Name_____

Changing Planet: Ocean Acidification - The Chemistry is Less than Basic!

Background

The ocean-atmosphere interface is one place where exchanges take place all the time. What if we change the balance of what is exchanged? For example, what if we increase the amount of carbon dioxide in the atmosphere – will it impact the amount of carbon dioxide that makes its way into our oceans? What will happen to the chemical balance of ocean water and the marine life living there? In this investigation, you will explore this exchange of gases and identify the changes in the chemical balance of seawater.

Lab Question

How does the presence of carbon dioxide change the pH of water? How has the increase in atmospheric carbon dioxide changed the chemistry of our oceans?

Materials per lab team

- Test tube rack
- Five test tubes
- One hole stopper with tubing attached
- Baking soda
- Vinegar
- Aluminum foil
- Cotton balls
- Bottle of BTB indicator solution
- Straws
- Sprig of Elodea
- Masking tape
- Markers
- Distilled Water
- 250 mL beaker or plastic cup
- Graduated cylinder
- Coral and shell specimens
- pH indicator solution

Procedure

Part 1: Detecting CO_2 Gas

- With masking tape, label 4 test tubes A thru D. One test tube will be left unmarked. Bromothymol Blue solution (BTB) is green if the solution is neutral, blue if it is a base (alkaline), or yellow if it is an acid.
- Fill test tubes A and B approximately 1/3 full with the BTB solution and place in the rack. Test tube A will be used as a control.
- Fill the unmarked test tube approximately 1/4 full of vinegar.
- Using the foil, make a small "boat" for the baking soda - fill 1/2 full of baking soda. See Figure 1.

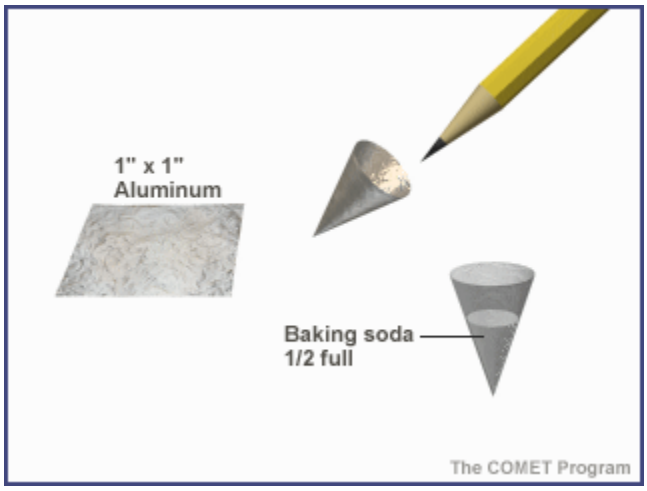


Figure 1

- The 'boat' should be small enough to easily fit into the test tube and float on the vinegar.
- Carefully slide the foil boat inside the unlabeled vinegar test tube (it is useful to tilt the tube at an angle to accomplish this).
- Plug the tube with the stopper and tubing.
- Place the free end of the tubing in test tube B with BTB, making sure the end of the tubing reaches the bottom of the tube. See Figure 2.

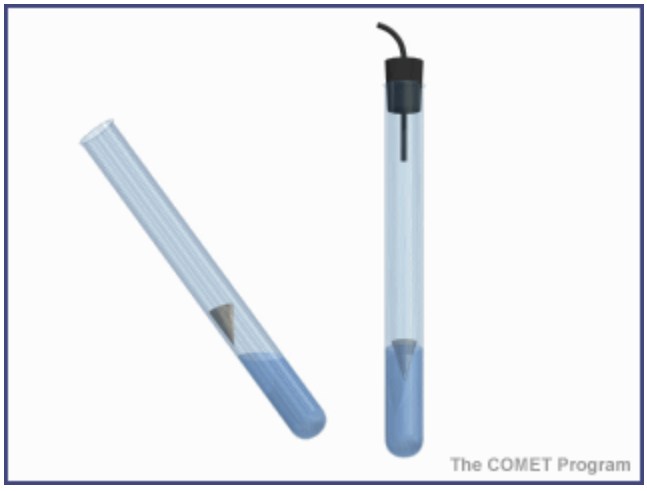


Figure 2

- Place a cotton ball into the neck of the tube with BTB.
- Mix the vinegar and soda together by GENTLY swirling the tube from side-to-side. Don't shake it upside down! Gas bubbles will begin to bubble rapidly out of the tubing into the test tube with BTB. See Figure 3.

