

# Making a "Bottle" Ecosystem

<b>Standard: 3240-05</b>	Investigate Changes in the Earth's Crust and Climate	<i>Topic:</i> Earth Changes <i>Course:</i> # 3240
<b>Objective: 3240-0504</b>	Evaluate the Relationships Between Biological Processes and Earth's Changes	
<b>ILO's:</b>	<b>2a</b> Identify variables <b>2b</b> Formulate research questions <b>2c</b> Plan field studies <b>2d</b> Collect and record data <b>2e</b> Analyze data and draw inferences <b>2f</b> Construct models and simulations	

## Description of Activity

*Title:* Making a "Bottle" Ecosystem

*Overview:* In this experiment students will construct and monitor a model ecosystem. With it they will design an experiment to better understand the impact of man-made changes on biological processes in air and water.

*Duration:* 1 classroom period for set-up, 1 week for skill building activities, indefinite amount of time for aquariums to be retested.

*Materials, facilities:* for ecosystem: 1 or 2 gallon glass food jar, small animals such as snails, insects, tadpoles or protists, and pond water, sun lamps, heat lamps, weak acid solutions, wooden splints, water test kits (or your own chemicals)

*Facilities:* room with tables, water, refrigerator

## Background Information:

Ecosystems exist in a delicate balance which has evolved over millions of years. Small changes can affect this balance. Cycles exist which restore nutrients to the systems. The water cycle, nitrogen cycle, and carbon cycle are three important ones. The success of plant and animal life depends on them. The atmosphere is in delicate balance. Too much CO<sub>2</sub> could increase atmospheric temperatures while a decrease in ozone levels may raise exposure to harmful UV rays. Change in weather patterns could change a normally high precipitation area into a low precipitation area. Industrial pollutants can cause acid rain. Plants and animals may be affected in unpredictable ways by these climactic changes.

Measuring ecosystems is an important part of ecology. Water tests can indicate nutrient and gas levels and may be performed in several ways. If you have a commercial water test kit, use it, following its' directions. If not, see the skill building activities for water and air tests.

## **Teaching and Learning Strategies:**

Students need little background knowledge for this activity. An understanding that nutrients cycle through and balance in a ecosystem should be enough.

Begin by providing (or having students provide) some aquatic plants and animals. Have students fill the "aquariums" about half full of water. Add a selected amount of plant material and just a few animals. (3 snails is fine) They will need to stabilize for a few days as the students do the skill building activities which are included. These activities will provide knowledge of how to test and measure their ecosystem.

When students are ready to begin this experiment, they should identify the variable they want to test. Some variables they may come up with are:

- the type and amounts of animals, water, and plants.
- addition of pollutants such as fertilizer, salts, pesticides, acid.
- changes in "atmosphere" by adding extra CO<sub>2</sub>, heat, cold.
- changes in "sunlight", color of light, UV exposure.

Students need to be reminded to test only one variable. They should write their plans out in advance and bring extra materials they might need. To preserve inquiry, the teacher should guide the student projects but not lead.

## **Development of Tools/Skills:**

See the skill building labs on following pages. They will teach the students various tests that can be done on water and air.

Safe operating procedures include cautions concerning the use of acid or any other chemicals used in the lab. Humane treatment of animal species should be emphasized.

## **Invitation to Learn**

When students have completed the skill building activities, it is time to test their ecosystems. The question they need to address is:

How do changes (natural or man-made) in an environment affect the living things in it?

Students should be given the lab sheet and decide what variable they want to test. You may want to limit the groups so that they can't all pick the same one. They should write it up and you may require them to get your OK before they begin. The first tests they do will establish a "control" or starting place for their experiment. The change they make in the environment may take several days for effects to show. Then the second set of tests should determine what effect the change has had.

## Summary of Learning

### *Multiple Choice Questions:*

1. Scientists think adding CO<sub>2</sub> to the atmosphere will affect the earth's climate. What effect is predicted?
  - a. the earth will cool off and no effects will be noticed
  - b. the earth will warm up and polar ice caps melt
  - c. the earth's temperature won't change but plant life will
  - d. skin cancer and sunburn will become more common.

answer: b

2. Pollutants in the air react with water to form acid rain. What ways does it affect living things?
  - a. birds' feathers no longer work properly
  - b. clouds take longer to rain, causing drought
  - c. acids harm trees and water dwelling animals
  - d. the temperature of the earth goes up, harming living things.

answer: c

### **Strategies to Share Findings:**

An oral report from each group could be required. A classroom summary in the form of a written "newspaper" or group lab report could also be generated. The school's video journalism class could be invited to interview the scientists.

