Getting the "Yuck" Out
Identifying and Removing Pollutants From Our Water Through Filtration

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Grade Level:
6 through 8

Discipline:
Environmental Science

This purpose of this lesson is to teach students about water pollution. In the first part, students examine various types of household materials for their usefulness as filters. They will work together in teams to design a filtration system that produces the cleanest water in the shortest time. In the second part of the lesson, the students will examine the effect of biodegradable waste on water quality by indirectly measuring the amount of dissolved oxygen in water samples.

Part I - Cleaning Yucky Water

Objectives:
Upon completion of this lesson, the student will be able to:
1. Apply the scientific method to problem solving.
2. Develop and construct a filtration system for polluted water.
3. Determine the turbidity of water.
4. Maintain written journal of procedures, observations, and conclusions in a scientific format.
5. Use team rules and assigned tasks to work cooperatively as a scientific team.
6. Identify and demonstrate the best way to obtain clean water from heavily polluted water.

Background:
Water is one of our most prized elements of our natural resources. The human body consists of more than 60% water. Human beings are able to survive without food for several weeks but the absence of water brings about death within a few days.

Indeed, water is essential to support life. An adult person needs about 1.5 L of water per day for drinking. In the United States, we each use about 110 L for

bathing, laundering, and housecleaning and 80 L for flushing toilets. Far greater quantities are known to be used for commercial and industrial use. Water supply is also a determinant of the life style of a population and site selection for industry.

The waterways that surround us have been the recipient of civilization's waste. Urbanization and industrialization contributes to unfavorable environmental factors. Filtration is a readily available and effective means for cleaning water. In filtration, large and small substances are separated from liquids by passing the liquid through a series of adsorbent materials that serve as filters.

Materials:

Five empty clear soda bottles without covered base.
Small rocks
Sand
Gravel
Pantyhose
Large Netting
Screen
Activated Charcoal (purchased at pet supply store)
Coffee Filters
Plastic Dish Scouring Pads
Medicine Dropper
Stopwatch
Food Coloring (blue or green)
Six Small Jars
Ring Stand and 3-5 Clamps
Large Bucket
Pollutants (substances that would darken and dirty regular tap water such as soil, grass clippings, leaves, etc.)

Advanced Preparation:

1. Cut off the top third of the five soda bottles. Retain both parts of each bottle. The portion of the bottle with the spout will serve as a funnel in the lesson.

2. Have students gather substances that can be used as pollutants .

3. Prepare turbidity test standards using small jars.
   a. Prepare stock standard by adding 5 drops of food coloring to 5 mLs of water.
   b. Place 20 mls of water into each jar. Prepare test standards by adding stock standard to each jar according to the following chart:

Standard	**Drops of Stock Standard**
1. 15 % cloudy	2
2. 30 % cloudy	4
3. 45 % cloudy	6
4. 60 % cloudy	8
5. 75 % cloudy	20
6. 100 % cloudy	50

Make copies of the following page for a standard chart. Place one jar

(without the lid) over each spot. You should be able to view the spot through the standard solution for the less cloudy standards. For the 100 % cloudy solution, you will not be able to see the spot. Turbidity is a measure of the cloudiness of a solution. Once the students have filtered their water through the various filter materials they can "measure" how efficient their filter is by comparing what comes through the filter with one of the standard solutions. They can then plot their results using a bar graph to determine which filter gave the least cloudy solution.

Procedures:

A. Creating Polluted Water

1. Gather pollutants and pour into large container of water.
2. Stir mixture to help break up and loosen compacted substances.
3. Maintain ongoing record of each step taken.
4. Take the bottom parts of the soda bottles and label each with A, B, C, etc. or with the name of the specific filter material to be used.

B. Comparing Filters

1. Place the spout of the soda bottle upside down on the lower part of each bottle.
2. Select which five filters you want to compare.
3. Place 1 filter material in each funnel.
4. Pour a small amount of "polluted water" into each funnel.
5. Record your results and discuss the effectiveness of each filter. Which resulted in the cleanest water? Which was fastest? Which was slowest? What kinds of substances did each filter separate?

C. Turbidity Measurement

1. Place each standard on a spot on the standard chart.
2. Take one of your filtered solutions from step B and place it on the spot next to the first standard solution and compare how well you can see the spot on the chart through the water sample to how well you can see it through the standard solution.
3. Compare the water sample to each standard until you find the one that it matches best. For example, if your sample looks most like the standard marked 45% cloudy then your water sample is 45% cloudy.
4. Record your result in your journal.
5. Perform the comparison procedure for each filtered sample that you have.
6. Chart your results using a bar graph. The y-axis will be "% Cloudiness" and the x-axis will be "Type of Filter."