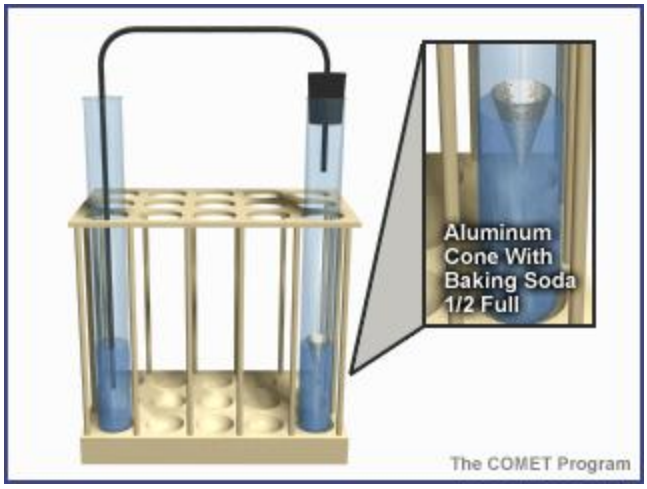


Figure 3

- Note the color change. What happened? Record your observations in the Data Table 1.

Part 2: Are animals a source of CO_2?

- Fill a test tube C approximately 1/3 full of BTB
- Place a straw in the test tube.
- Place a cotton ball in the test tube opening.
- Gently blow in the straw.
- Note the color change. What happened? Record your observations in the Data Table 1.

Part 3: Are plants a source of CO_2?

- Fill test tube D approximately 1/3 full of BTB.
- Place a sprig of Elodea into the test tube (Use a pencil or pen to push it all the way into the bottom of the tube.).
- Wrap the tube in foil so that no light can get in.
- Place in test tube rack and leave for at least 24 hours. (Your teacher has begun this part of the lab up to this point.)
- Unwrap the foil and note the color change. What happened? Record your observations in the Data Table 1.

Part 4: Do Plants take up CO_2?

- Using the now-unwrapped test tube with Elodea from Part 3, leave in the light and observe the BTB color change.
- Note the color change. What happened? Record your observations in the Data Table 1.

Part 5: Are Fossil Fuels a Source of CO_2?

- Your teacher will do this for you as a demonstration.
- Note the color change. What happened? Record your observations in the Data Table 1.

Data Table 1:

	BTB Color Change	Acid or Base	What Happened?
Part 1	From: To:		
Part 2	From: To:		
Part 3	From: To:		
Part 4	From: To:		
Part 5	From: To:		

Part 6: pH and Marine Ecosystems

- Gather the distilled water, beaker/cup, straw, and pH indicator solution. Pour approximately 50 mL of distilled water into the beaker/cup and add 15 drops of pH indicator solution and swirl to mix the solution. Record the color of the solution and pH in Data Table 2.
- Using the straw, gently exhale into the solution until you notice a color change in the solution. Record the color of the solution and pH in Data Table 2.
- Now add some crushed shells or coral to your solution and swirl it around until the coral changes. Record the color of the solution and pH in Data Table 2.

Date Table 2:

	Color	pH	What Happened?
pH indicator solution + water			****Initial color****
pH indicator solution + water + breath			
pH indicator solution + water + breath + shells/coral			

Analysis

1. After finishing all the parts of this activity, compare the colors in all the tubes. Are they different? Describe the phenomena that took place in each test tube and the beaker/cup.

A.

B.

C.

D.

E.

Beaker/cup:

2. What happens when carbon dioxide enters ocean water? Refer to your lab results.

What happened to the pH of the solution after you added the shells?

What happened to the shells or coral after they remained in the solution for a little while?

Based on what happened in this investigation, can the same effects happen in our oceans to marine life with shells or calcium carbonate exoskeletons? Explain your answer.

Conclusion

1. Use this image of the carbon cycle and the terms *sources* and *sinks* to write a paragraph about the processes in the carbon cycle.

