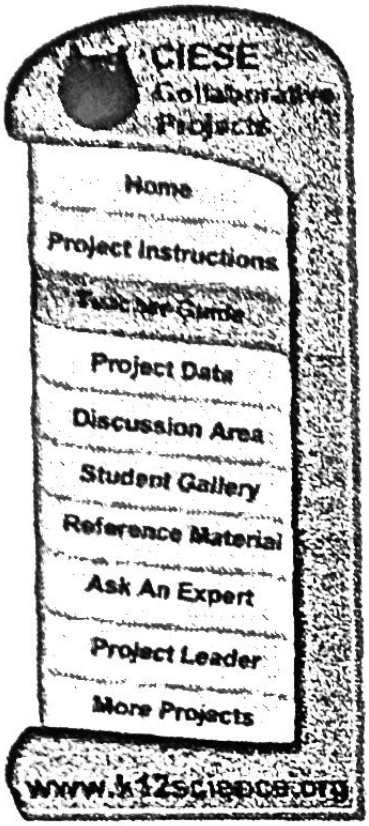
To perform the dissolved oxygen test, use a dissolved oxygen test kit. Follow the instructions provided with the kit. Record results in parts per million (ppm). Some important points to remember are:

- Try to sample the water away from the bank and below the water surface level.
- Be careful not to get any air bubbles in the sample during collection; it may result in a false high reading.
- Allow the water to gently fill the DO sample bottle from bottom to top. Put a lid on the bottle while it is under water.
- Test the DO level immediately. Biological activity in the sample and exposure to air can quickly change the DO level.
- Repeat the DO test three times.

What to Expect

At 20 °C (room temperature) and standard atmospheric pressure (sea level), the maximum amount of oxygen that can dissolve in fresh water is 9 ppm. If the water temperature is below 20 °C, there may be more oxygen dissolved in the sample. Generally a dissolved oxygen level of 9-10 ppm is considered very good. At levels of 4 ppm or less, some fish and macroinvertebrate populations (e.g. bass, trout, salmon, mayfly nymphs, stonefly nymphs, caddisfly larvae) will begin to decline. Other organisms are more capable of surviving in water with low dissolved oxygen levels (i.e sludge worms, leeches).

DO Percent Saturation values of 80-120 % are considered to be excellent and values less than 60% or over 125% are considered to be poor.



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Temperature

Background Information

It is important to know the temperature of the water at the test site. The water temperature has a direct influence on other water quality factors such as dissolved oxygen (DO) and biological oxygen demand (BOD), as well as on the survival of some aquatic species. Knowing the water temperature at the test site could help predict and/or confirm other conditions of the water.

The amount of oxygen that can dissolve in water (DO) depends on temperature. Colder water will have a higher DO level than warmer water. A difference in DO levels at the test site may be detected if tested early in the morning when the water is cool and then later in the afternoon on a sunny day when the water temperature has risen. A difference in DO levels may also be seen between winter water temperatures and summer water temperatures. Similarly a difference in DO levels may be seen at different depths of the water if there is a significant change in water temperature.

Also, warmer water usually will have a higher BOD level than colder water. As water temperature increases, the rate of photosynthesis by algae and other plant life in the water also increases. When this happens, plants grow faster and also die faster. When the plants die, they fall to the bottom where they are decomposed by bacteria. The bacteria require oxygen for this process so the demand for oxygen (BOD) is high at this location. Therefore, increased water temperatures will speed up bacterial decomposition and result in higher BOD levels.

Temperature also influences the survival of aquatic organisms. The metabolic rates of aquatic organisms increases in warm water. Since metabolism requires oxygen, some species may not survive if there is not enough oxygen in the water to meet their needs. Also, water temperature may affect the reproductive rates of some aquatic species; some species may not be able to reproduce in warmer waters. Since bacteria and other disease causing organisms grow faster in warm water, the susceptibility of aquatic organisms to disease in warm water increases as well.

Sudden increases in temperature may be a result of thermal pollution which is the discharge of large amounts of warm water from industrial plants. Sudden changes in water temperature may cause thermal shock in some aquatic species and result in the death of that species. Thermal pollution, even if gradual, may disrupt the ecosystem balance in such a way to eliminate heat intolerant species from that area.

