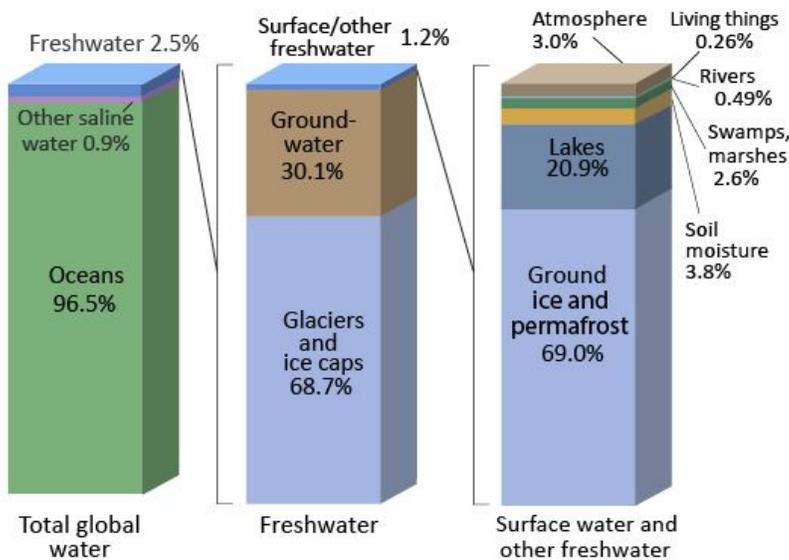


Lab 1 - Ocean Acidification Lab- What is the Atmospheric Carbon Dioxide Effects on Fresh vs Salt Water?

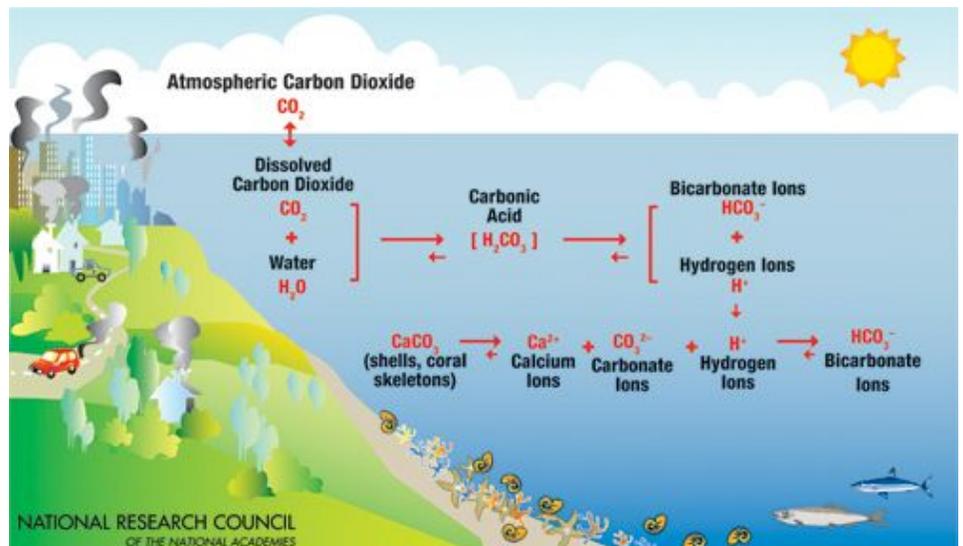
The Earth is 70% covered by water but only 3% of that is freshwater and the rest is in the world's oceans. However, 2% of the freshwater is locked up in glaciers and ice at the poles, so only 1% of freshwater is readily available for humans.

Where is Earth's Water?



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, *Water in Crisis: A Guide to the World's Fresh Water Resources*.
NOTE: Numbers are rounded, so percent summations may not add to 100.

We learned that atmospheric carbon dioxide CO_2 is soluble in water but what happens to it at that point? Carbon dioxide CO_2 reacts with water H_2O to form carbonic acid $\text{H}_2\text{CO}_3(\text{aq})$. This carbonic acid H_2CO_3 partially dissociates (it is a *weak acid*) into bicarbonate ion and