D. Construction of a Progressive Filtration System

1. Design (draw) a vertical filtration system.
2. Pour all filtered water back into the bucket.
3. Wash out all of the material used in the previous steps.
4. Using ring stand, clamps, funnels, and jars, build a vertical

filtration system according to the design from step 1.

5. Place filter materials into the funnels.

6. Pour polluted water into the top funnel and let the water trickle down through the remaining filters and collect in a jar at the bottom of the apparatus

7. Record observations and the time that it took for the water to be filtered.

8. (Optional) Rearrange the order of the filters or replace some of them and repeat steps 6 and 7. Record your results.

E. Results

1. Determine the turbidity of the filtrate obtained in Step D.
2. Compare the result to the results obtained by other teams in the class.
3. Graph class results.

Part II - Effects of Biodegradabe Waste on Dissolved Oxygen

Goal:

The student will understand the importance of oxidation and its effects on aquatic life.

Objectives:

1. Students will define oxidation.
2. Students will determine levels of oxygen in water in given containers.
3. Students will identify types of biodegradable waste.
4. Students will identify decayed organisms.
5. Students will compare and analyze the samples using a graph.

Background:

Bacteria and fungi eat wastes such as food scraps and some synthetic chemicals (like detergents). These wastes are **biodegradable** (can be broken dowm) and can harm the environment. When **aerobic bacteria** eat waste, they consume large amounts of oygen needed for the survival of fish. Water **Dissolved Oxygen** levels of about 9 parts per million (ppm) are needed to support most fish and 4.5 ppm is the minimum for life support. Trout use 50-60 milligrams of oxygen per hour at 41 degrees Fahrenheit (F) but need five or six times that amount at 77 F. When the oxygen level is zero, no fish or aerobic bacteria can survive and only **anerobic bacteria** live (without air and usually giving off a foul rotten egg odor). In this experiment, the relationship between dissolved oxygen and biodegradable waste will be investigated. Yeast represents the microorganisms, milk the biodegradable waste and methylene blue (a dye) will indicate when the oxygen is used up.

Materials:

Four small jars or test tubes
Beaker
Yeast
Skim Milk For a faster color change, dilute the milk to 50% strength and warm slightly before the experiemnt.

Graduated cylinder or graduated medicine cup - available at a drugstore as "the First Years" 2.5 ml (1/2 Tsp) Graduated Eye Dropper and 10 ml (2 Tsp) Cylinder

Test tubes and rack
Coffee stirrer
Eye dropper or pipette
Methylene blue solution - Carolina Science Materials Cat # F6-87-5733
Masking Tape
Polluted water

Procedure:

1. Take 25 mL of filtered water from Part I to workplace.
2. Place 4 test tubes in rack and label with masking tape (1, 2, 3, 4).
3. Add 2.5 mL of milk to tube 1.
4. Add 2.0 mL milk to tube 2.
5. Add 1.5 mL of milk to tube 3.
6. Add 1.0 mL milk to tube 4.
7. Add 0.5 mL of filtered water to tube 2.
8. Add 1.0 mL filtered water to tube 3.
9. Add 1.5 mL filtered water to tube 4.
10. Add 3 drops of methylene blue to tube. Cover and invert and shake 5 times.
11. Repeat step 10 for tubes 2, 3, and 4.
12. Prepare sample of yeast by adding 1 teaspoon (4 mL) dry yeast to 20 mL of tap water in a jar. Mix thoroughly.
13. Put 30 drops of yeast solution into tube 1. Invert and shake 5 times. Begin timing as drops are placed into the solution. Record the time required for the blue color to disappear (a blue film will always remain at the top).
    of the solution because of the water/air interface).
14. Repeat step 13 for tubes 2, 3, and 4.
15. Repeat steps 1 through 14 adding 1/8 teaspoon bread crumbs into each tube.

Conclusions:

1. What is the gas the microorganisms are taking in?
2. Where does aquatic life and fish get the oxygen they need to live?
3. What is the gas given off by these organism?
4. What part of the experiment represents microorganisms?
5. What part represents the biodegradable waste?

Chart:

Test Tube	Time for Color Change
1	
2	
3	

Graph:

1. Plot results on a graph. The y-axis will be "Time or Color Change" and the x-axis will be "mL of Milk". See following page for an example.
2. What does the line plotted show about the amount of oxygen in the filtered water ? What does it say about the amount of waste?
3. If there was a sizable amount of biodegradable waste dumped into a waterway what would happen to the fish and aquatic life?

Extension:

Add other biodegradable waste to the test tubes such as pieces of apples, cabbage, etc.

Reference:

Jacobson, Cliff. **Water, Water Everywhere**. Hach Company World Headquarters. Loveland, Colorado, 1991.

Conclusions (Answers)

1. Oxygen
2. From the dissolved oxygen in water
3. Carbon dioxidde
4. Yeast
5. Milk

Standard Solution	Water Sample
	15%
	30%
	45%
	60%
	75%

100%