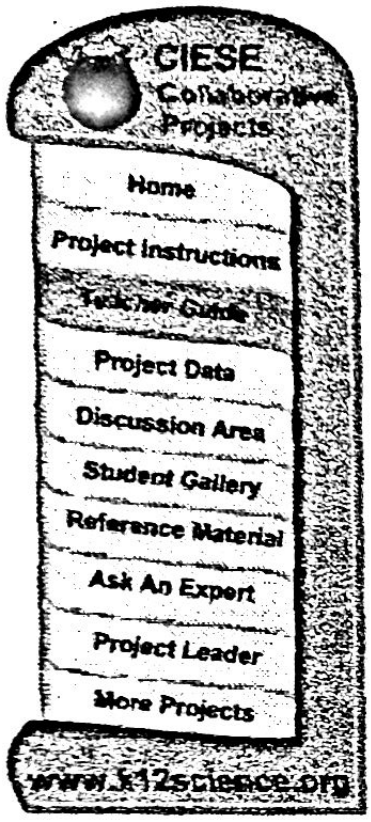
Test Procedure

If possible, measure the water temperature at the same level that the sample for the dissolved oxygen test is taken. That way, a correlation may be made between DO level and temperature (especially if you do more than one test). In any case, make sure the tip of the thermometer is at least a few inches below the surface of the water and take a reading when the temperature has stabilized (usually after a couple of minutes). Record the temperature in degrees Celsius (C). If the temperature is measured in degrees Fahrenheit (F), use a unit conversion calculator to convert to Celsius.

What to Expect

In colder water, the DO levels should be higher since oxygen can dissolve in colder water more easily than in warmer water. If the DO levels are high, the water will be able to support aquatic life (fish and plants) more readily.

In warmer waters, the DO levels may go down and the BOD levels may go up because of the increased decomposition of plant matter (see above). The metabolic rate of some organisms may increase to a point at which it is impossible for them to survive.



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Nitrates

Background Information

Nitrogen is an element needed by all living plants and animals to build protein. In aquatic ecosystems, nitrogen is present in many forms. It can combine with oxygen to form a compound called nitrate. Nitrates may come from fertilizers, sewage, and industrial waste. They can cause eutrophication of lakes or ponds. Eutrophication occurs when nutrients (such as nitrates and phosphates) are added to a body of water. These nutrients usually come from runoff from farmlands and lawns, sewage, detergents, animal wastes, and leaking septic systems. High levels of nutrients in a body of water may cause plant life and algae to flourish. As the plants grow, they can choke out other organisms. Algae blooms may eventually cover the water's surface. These large plant populations produce oxygen in the upper layers of the water but when the plants die and fall to the bottom, they are decomposed by bacteria which use a lot of the dissolved oxygen in the lower layers. Bodies of water with high levels of nitrates usually have high BOD levels due to the bacteria consuming the organic plant waste and subsequent low DO levels.

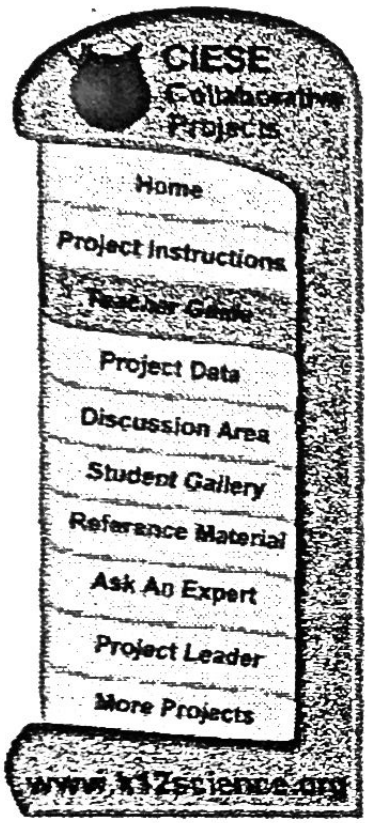
Test Procedure

Perform the nitrate test using a nitrate-nitrogen test kit. Follow the instructions provided with the kit. Concentrations of nitrates are usually expressed as nitrate-nitrogen (NO_3-N) and not as nitrate (NO_3). For this project, nitrate measurements should be reported as nitrate-nitrogen (ppm).

What to expect:

The following table shows what levels of nitrates are considered unpolluted or polluted, based on how many parts per million (PPM)of phosphates are found in a water sample.