Adapted by Leigh Foy York Suburban High School York PA 2016

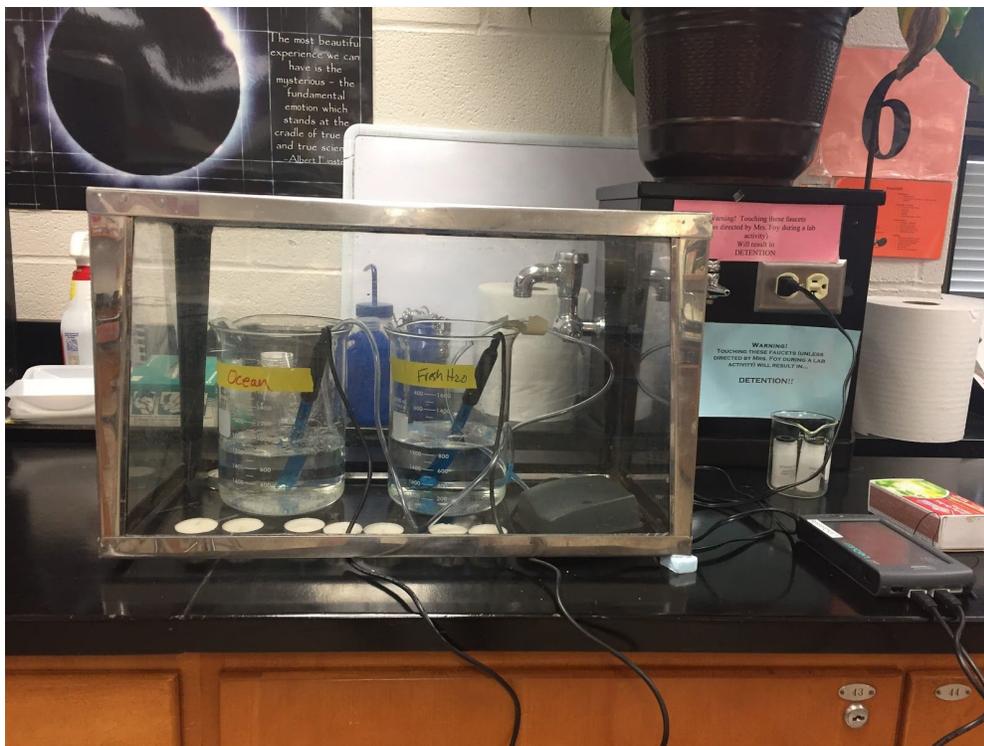
hydrogen ion. We have learned that increasing the H^+ ion concentration in a solution makes it more acidic. pH is a measure of this H^+ concentration

(<http://dels.nas.edu/resources/static-assets/materials-based-on-reports/special-products/ocean-acid-image1-webready.jpg> free for use)

Living things have to maintain a balance of pH or die. Humans must control their blood pH from 7.35 to 7.45. Even small changes in pH (even .1) can make a difference between life and death. Humans can only live a few HOURS when their pH changes this much! (<http://www.biologyreference.com/Ho-La/Homeostasis.html>)

The salinity of the oceans is determined by the concentration of compounds dissolved in the oceans. What effect does the salinity of water have on the pH? Does increasing CO_2 have a different effect on freshwater or saltwater? Would the increased atmospheric CO_2 have a different effect on lakes and streams vs the oceans?

Your teacher will show you the setup for quantitative measurements for this experiment. You will use your pH meters and your stopwatch to measure pH changes over time.



Aquarium
2 500 mL beakers
8 tea light candles
Aquarium bubblers
Plastic tubing
Two pH meters
Distilled water
Instant ocean
Stopwatches

State your Experimental Question

State your Hypothesis

What is your Independent Variable?

What is your Dependent Variables?

What are some variables to control? List 3

Procedure - Summarize briefly outline your procedure in steps below:

- 1.
- 2.
- 3
- 4.
- 5.

Data Table

LET THE pH meters record for 5 min WITHOUT lighting the candles. Record starting pH	
Fresh Water	Sea Water
Starting pH (after 5 min equilibration WITHOUT candles lit)	Starting pH (after 5 min equilibration WITHOUT candles lit)
Light candles!	Light candles!
Min 1 pH	Min 1 pH
Min 2 pH	Min 2 pH
Min 3 pH	Min 3 pH
Min 4 pH	Min 4 pH
Min 5 pH	Min 5 pH

Min 6 pH	Min 6 pH
Min 7 pH	Min 7 pH
Min 8 pH	Min 8 pH

Create a double line graph in Google Spreadsheets using all good graphing rules and insert it below:

Analysis Questions

1. In which beaker was there a greater pH change? Did the beaker become more acidic or more basic?

2. Many aquatic organisms cannot survive a significant change in pH. What do you think will be the effect on organisms in lakes and in oceans with an increase of atmospheric CO₂? Explain.

