CO_2 Surface Interactions: Atmosphere to Ocean

Objectives:

1. To understand the diffusion of CO2 from air into water as a model for the ocean/atmosphere interactions.
2. To explain the change in color of a pH indicator when CO2 is added.

Materials (per group):

dilute acid/base indicator ½ tsp baking soda 7 ml vinegar 2 clear cups
medicine cups safety goggles white paper gram scale masking tape
graduated cylinder Petri dish (to use as a lid)

To Do and Notice:

1. Put on safety goggles.
2. Pour 5-10 drops of indicator into each of two clear cups. One cup is the control.
3. Add 2 g of baking soda to the medicine cup.
4. Then tape this cup into one of the clear cups containing indicator so that the top of the medicine cup is about 1 -2 cm below the top of the clear cup.
5. Place both clear cups onto a sheet of white paper, and arrange another white paper as a backdrop.

6. Add 6 ml of vinegar to the baking soda, being careful not to let any vinegar spill into the indicator.
7. Immediately place a petri dish on top of each plastic cup.
8. Move your eye to the level of the surface of the indicator to observe the liquid's surface.

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Total: 4 x 2 = 8

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Data

1. Sketch your two cups before and after the reaction occurs. Be sure to use color to indicate changes.

+1 (color) +1 (reasonable)

Remind students to use color.

2. Record the initial and final pH of the water.

About 8 to about 6

Actual blue → green

Analyze

1. Vinegar is a solution of acetic acid, CH_3COOH, and water. Baking soda is the common name for sodium bicarbonate $NaHCO_3$.

   a. Write a chemical equation for the reaction of acetic acid with sodium bicarbonate ~~(hint: use double replacement reaction)~~

   $CH_3COOH + NaHCO_3 \rightarrow NaC_2H_3O_2 + H_2O + CO_2$

   SS will copy from board

   b. Write a chemical equation for the decomposition of H_2CO_3.

   get rid of this question

   c. Write a chemical equation for the dissolution of CO_2 in H_2O.

   $H_2O + CO_2 \rightarrow H_2CO_3$

   d. Write a chemical equation for the dissociation of H_2CO_3.

   $H_2CO_3 \rightarrow CO_3^{2-} + 2H^+$ OR $H_2CO_3 + H_2O \rightarrow CO_3^{2-} + 2H_3O^+$

   +1

2. Why is the final solution acidic?

   It produces H^+

-1 if any wrong

3. Seashells and coral are both made of $CaCO_3$. Write a chemical equation for the reaction of $CaCO_3$ with H^+ ions in acidic ocean water.

   $CaCO_3 + H^+ \rightarrow HCO_3^- + Ca^{2+}$

4. What affect does this have on the shells of sea creatures?

   It depletes their shells making them weaker

   +1

5. How is this reaction a good model for ocean acidification?

   It demonstrates how CO_2 gets into the water and the effect this has on ocean life.

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Reflection after lesson:

Students enjoyed this project. They are not used to reading a procedure and following it. Maybe next time I should not read it to them and have them just read it and start on their own to build this skill. Also the cups need to be cut small enough and lowered so gas can move from the small cup throughout the big cup. I went through the reactions with the students as these would be too difficult for students to predict on their own. All students were able to complete the lab component but few were able to also complete the questions by the end of the period. Questions were left for homework. I had done a follow up poster making activity for the reactions in the past but am not doing this this year due to testing and time constraints.

Upon grading this a lot of students really struggled putting the equations in the correct places even when the equations were given on the board. This shows a lack of understanding when moving from verbal descriptions to chemical equations.