

ACTIVITY 1

Ocean Acidification

ACTIVITY MISSION

The pH of the ocean is variable: it changes depending on location and environmental inputs. This demonstration is designed to aid the presenter in a discussion with visitors about ocean pH: its dynamic nature, the narrow pH range that is optimal for most living organisms, how atmospheric carbon dioxide (CO₂) leads to ocean acidification, and how acidification is a process, not a state. Learners will have a deeper understanding of possible effects of acidification and will use this information to understand and interpret other information about climate change.

This activity works as an introduction to discussions about climate change, other activities in this curriculum, or the *Around the Americas* expedition in general.

Time: 5-20 min.

CONCEPTS

- The ocean is a dynamic system.
- There is a narrow pH range that is optimal for most living organisms.
- Acidification is a process of change, not a state.

LEARNING OBJECTIVES

- Learners will be able to demonstrate their understanding of ocean acidification by defining terms.
- Learners will be able to demonstrate their comprehension of ocean acidification by interpreting charts.
- Learners will be able to demonstrate their application of ocean acidification by making predictions and manipulating models.

STANDARDS AND PRINCIPLES

U.S.: 1.4, 8.3, 11.3, 11.4

Canada: 311-9, 307, 116-6

Ocean Literacy Principles: 3e, 3f

PRE-DELIVERY PREP

Supplies Needing a Day or More to Prepare

- Obtain dry ice

Hard-to-Obtain Materials

- Dry ice

SAFETY PROCEDURES

Safety Procedures

- Dry ice – Avoid contact with skin. Wear goggles, lab coat and use thermal leather gloves or tongs.

Hazardous Materials

- Dry ice is a contact hazard. Follow MSDS or accompanying instructions for proper handling and storage.
- Universal Indicator is flammable. Follow MSDS for handling and storage.

Safety Concerns for Visitors

- Dry ice – Avoid contact with skin.

SUMMARY OF SUPPLIES

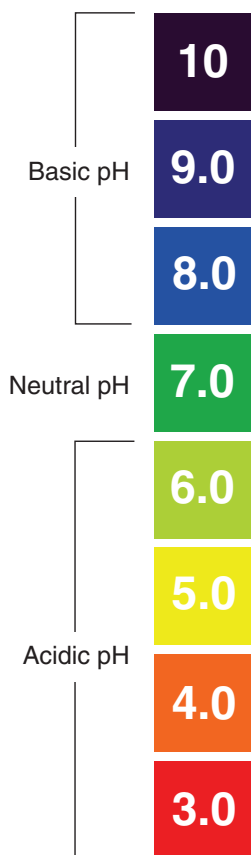
Durable Supplies

ITEM	DESCRIPTION	QUANTITY
Stir plate	With magnetic stir bar	1
Beaker or wide-mouth glass container (Pyrex)	2-L (or 1-L) capacity	1
Metal tongs	Long	1
Ice chest	Small, not air-tight	1
Safety goggles	For demonstrator	1
Hammer		1
Safety goggles	For demonstrator	1
Lab coat	For demonstrator	1
pH chart	Laminated	1
Map of <i>Around the Americas</i> journey	Laminated	1

Consumable Supplies

ITEM	DESCRIPTION	QUANTITY
Water		Enough to fill beaker approximately $\frac{3}{4}$ full
Dry ice		1-2 lb. (0.5-1 kg)/demo ~10-20 mL/demo
Universal Indicator		(For repeated use, stock 1 L)
Ammonia	Household, without surfactants	1 bottle
Dropper bottles or Pipets	Plastic	2, more for repeated use
Table salt		A pinch, optional

PROCESS AND PROCEDURE



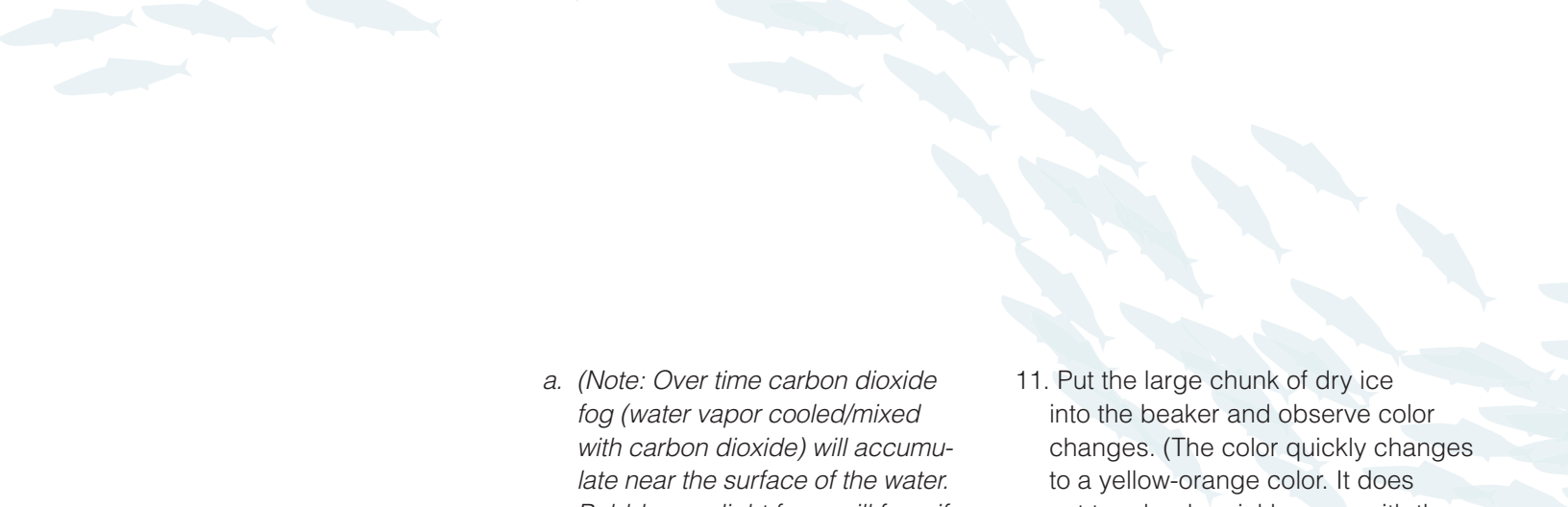
The pH scale measures how acidic or basic a substance is.

