



1: SHELLS IN ACID

Grade Level: K-5

Time: 25-35 minutes

SUMMARY

In this lab, students will test the strength of normal seashells versus shells that have been soaked in vinegar to simulate the weakening effect of ocean acidification. Heavy books are used to demonstrate that shells that have been soaked in vinegar will crack more easily and hold less weight than shells that have not been in acidic conditions.

OBJECTIVES:

Students will:

- Identify the correlation between decreasing oceanic pH (ocean acidification) and the weakening of shells.
- Discuss the effect this could have on the health of shellfish in the world's oceans.

STEM APPLICATIONS:

- **Engineering** – Students will test the structural integrity and relative strength of shells that have been weakened by soaking in acid (vinegar) and comparing the value to normal shells.
- **Science** – Students will learn about ocean acidification and its effects on organisms with shells.

NGSS ALIGNMENT:

- **Practice 1.** Asking Questions and Defining Problems.
 - **K-2** – Ask and/or identify questions that can be answered by an investigation.
 - **3-5** – Identify scientific (testable) and non-scientific (non-testable) questions.
- **Practice 4.** Analyzing and Interpreting Data
 - **K-2** – Record information (observations, thoughts, and ideas).
 - **3-5** – Analyze and interpret data to make sense of phenomena using logical reasoning, mathematics, and/or computation.

VOCABULARY:

Brittle – Thin, breakable, fragile and/or easily cracked.

Calcium Carbonate – The natural substance that shells are made from.

Dissolve – To break down, either quickly or over time, due to a chemical reaction.

Ocean Acidification – A phenomenon that is currently being observed in the world's oceans wherein seawater absorbs carbon dioxide from the atmosphere and in turn becomes more acidic. The impacts to marine life are unknown, but a quick change in acidity could make it hard for marine organisms – especially shellfish – to survive.

Acid – A substance, like vinegar, with a low pH.

Invertebrate – Animals, including shellfish, that do not have a backbone.

Exoskeleton – A hard covering on the outside of an organisms body that helps give it structure and protect its body.

MATERIALS:

- White vinegar*
- Small, thin seashells*
- Non-reactive containers (glass beakers, Pyrex)*
- Water*
- Heavy books
- Paper towels

*Before beginning this activity, shells should be pre-soaked overnight in a 1:1 solution of vinegar and fresh water.

BACKGROUND:

Shell-forming organisms are especially at risk if the world's oceans continue to become more acidic. Their shells are made from a material called calcium carbonate, which is both prone to dissolving in acidified conditions, and more difficult for the organisms to make when fewer carbonate ions are available. This is predicted to be the case as more carbon dioxide enters the oceans. This lab demonstrates that a strong acid like vinegar (which has a pH of about 2.4 undiluted, and 2.56 in the 1:1 solution with fresh water) can significantly weaken shells and cause them to break more easily under pressure and weight.



ACTIVITY

1. Engage/Elicit

Ask the students to give examples of different species of shellfish. Answers may include clams, oysters, mussels, scallops, etc. Ask students why and where they have seen these creatures. Students' knowledge may come from eating seafood, or perhaps from having seen them in a marina or in coastal areas. Ask the students why these animals are important to the marine environment and to human beings.

2. Explore

Lay out an assemblage of the non-soaked shells. Have the students observe and identify the different species mentioned during the first part of the activity. Allow the students to handle the shells and ask them why the development of shells is advantageous to such animals. Explain that shellfish are invertebrates, meaning that instead of having an internal skeleton like humans, invertebrates produce a hard, protective covering. Mention that shellfish make their shells by combining calcium (also a major component of our bones!) with carbonate, two substances found in seawater. The product, calcium carbonate, is the same material that chalk is made out of.

After dividing students into groups of 3-4, give each group of students a control group of non-soaked shells and an experimental group of vinegar soaked shells that contain similar species, so that students can make a visual and direct comparison for each species.

Give each group two sheets of paper towel, labeled "Normal" and "Acid Washed." Ask students to lay the shells out on the paper towels in two groups according to the treatment. Make sure that the paper towels and arranged shells are close enough to one another so that the books you are using can cover all of them at once, but far enough to keep the groups visually separate.

The shells soaked in vinegar should look frail, brittle, washed out and feel less "intact" than their non-soaked counterparts. Ask the students to make predictions about which group of shells will withstand a greater amount of pressure (from the weight of the books) before they conduct the experiment. You can also ask them to guess how many books will cause shells from either group to break. Note that the books used for the control and experimental groups should be the same weight. If you do not have books with comparable weights, have students perform the experiment with the non-soaked shells first and then with the soaked shells to compare.

Have students carefully lay books on top of the two groups of shells until you hear or see shells cracking. Notice how much weight (how many books) is necessary to break the shells, and which kind of shell breaks first! See if the students can continue adding weight to the shells to break the (hint!) non-soaked shells – it's hard to do!

3. Explain

Initiate a discussion and ask students to share the results of their experiments. Have the students refer back to their original predictions – do the results support or refute their predictions?

4. Extend

Calcium carbonate is also the main ingredient in chalk. For a dramatic demonstration in real time, you can bring in a bottle of seltzer water (contained in a non-reactive glass beaker or Pyrex container) and drop the chalk in. The bubbles in the seltzer water are made of carbon dioxide, which will eat away at the chalk quickly and cause it to dissolve completely in a few minutes.

After watching this happen, explain that the same substance, carbon dioxide, is produced by burning fossil fuels and is entering the oceans, causing acidification. In the ocean, however, this process is happening at a much slower rate because ocean water (pH 8.1) is not nearly as acidic as seltzer water (pH 3.5).

5. Evaluate/ Wrap-up

Ask the students to brainstorm some possible implications of ocean acidification on shell-forming organisms, and problems that could come from weaker shells.

After establishing that shells can become brittle, fragile, and more easily breakable due to acidification, consider the connection between a strong, protective shell and a healthy organism. Discuss how a shell protects an organism from dangers such as predation, pounding surf, and the hot sun, and have the students think about the challenge of surviving these harsh conditions with a weakened shell. What does this mean for shellfish populations? How will this affect marine ecosystems, and/or areas where these organisms are usually plentiful?

6. Dive Deeper

This lesson was adapted from the NRDC's Ocean Acidification LabKit, which can be found by visiting the following web address: www.nrdc.org/oceans/acidification/files/labkit.pdf. To learn more about ocean acidification and other important issues facing the world's oceans, please visit www.namepa.net/education.