POLLUTION LEVELS	Nitrates
1. Excellent (not polluted):	Test result = 0 ppm
2. Good (not polluted):	Test result = 5 ppm
3. Fair/Mildly Polluted:	Test result = 20 ppm
4. Moderately Polluted:	Test result = 30 ppm (between 20 and 40 on card)
5. Severely Polluted:	Test result = 40 ppm



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Phosphates

Background Information

Phosphorus is usually present in natural waters as phosphate. Phosphates are present in fertilizers and laundry detergents and can enter the water from agricultural runoff, industrial waste, and sewage discharge. Phosphates, like nitrates, are plant nutrients. When too much phosphate enters a water, plant growth flourishes. Phosphates also stimulate the growth of algae which can result in an algae bloom. Algae blooms are easily recognized as layers of green slime, and can eventually cover the water's surface. As the plants and algae grow, they choke out other organisms. These large plant populations produce oxygen in the upper layers of the water but when the plants die and fall to the bottom, they are decomposed by bacteria which use a lot of the dissolved oxygen in the lower layers. Bodies of water with high levels of phosphates usually have high BOD levels due to the bacteria consuming the organic plant waste and subsequent low DO levels.

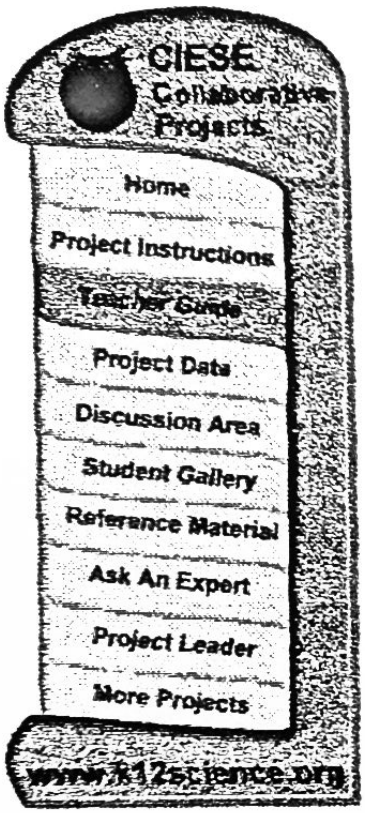
Test Procedure

Test for phosphates by using a phosphate test kit. Follow the instructions provided with the kit. It is important that the vials or test tubes used in the test be extremely clean. Preferably they should be rinsed with distilled or demineralized water prior to the test. Record your results for the phosphate test in ppm.

What to expect:

The following table shows what levels of phosphates are considered unpolluted or polluted, based on how many parts per million (PPM) of phosphates are found in a water sample

POLLUTION LEVELS	Phosphates
1. Excellent (not polluted):	Test result = 0 ppm
2. Good (not polluted):	Test result = 1 ppm
3. Fair/Mildly Polluted:	Test result = 2 ppm
4. Moderately Polluted:	Test result = 3 ppm (between 2 and 4 on card)
5. Severely Polluted:	Test result = 4 ppm



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pH

Background Information

pH measures the relative acidity of the water. A pH level of 7.0 is considered neutral. Pure water has a pH of 7.0. Water with a pH level less than 7.0 is considered to be acidic. The lower the pH, the more acidic the water. Water with a pH greater than 7.0 is considered to be basic or alkaline. The greater the pH, the greater its alkalinity. In the US, the pH of natural water is usually between 6.5 and 8.5. Fresh water sources with a pH below 5 or above 9.5 may not be able to sustain plant or animal species.

Industries and motor vehicles emit nitrogen oxides and sulfur oxides into the environment. When these emissions combine with water vapor in the atmosphere, they form acids. These acids accumulate in the clouds and fall to earth as acid rain or acid snow. Acid rain damages trees, crops, and buildings. It can make lakes and rivers so acidic that fish and other aquatic organisms cannot survive.

