CO_2 and Coral Calcification

Student Activity:
In this activity you will demonstrate the role of carbon dioxide (CO_2) in photosynthesis and cellular respiration. You will also demonstrate carbonic acid's impact on calcification and dissolution of coral skeletons, and its ability to influence pH. Humans and other animals take in an air mixture and, in the lungs, oxygen is diffused to capillaries. Carbon dioxide waste, carried from cells as a by-product of cellular respiration, is removed by lung alveoli and diffuses into the lungs, where it is exhaled (or diffused depending on the animal). Plants also respire, producing, CO_2, and some of this CO_2 is reused in photosynthesis.

Part 1 (This may be done as a teacher demonstration)
Materials:
- 300 ml of bromthymol blue
- 500 ml beaker
- drinking straw
- sprig of *Elodea* (may be purchased at aquarium stores) or other aquatic plant available

Procedure:
1. Note the color of the bromthymol blue. Be sure to record your observation in Table 1. When CO_2 is added to bromthymol blue, its color will change from blue to greenish yellow. Carefully place 300 ml of bromthymol blue into the beaker. Inhale deeply with your nose, then, using a straw, carefully blow bubbles into the blue liquid. CAUTION: DO NOT SLURP OR INGEST BROMTHYMOL BLUE!! Repeat blowing bubbles 2 more times.
Note the color of the liquid and record your observations in Table 1.

2. Now add a sprig of *Elodea* to your bromthymol blue solution into which you exhaled. Leave undisturbed for 24 hours. The next day, observe and record your observations.

TABLE 1
Color change of bromthymol blue with exhaled air and aquatic plant over 24 hours.

Bromthymol Blue (Original Color)	Color after Exhale	Color Day 2 (w/plant)	Observations

Part 2

Materials:
- 4 beakers, 50-100 ml each (all same size
- 240ml distilled water
- 240 ml clear soft drink (soda pop) or vinegar

- pH paper or pH probes if available
- 2 calcite chip samples OR 2 small pieces of coral rock (if available)
- triple- beam or electronic balance
- labeling tape or wax pencil (glass marking pencil)

Procedure:

1. Place 30 ml of water in each of 2 beakers and 30 ml of clear soft drink in each of 2 beakers.
2. Label your beakers: H_2O, H_2O + Calcite, Soda, Soda + Calcite.
3. Using probes or pH paper, obtain the pH of each solution and record in Table 3a.
4. Check for the initial presence of calcium ions by adding 5 drops of ammonium oxalate ($NH_4C_2O_4$) to each of the beakers. The presence of Ca^{+2} is indicated by a white precipitate forming in the solution. Record your results in Table 2, discard the solutions with the indicator, rinse the beakers, and place 30 ml of water and 30 ml of soda in the corresponding beakers.
5. Mass each calcite chip and record its mass. Be sure to note which chip will be placed in which beaker.
6. Place each calcite chip in its corresponding beaker. It is important that you keep track of which chip goes where as you continue your data collecting each day.
7. Check the pH of your solutions with the calcite chip and record in Table 3. Leave undisturbed until the next day.
8. Days 2-5. Test the pH of each solution. Record pH value in Table 3a (and/or 3b) and indicate whether this value is acid, base or neutral (example: *7, Neutral*).
9. Days 2-5. Take out the calcite, dry the piece using paper towels, and mass. Record your data in Table 4
10. Day 5: To test for presence of calcium ions (Ca^{2+}), after removing the calcite or coral chips, add 5 drops of ammonium oxalate ($NH_4C_2O_4$) to each beaker. If Ca^{2+} (calcium ions) are present, a white precipitate will form. Record your observations in Table 5.

TABLE 2

Ammonium oxalate test for presence of calcium ions by white precipitate. (Baseline)
Day 1

Beaker Conditions → **$NH_4C_2O_4$Test ↓**	**H_2O**	**H_2O + Calcite**	**Soft Drink**	**Soft Drink + Calcite**
White precipitate (+ or -)				
Ca^{2+}present? (Yes or No)				

TABLE 3
pH quantitative and qualitative values of solutions and change in pH over 5 days.

Beaker Conditions → Days ↓	H_2O	H_2O + Calcite	Soft Drink	Soft Drink + Calcite
1 (Initial)				
2				
3				
4				
5				
CHANGE				

TABLE 4
Mass in grams of calcite in H_2O and soft drink, and change in mass, over 5 days.

Beaker Conditions → Days ↓	H_2O + Calcite	Soft Drink + Calcite
1 (Initial)		
2		
3		
4		
5		
CHANGE		

TABLE 5
Ammonium oxalate test for presence of calcium ions by white precipitate.

Day 5

Beaker Conditions → **$NH_4C_2O_4$Test** ↓	**H_2O**	**H_2O + Calcite**	**Soft Drink**	**Soft Drink + Calcite**
White precipitate (+ or -)				
Ca^{2+}present? (Yes or No)				

Analysis

Part 1

1. Explain the color change in the bromthymol blue after bubbles were blown into it. Be sure to explain what caused the color change and the source of this cause.

2. What did you observe after placing an aquatic plant in the bromthymol blue solution?

3. Explain what caused this new (2^{nd}) color change by referring to the introduction.

Part 2

1. State your hypothesis (use *if…then*) about what you and your group expect to occur in this experiment.

2. a. Why is water alone used in one beaker?

   b. Why is soft drink alone used?

   c. In the scientific method, what are these conditions called?

3. Explain the results of Table 2. Why do you think this was done on Day 1 when it will be repeated on Day 5?

4. a. What was the initial pH of the soft drink?

   b. From the background information provided, and knowing that this soft drink is carbonated, which acid may be found in this solution?

5. Explain the results of Table 3 (a and/or b). If there was a change, why did this occur, and why were there no changes in some conditions?

6. Using Table 4 (a and/or b), in which solutions did you observe changes in the masses of the calcite (or coral rock)? EXPLAIN.

7. At the end of the experiment, in which conditions were calcium ions detected? Why?

8. Review the introductory information. Where did calcium ions come from?

9. What does this (presence of calcium ions) mean for corals on a coral reef (in this case, for the calcite chips)?

10. Relate the findings of this experiment to the plight of coral calcification. How does this experiment show that coral skeletons are in danger of slowing their rates of calcification?

11. Where does the CO_2 in the oceans come from?

12. How has human activity contributed to increase atmospheric CO_2?

13. Suggest ways that changes in human behavior can improve the conditions for coral calcification and health.

Florida Sunshine State Science Standards covered:
SC.B.1.4.2, /SC.D.1.4.3, SC.D.1.4.4, SC.D.2.4.2, SC.G.1.4.3, SC.G.2.4.1, SC.G.2.4.2, SC.G.2.4.6, SC.H.1.4.1, SC.H.2.4.1, SC.H.2.4.2 and SC.H.3.4.3.