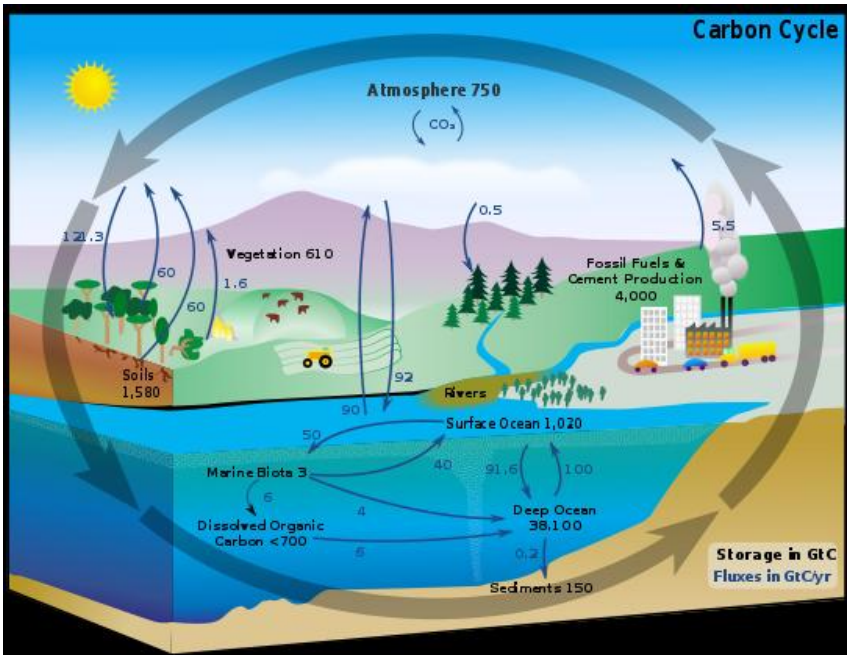
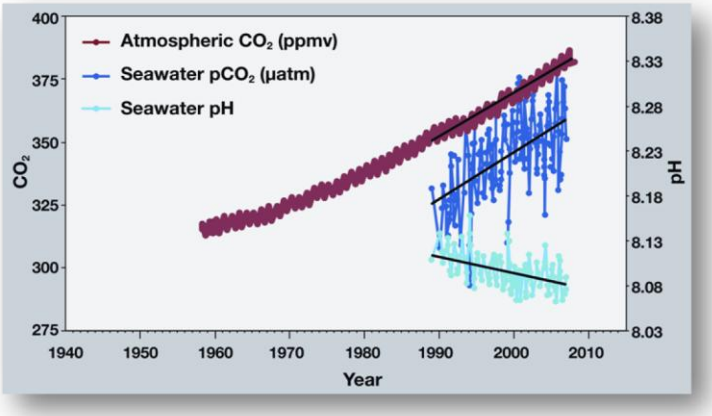


Figure 4: This carbon cycle diagram shows the storage and annual exchange of carbon between the atmosphere, hydrosphere and geosphere in gigatons - or billions of tons - of Carbon (GtC). (Source: Wikipedia Commons)

2. What is meant by the term ocean acidification?

3. When ocean acidification occurs, calcium carbonate molecules dissociate causing a loss in shells, exoskeletons, or coral reefs. Research a marine organism (other than coral) which relies on calcium carbonate for its exoskeleton. Use the results of this lab to predict what would happen if our oceans became more acidic.

Application



This graph shows the correlation between rising levels of carbon dioxide (CO_2) in the atmosphere at Mauna Loa with rising CO_2 levels in the nearby ocean at Station Aloha. As more CO_2 accumulates in the ocean, the pH of the ocean decreases. (Modified after R.A. Feely, Bulletin of the American Meteorological Society, July 2008)

Figure 5
(Source: NOAA PMEL Carbon Program
http://www.pmel.noaa.gov/co2/file/Hawaii+Carbon+Dioxide+Time-Series)

1. Study the graph above. What is the overall relationship between the atmospheric carbon dioxide and the amount of carbon dioxide in the oceans?

2. What happens to the pH of seawater as more and more carbon dioxide dissolves in the seawater?

3. What implications does this have for marine life around the globe?

4. How will this affect populations relying on the marine life for food and their economy?

5. What can be done to reverse the trend in this graph? Explain why you think this could work? What would the challenges be to making it work?