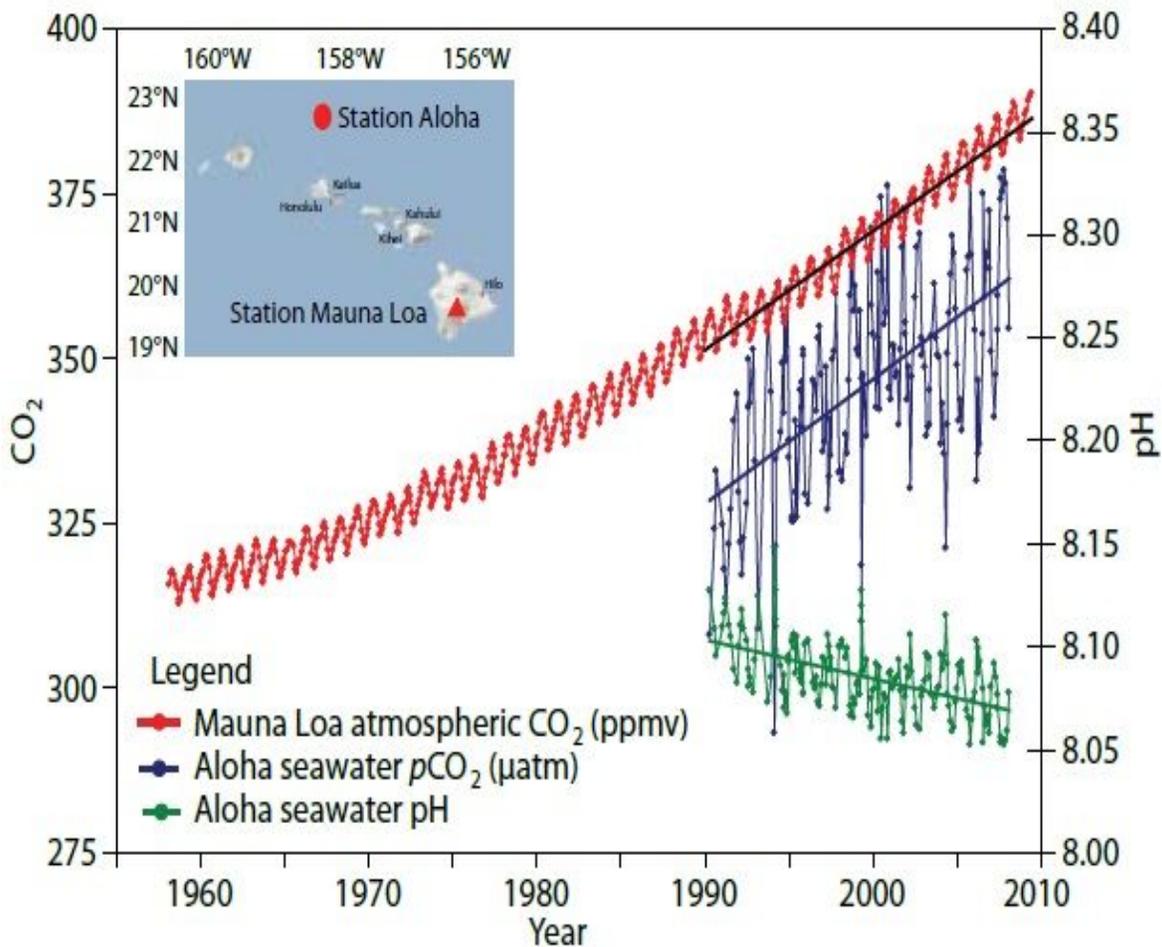
3. What was the purpose of the aquarium pump in this experiment? What do you think would be the effect on this experiment if no pump was used?

4. In the real oceans, what natural forces have the same effect as the aquarium pump in this experiment?

5. Based on the results of your experiment, what is the effect of increasing atmospheric CO₂, due to the burning of fossil fuels? What role did the burning candles play in this experiment? What was the “fuel” that was burned in this experiment? Explain.

6. Look at the graph below and answer the following questions.

- a. What ocean does this data come from?
 - b. What 3 things are being measure in this graph?
 - c. What is the summary of this graph in your own words?



Caption from [Scott C. Doney et al., 2009: Ocean Acidification - a critical emerging problem for the ocean sciences. *Oceanography*, Volume 22, Number 4, a quarterly journal of The Oceanography Society](#) : Time series of atmospheric CO₂ at Mauna Loa (in parts per million volume, ppmv; red), surface ocean pCO₂ (µatm; blue) and surface ocean pH (green) at Ocean Station ALOHA in the subtropical North Pacific Ocean. Note that the increase in oceanic CO₂ over the past 17 years is consistent with the atmospheric increase within the statistical limits of the measurements. Mauna Loa data courtesy of Pieter Tans, [National Oceanic and Atmospheric Administration/Earth System Research Laboratory](#) ; Hawaii Ocean Time-Series (HOT)/ALOHA data courtesy of David Karl of [University of Hawaii](#) ; see also [Dore et al., 2009](#)

7. What were some errors in your experiment? List 3. What would be a good follow up experiment that you might like to try?

Enrichment!

Watch the 5 min video and quiz on EDPuzzle - click [HERE](#)

Additional Resources

Click [HERE](#) for a Prezi on Le Chatelier's principle

Click [HERE](#) for background info and more activities on ocean acidification

This lab was edited into a guided inquiry lab by Leigh Foy 2016 but developed for CarboSchools by S. Soria-Dengg, IFM-GEOMAR, Annika Sabrowski and Patrick Silva, Gymnasium Wellingdorf, Kiel, Germany. Mail: sdengg@ifm-geomar.de
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