### **Student Planning Worksheet for 2-liter Bottle Ecosystem**

Step 1: What variable are you considering changing in the experimental ecosystem?

Step 2: What materials will your group need?

Step 2: What hypothesis do you have as to how your ecosystem will react to the changes you make?

Step 3: Describe the procedures for setting up your ecosystem:

Step 4: Describe the procedure for the test you wish to make:

Step 5: How will you alter the environment?

Step 6: a. How will you record data will you collect?

b. How do you plan on gathering that data? (how often, by whom, where?)

Step 7: How will you analyze your results?

Step 8: Have your teacher check this paper and you may begin.

Step 9: Don't forget your conclusions!

## Student Designed Experiment Scoring Rubric

RESPONSE	CRITERIA	RATING
Exemplary	Completes all steps. Experiment has a control, logical and clear procedures, data is recorded and thoroughly analyzed. Graphs are present. Prediction made. Conclusions thorough and thoughtful.	6
Competent	Completes all steps. Experiment may lack control, procedures lack thoroughness. Data is recorded, analysis not complete. Conclusions too brief.	5
Satisfactory	Completes nearly all steps. Control missing, procedures lacking or illogical. More than one variable present. Data recorded but poorly analyzed. Conclusion does not accurately sum up experiment.	4
Nearly Satisfactory	Completes most steps. Procedures missing. Data recorded but not analyzed. Conclusion missing.	3
Fails to Complete	Most steps missing. Data recorded but procedures do not indicate it's origin. Conclusion missing.	2
Fails to Begin Effectively	Directions not followed. Nearly all steps missing. Doesn't show understanding of how to develop experiment.	1
No Attempt Made	Does not begin experiment.	0

## **Teacher Page**

### **Skill Building Activity for "Bottle" Ecosystem**

Title: Water Testing

Description: This activity allows students to learn how to do five water quality tests routinely done to measure the purity of water

Materials: Commercially prepared water test kits are recommended. It is possible to make your own reagents, but extremely time consuming. pH paper and scales, thermometers, water with a little fertilizer in it, cold tap water, small beakers, student page

Facilities: a well ventilated science room with sinks

Background Information: Students should work in groups and could do all the tests or be assigned just one and share their findings.

Nitrogen forms in water as bacteria break down large protein molecules into ammonia. Ammonia is then oxidized by specialized bacteria to form nitrites and nitrates. These in turn act as a plant nutrient and encourage their growth. This causes eutrophication to occur. As the abundant plant growth dies, it removes oxygen from the water during decomposition. Animal life suffers as a result and only species that can tolerate low oxygen levels will survive.

Phosphorus is usually present in water in low levels. It is an essential element for life and acts as a limiting factor for plant growth in water. Fertilizers, sewage, and disturbance of the land increase phosphorus levels. It also acts to eutrophy bodies of water.

Dissolved oxygen is necessary for survival of aquatic organisms. It dissolves in water from the atmosphere and is produced during photosynthesis of water plants. Oxygen is removed from water as bacteria decompose organic materials.

Temperature is important to water because gases dissolve better in cold water than warm. Oxygen levels will drop as water warms up increasing the rate of photosynthesis and plant growth. Metabolic rates increase in warm water and even more oxygen is needed.

Safety Suggestions: Follow directions and safety information on the commercial kits. Goggles should be worn when using acids or bases.

## **Student page**

Title: Testing Water

Purpose: To learn how water is tested and what the tests indicate.

Materials: water test kits, litmus paper, thermometer, acid and base, tap water, water with fertilizer in it, small beakers

Prediction: What pH might tap water be?

Procedure:

1. Do the assigned tests (nitrogen, phosphorus, dissolved oxygen) on both the tap water and "fertilized" water.

Follow the directions on the kit.

2. To test pH, get the water in your beaker. Dip the litmus paper in the water and compare it to the scale.
3. Test the acid and base in the same way.
4. Use the thermometer to find temperature of the water and of the air.

Data:

1. Results of tests:

Test	tap water	"fertilized" water
nitrogen		
phosphorus		
dissolved oxygen		
pH		
temperature		

2. pH of acid \_\_\_\_\_ base \_\_\_\_\_

**Analysis:**

1. In which test was the "fertilized" water most different from the tap water?
2. Which test was most alike?
3. Why would the air and "fertilized" water temperatures be similar?
4. Which numbers on the pH scale indicate acidity? Which are bases?
5. Why would plants like "fertilized" water better than tap water?
6. Why would an overabundance of plants be harmful in water?