Pre-presentation Preparation:

1. Break the dry ice block into smaller chunks: while the block of dry ice is covered with its paper/plastic wrapper, hit the block with the hammer a few inches away from an edge, forming chunks of various size: 4-6 medium chunks (approximately the size of a golf ball) and 2-3 larger chunks (that can fit into the beaker). Store these chunks in the small cooler.
2. Plug in the stir plate.
3. Place the beaker on the stir plate.
4. Add water to the beaker (approximately $\frac{3}{4}$ full).
5. Gently add a magnetic stir bar to the beaker.
6. Add approximately 10-20 mL universal indicator (enough to give a definite color) to the water in the beaker.
7. Set out the other materials: pH chart, tongs, gloves, dropper bottle of ammonia.

Presentation:

1. Begin with “Welcome” phrase typical of your institution.
2. Explain the materials present: water, pH indicator, (a pinch of salt, optional). In this model, the water represents the ocean.
3. Turn on the STIR plate so the magnetic bar gently stirs the solution.
4. Add enough ammonia to the water so it turns color from green (neutral) to blue (basic).
5. Ask the visitors:
 - **What will happen to our “ocean” when carbon dioxide in the atmosphere is added?** Show visitors dry ice and briefly explain that it is a solid form of carbon dioxide.
6. Use the tongs to put a small chunk of dry ice into the water. (*The carbonic acid will lower the pH and change the color of the water.*) Monitor the color change. Remove the dry ice before the pH drops below 7 (yellow-orange).
7. Allow the solution to stir a few moments. If only slight changes in pH have occurred, the solution should turn back to a higher pH (although it will not return to its original value).
8. Repeat this process a few times. Change the pH back and forth by adding/removing the chunk of dry ice. (*Under normal conditions, the ocean is able to accommodate additions of CO_2 without major changes to its pH.*) After a while, the equilibrium range in the beaker will shift and you may need to add a few drops of diluted ammonia to bring the pH of the water back up.



a. (Note: Over time carbon dioxide fog (water vapor cooled/mixed with carbon dioxide) will accumulate near the surface of the water. Bubbles or slight foam will form if the ammonia contains surfactants. Explain or ignore, depending on the audience.)

9. Explain ocean acidification: pH drops and becomes more acidic than it was, but it doesn't necessarily indicate a pH below 7.
10. What will happen to our "ocean" when a LARGE amount of carbon dioxide is added? Hold a large chunk of dry ice over the beaker. [*pause for emphasis and to build anticipation*]

11. Put the large chunk of dry ice into the beaker and observe color changes. (The color quickly changes to a yellow-orange color. It does not turn back quickly, even with the addition of drops of ammonia.)

12. Refer to Extensions.

13. Dialogue with visitors.

Clean-up:

1. Clean the demonstration area, wiping up any spills.
2. Store the chemicals, stir plate and other equipment.
3. Rinse and store the glassware.

EXTENSIONS

- Connect with the following *Around the Americas* curricular activities: *Sea Levels and Melting Sea Ice, Ocean Currents and Marine Debris, Inquiry into Acidification and Coral, Carbon and Calcification.*
- Highlight the latest news about ocean pH (see Recommended Resources).

FACILITATION NOTES

- A pinch of salt can be added, if desired, to simulate seawater.
- Prepare for encores: If a sink is not available at the demo area, have a bucket for waste water, a supply of water, ammonia and extra dry ice on hand so the demonstration can be repeated. Replenish as necessary.
- Help visitors interpret this model. Focus on the dynamic nature of pH and the process of ocean acidification. However, tailor your presentation to your audience by including or omitting details that aid understanding. Take time to explain the parts of the model – even the aspects that do not fit (the mechanism of the stir bar/plate ("*It stirs, so I don't have to.*"), the sublimation of dry ice and the bubbles produced by carbon dioxide vapor and surfactants in the ammonia). Be patient and remember that some visitors will show more interest in the parts of this model, than in the concepts they illustrate.
- Be aware of visitors' attention and body language. Be willing to tailor the length/content of presentation to your audience. (Rule of thumb for attention length: 1 min/year of age)
- Use a mix of concrete language and analogies in explanations.