NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Equilibria in the Environment

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Part I – Bubble, Bubble, Toil and Trouble

Gather Information

1. What chemicals are higher in concentration in your exhale than in the ambient air?

Develop a Hypothesis

2. What will happen to the pH of the water when someone exhales through a straw into the solution?
   a. pH will increase
   b. pH will decrease
   c. pH will stay the same

Justify Your Hypothesis

3. Why? Write balanced chemical equations to support your hypothesis using the chemicals identified in the first question.

Experiment

Blow bubbles (exhale) into water with a few drops of universal pH indicator. Then blow ambient air into the same water.

Make Observations/Assess Hypothesis

4. What happened to the pH of the water when someone exhaled through the straw?
   a. pH increased
   b. pH decreased
   c. pH stayed the same

5. What happened to the pH of the water as the ambient air was blown through the solution?
   a. pH increased
   b. pH decreased
   c. pH stayed the same

6. Write a balanced chemical equation that might explain the experimental results.

Extrapolate a New Hypothesis

7. Based on the information given and your previous experimental results, what do you think is happening to the pH of the oceans?
   a. pH is increasing
   b. pH is decreasing
   c. pH is staying the same

Assess the New Hypothesis

8. Do experimental results reported by NOAA support your hypothesis?

Part II – Dissolution of Antacids

After reading the description of the experiment on the PowerPoint slide, answer questions #1–5.

Gather Information

Given: the active ingredient in the antacid is calcium carbonate.

1. Write the chemical formula for calcium carbonate.

2. The solubility product for the dissolution of calcium carbonate in water (at pH=7, 20° C) is $K_{sp} = 4.8 \times 10^{-9}$. Write the balanced chemical equation for the dissolution of calcium carbonate in water described by this K_{sp}.

3. Label each beaker as acidic, basic, or neutral and write the $[H^+]$ for each.

	Acidic/basic/neutral	$pH_{observed}$	$[H^+]_{calculated}$
pH 2	_____	_____	_____
pH 7	_____	_____	_____
pH 10	_____	_____	_____

4. What is the chemical difference between the three beakers? (pH = 2, pH = 7, pH = 10).

Develop Hypothesis

5. Rank the beakers in order from largest to smallest solubility of calcium carbonate.
   a. pH 10 > pH 7 > pH 2
   b. pH 2 > pH 7 > pH 10
   c. pH 7 > pH 2 > pH 10
   d. pH 10 > pH 2 > pH 7
   e. The rates of dissolution will be approximately equal.
   f. There is no way to predict.

Experiment

Drop one antacid in each of the beakers. Observe the results for a few minutes.

Make Observations/Assess Hypothesis

6. How can you tell the tablet is dissolving? (What do you see or measure?)

   Write down your observations.

7. How did the pH affect the dissolution of the antacid?
   a. The higher the pH the greater the dissolution of the tablet.
   b. The lower the pH the greater the dissolution of the tablet.
   c. pH did not seem to affect dissolution of the tablet.

8. Does this support or refute your hypothesis? How would you modify your hypothesis?

9. Write a balanced chemical equation to support your experimental observations.

Extrapolate

10. Based on the experimental information you have collected today and the information given in the PowerPoint presentation, predict what will happen or is happening to coral reefs and ocean mollusks.

Assess Hypothesis

11. Do current headlines support your hypothesis?

Part III – Shell-lacked

Read the description of the seashells and the solutions they have soaked in overnight, then work through the scientific method by answering the following questions.

Gather Information

1. List the relevant background information that we have discussed today that might affect the way the way the seashells react to the two different solutions. (In other words, what relevant information do you know?)

2. Observe the visible differences in the seashells.

Seashell in vinegar	*Seashell in tap water*

3. Record the pHs of the two solutions.

   Vinegar initial pH = _____, final pH = _____

   Tap water initial pH = _____, final pH = _____

Develop Hypotheses

4. Predict how the seashells from the two different solutions might differ.

Design an Experiment

5. Work in groups to design an experiment to test your hypothesis. Write a bullet point outline of the procedure of the experiment that your group proposes. (8 min)

Experiment

After hearing each group propose an experiment, your instructor will perform one or two experiments.

6. Write down the procedure used.

Make Observations/Collect Data

7. Record the results of the experiment.

Assess Your Hypothesis

8. Did the experiment support or refute your hypothesis? How would you change your hypothesis?

Homework

9. Develop a hypothesis related to ocean acidification that applies to a broader situation than the one specifically tested during class.

10. Based on the information you have learned today, propose a method to slow or counter the process of ocean acidification.