Conclusion:

## Teacher Page

### Skill Building Activity for "Bottle" Ecosystem

Title: Testing Gasses

Description: Students will generate and trap two gasses, oxygen and carbon dioxide and learn how to do burning splint tests to identify them.

Materials: ring stand, ring stand clamp, test tube, 8-10 cm glass tubing, 30-40 cm plastic tubing, large beaker, goggles, Alka Seltzer(or dry ice for the adventuresome), graduate, hydrogen peroxide, yeast or manganese dioxide, wooden splints, 1-hole rubber stopper, 2 solid stoppers

Background: Gasses are difficult for students to visualize because they are invisible. We can find out more about them by testing them. Gasses react in different ways to a burning or glowing splint. First the gas has to be generated and trapped. Alka Seltzer and water together release carbon dioxide. When a burning splint is placed in carbon dioxide it promptly goes out. Carbon dioxide is used in some fire extinguishers. To generate oxygen, add 5 ml of hydrogen peroxide to a pinch of yeast or manganese dioxide. To test oxygen, a glowing splint placed in it will burst back into flame. The oxygen itself is not burning but it supports combustion. If you want to try a third gas, hydrogen, it burns very quickly and makes a popping sound in the test tube. It can be generated by mixing a weak hydrochloric acid solution with magnesium or zinc. Hydrogen is not likely to be formed in the "Bottle" ecosystem, however.

Safety Suggestions: Students should wear goggles as there is a small risk of a stopper flying off if the tubing gets crimped. There will also be fire used to light the splints. The wooden splints may be lit individually by you or if you want students to have alcohol burners they could light their own. They should be familiar with safety concerning them.

## Student Page

Title: Testing Gasses

Purpose: To learn how gasses may be made, trapped and tested. To identify gasses based on their reaction to flame.

Materials: ring stand, clamp, 3 test tubes, glass tubing, plastic tubing, goggles, one half of an Alka Seltzer, beaker, graduate, hydrogen peroxide, yeast or manganese dioxide, glycerin

Procedure:

1. Place 10 ml of water in one test tube.
2. Set up apparatus. The clamp will hold the test tube on the ring stand, the glass tube needs glycerin on the end you place through the stopper. The vinyl tubing attaches to the glass tube. Fill the beaker half full of water. Two test tubes need to be filled with water and turned upside down in the beaker. Put a stopper on to keep the water in while you do this. Take it off underwater. Place the end of the vinyl tubing under the mouth of one test tube. Look at the drawing and make sure it is correct before you add the Alka Seltzer to the test tube on the ring stand.
3. Drop the alka seltzer in the test tube and put on stopper. When one tube fills up, move the tubing under the other.
4. Stopper the tubes underwater and remove them from the beaker.
5. Do the flame test with the wooden splint by lighting it, quickly removing the stopper from one of your tubes

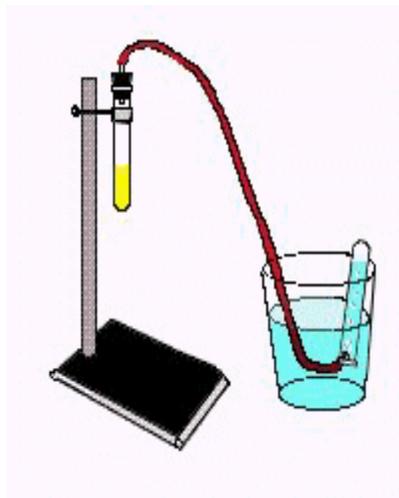
and placing it in the tube. Test both tubes.

6. Rinse the tubes and set-up for the second test.

7. Add 10 ml hydrogen peroxide to the reaction tube. Add a pinch of yeast or manganese dioxide and place the stopper on. Collect gas as before.

8. Test this gas with a glowing splint. To make it glow, light it, allow it to burn briefly, then blow it out.

9. Record your findings on both gas tests.



Data:

1. Reaction of flaming splint with Alka Seltzer gas:

2. Reaction of glowing splint with hydrogen peroxide gas:

Analysis:

1. Alka Seltzer gas is carbon dioxide. What characteristics does it have? (color, smell, flammability?)

2. The gas produced with hydrogen peroxide is oxygen. What are its' characteristics?

3. Which gas is a product of photosynthesis?

4. Which gas do animals exhale?

5. Which would be safer to have a high concentration of? Why?

Conclusion: