**Ocean Acidification:** pH’s Effect on Mussels

**Topic:** Ocean chemistry

**Time:** Total: 2 hours; split over the course of two days

**Materials:** ocean water, vinegar, coca cola, soap water, 4 containers for each group, 4 mussel shells for each group, pH testing strips, paper towel, scale

**Goals:** Students will understand the effects that ocean acidification has on shelled marine animals and in the marine food web. Students will practice forming a hypothesis around shell erosion in different pHs and test it out and increase understanding of the scientific process.

**Introduction**

* Shells serve as a protective layer for marine and terrestrial animals. Marine ecosystems such as coral reefs and oyster beds depend upon calcium-carbonate to create their exoskeletons.
* Since the Industrial Revolution about 200 years ago, Carbon Dioxide in the atmosphere has increased. During this time, the pH of surface ocean water has fallen by 0.1 pH units, which is a 30% increase in acidity.
* The ocean absorbs about 30% of the carbon dioxide that is released into the atmosphere. This increases hydrogen ions in the water, increasing the water’s acidity.
* As ocean acidification increases, available carbonate ions bond with excess hydrogen. What does this mean for shelled marine animals? There are fewer carbonate ions available for calcifying organisms to build their shells, skeletons, and other structures.
* Because of human-driven increased levels of carbon dioxide in the atmosphere, there is more carbon dioxide in the ocean. The ocean’s average pH is now around 8.1, and as the ocean continues to absorb more carbon dioxide, the pH will decrease, denoting an ocean becoming more and more acidic.

Day 1 Activity:

1. Give each group 4 mussels and 4 separate containers. Have students label each container control (ocean water), vinegar, coca cola, or soap water.
   1. Students can collect the mussels before beginning the lab if allotted the time
2. Weigh each mussel on a scale and record the “before treatment” weight on the table within the worksheet.
3. Make observations about the shells’ texture and hardness on the worksheet.
4. Pour the respective solutions into each of the containers, making sure that the shell is covered.
5. Measure the pH of each of the solutions and record on datasheets
   1. Using a pipet, fill a vial with 10mL of solution. Drop pH tablet in and shake until dissolved, then compare color with pH chart
6. Create and record a hypothesis about what will happen to the shells in each of the solutions
7. Leave mussels covered in the containers for one week

**Day 2 Activity:**

1. Take mussels out of treatment solution and put them on labeled napkins and let dry for at least an hour before weighing
2. Weigh each of the mussels and record their “after” weights on datasheets
3. Measure the pH of each of the solutions and record on datasheets
   1. Using a pipet, fill a vial with 10mL of solution. Drop pH tablet in and shake until dissolved, then compare color with pH chart
4. Decide within group whether or not hypothesis was right and why
5. Have a discussion with the entire group about their hypotheses. Draw out questions such as what a more acidic ocean means for shelled species. What does this mean for marine food webs? What does this mean for humans?

**Ocean Acidification and Mussels**

Group Member Names:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

| Solution | pH of solution Before Treatment | Mussel weight (g)  Before Treatment | pH of solution After Treatment | Mussel weight (g)  After Treatment |
| --- | --- | --- | --- | --- |
| Control |  |  |  |  |
| Vinegar |  |  |  |  |
| Coca-Cola |  |  |  |  |
| Soap Water |  |  |  |  |

**Shell observation before treatment (Day 1):**

**Shell observation after treatment:**

**Create a hypothesis for each treatment type:**

Control:

Vinegar:

Coca-Cola:

Soap Water:

**Results:**

**Resources**

Adapted from the Cosee West Shells and the Impacts of Ocean Acidification lesson

NOAA: [Ocean Acidification](https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification)

Woods Hole Oceanographic Institution: [Carbon Dioxide, Shell Building, and Ocean Acidification](https://www.whoi.edu/multimedia/carbon-dioxide-shell-building-and-ocean-acidification/)

Scientific Reports: [Ocean acidification impacts mussel control on biomineralisation](https://www.nature.com/articles/srep06218)