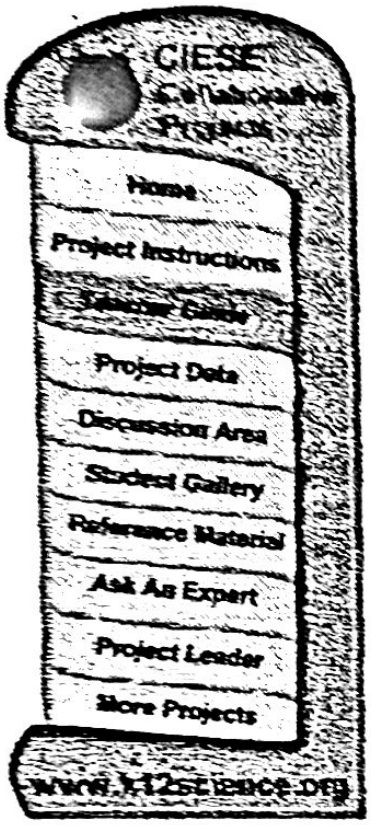
Test Procedure

To perform the pH test, use a pH test kit or pH paper. Follow the instructions provided with the kit. pH must be measured immediately at the test site because changes in temperature affect pH value. Try to take the water sample at a location away from the bank and below the water surface. pH is recorded with a number value only, there are no units associated with the pH value.

What to expect:

The following table shows what levels of pH are considered unpolluted or polluted. Remember, a pH or 7.0 is neutral, which is neither acidic nor basic; pH's less than 7.0 indicate acidic water, and pH's more than 7.0 indicate basic or alkaline water.

POLLUTION LEVELS	pH
1. Excellent (not polluted):	Test result = 7
2. Good (not polluted):	Test result = 6 or 8
3. Fair/Mildly Polluted:	Test result = 5 or 9
4. Moderately Polluted:	Test result = 4 or 10
5. Severely Polluted:	Test result = 11



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Turbidity

Background Information

Turbidity refers to how clear or how cloudy the water is. Clear water has a low turbidity level and cloudy or muddy water has a high turbidity level. High levels of turbidity can be caused by suspended particles in the water such as soil, sediments, sewage, and plankton. Soil can get in the water by erosion or runoff from nearby lands. Sediments can be stirred up by too much activity in the water, either by fish or humans. Sewage is a result of waste discharge and high levels of plankton may be due to excessive nutrients in the water.

If the turbidity of the water is high, there will be many suspended particles in it. These solid particles will block sunlight and prevent aquatic plants from getting the sunlight they need for photosynthesis. The plants will produce less oxygen thereby decreasing the DO levels. The plants will die more easily and be decomposed by bacteria in the water, which will reduce the DO levels even further.

Suspended particles in the water also absorb additional heat from sunlight which will result in warmer water. Warm water is not able to hold as much oxygen as cold water so DO levels will decrease, especially near the surface.

Suspended particles are also destructive to many aquatic organisms. They can clog the gills of fish and interfere with their ability to find food. They can also bury bottom dwelling creatures and eggs. Suspended particles can transport pollutants through the water.

Test Procedure

There are several ways to measure turbidity. One way is with a Secchi disk which is slowly lowered into the water until it is no longer visible, then raised until just visible, and lowered to just no longer visible. The depth at which the Secchi disk is no longer visible the second time is recorded in meters. A Secchi disk is usually more appropriate for deep waters of lakes, ponds, and rivers.

For shallow waters, a turbidity test kit that has a image at the bottom of a clear tube can be used. This is the recommend method for this project. Sample water that is collected can be added to the tubes to determine the turbidity level. The turbidity level is measured in Jackson Turbidity Units (JTU). This method does not require students to go out into deeper water.

If using a meter to measure turbidity, the meter will most likely report in NTUs, (Nephelometric Turbidity Unit). NTU and FNU (Formazin Nephelometric Unit) are the USEPA-designated units of turbidimetric measurement. They are based on use of a detector (meter) placed at 90° from the incident beam to detect scattered light, and are interchangeable units.

A clear mountain stream might have a turbidity of around 1 NTU, whereas a large river like the Mississippi might have a dry-weather turbidity of around 10 NTUs. These values can jump into hundreds of NTUs during runoff events. Therefore, the turbidity meter to be used should be reliable over the range in which you will be working.

So, if using a Secchi disk for this testing parameter, please submit the results using units of meters. If using a turbidity test kit, submit the results in JTUs, and if using a meter, please report results in NTUs.

Unfortunately, there is not easy way to convert these units.

What to expect:

The following table shows what levels of turbidity are considered unpolluted or polluted, based on how many JTU's are found in a water sample.

POLLUTION LEVELS	Turbidity
1. Excellent (not polluted):	Test result = 0-20 JTU's
2. Good (not polluted):	Test result = 40 JTU's
3. Fair/Mildly Polluted:	Test result = 60 JTU's
4. Moderately Polluted:	Test result = 80 JTU's
5. Severely Polluted:	Test result = 100 JTU's