Lesson Plan: Teaching the pH Scale, and Acids and Bases through Climate-related Examples

As a **high school Chemistry** teacher, you can use this set of computer-based tools to help you in teaching **the pH scale**, **acids and bases**, **acidification**, and **environmental chemistry**.

This lesson plan allows students to understand the pH scale and acidification by analyzing the effect of atmospheric carbon dioxide on ocean chemistry. The activity will also explore the potential effects of climate change on ocean acidification, and the possible impacts of ocean acidification on marine organisms.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in Chemistry.

Use this lesson plan to help your students find answers to:

- *What is the pH value of ocean water? Is it alkaline or acidic?*
- *What are the main chemical reactions in ocean acidification?*
- *How could an increase in fossil fuel usage change the pH value of ocean water?*
- *If ocean water became more acidic, how might it affect oyster and sea urchin populations?*
- *What are the possible impacts of climate change on ocean chemistry?*

About the Lesson Plan

Grade Level High school

Discipline	Chemistry
Topic(s) in Discipline	pH Scale, Acids and Bases, Acidification, Ocean Carbonate Chemistry, Seawater Chemistry, Aragonite Saturation State, Ocean Acidification
Climate Topic	Climate and the Hydrosphere
Location	Global, USA
Access	Online (some material can be downloaded for offline use)
Language(s)	English (Visualization tool available in English, French, German, Portuguese, and Spanish)
Approximate Time Required	120 – 150 min

1 Contents

3. Classroom/Laboratory activity (60 – 90 min)	A classroom/laboratory activity to explore and analyze the relationship between the growth of oyster larvae and the chemistry of ocean water (aragonite saturation state) by using actual data from the Whiskey Creek Hatchery in Oregon, USA. https://pcc.uw.edu/education/curriculum/climate-teaching-modules/uwhs-atms-211-ocean-acidification-and-oysters-lab/
4. Suggested questions/assignments for learning evaluation	• *What is the pH value of ocean water? Is it alkaline or acidic?* • *What are the main chemical reactions in ocean acidification?* • *How could an increase in fossil fuel usage change the pH value of ocean water?* • *If ocean water became more acidic, how might it affect oyster and sea urchin populations?* • *What are the possible impacts of climate change on ocean chemistry?*

2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

1. Introduce the topic through an interactive visualization	• Introduce the topic of acids and bases. • Proceed with your existing lesson plan to explain the pH scale. • Discuss the pH values of various common compounds. • Give a few examples of chemical reactions that generate acids and bases.

- Next, use "part 1" of the visualization, "Our Acidifying Ocean," from the Inquiry to Student Environmental Action (I2SEA) project for an interactive learning session. The tool will help you introduce the topics of **pH scale**, **pH of different liquids**, **ocean acidification**, and **possible impacts of ocean acidification on marine life**.

  The tool can be accessed at: http://i2sea.stanford.edu/AcidOcean/AcidOcean.htm.
  It is available in English, French, German, Portuguese and Spanish.

  Note: This tool requires a Flash player, and therefore, may not play in some browsers. The visualization tool works well in Firefox and MS Edge.

2. Play a short video

Then play this short video (approx. 6 min), "Ocean Acidification", to explain how carbon dioxide (CO_2) affects the pH of the ocean and how an increase in ocean acidification might adversely impact marine animals.

The video "Ocean Acidification", provided by the National Science Foundation and NBC Learn (available on Science360 News Service), is available at https://news.science360.gov/archives/20110520.

3. Conduct a classroom/laboratory activity

Now, explore this topic in an engaging manner through a classroom/laboratory activity, "Ocean Acidification and Oysters Lab", created by Hilary Palevsky, UW Oceanography:

This activity will help your students explore how a change in ocean chemistry can affect the growth of marine organisms, specifically, oyster larvae. Students will use actual data from the Whiskey Creek Hatchery in Oregon, USA, to plot graphs in MS Excel, and perform data analysis and interpretation.

- Download the documents for the Ocean Acidification and Oysters Lab from https://pcc.uw.edu/education/curriculum/climate-teaching-modules/uwhs-atms-211-ocean-acidification-and-oysters-lab/.

- Read the content in the Oysters and Ocean Acidification Module (PDF file).
- Conduct the activity described in Part 1 of the module (plotting and analysis of actual data by using MS Excel).
- Optional: You may also perform the activities in Part 2 and Part 3, depending on the time available for teaching this topic.

4. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- *What is the pH value of ocean water? Is it alkaline or acidic?*
- *What are the main chemical reactions in ocean acidification?*
- *How could an increase in fossil fuel usage change the pH value of ocean water?*
- *If ocean water became more acidic, how might it affect oyster and sea urchin populations?*
- *What are the possible impacts of climate change on ocean chemistry?*

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- describe the pH scale
- explain ocean acidification
- discuss the effect of atmospheric carbon dioxide on ocean chemistry
- determine the potential effects of climate change on ocean acidification
- explore the possible impacts of ocean acidification on marine organisms

4 Additional Resources

If you or your students would like to explore the topic further, these additional resources will be useful.

1. **Reading** — A reading, "What is ocean acidification?", from the European Project on OCean Acidification (EPOCA): http://www.epoca-project.eu/index.php/what-is-ocean-acidification.html
2. **Video** — A short film, "Ocean acidification: Connecting science, industry, policy and public," from Plymouth Marine Laboratory: https://www.youtube.com/watch?v=_BPS8ctVW2s&feature=fvst
3. **Laboratory Activity** — A hands-on laboratory activity to understand and examine the effect of anthropogenic carbon dioxide on oceans and marine animals: https://serc.carleton.edu/integrate/workshops/risk_resilience/activities/81316.html

5 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and ownership details for each tool by following the individual links provided.
We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

1. **Interactive Tool, "Our Acidifying Ocean"**	Inquiry to Student Environmental Action (I2SEA) project
2. **Video, "Ocean Acidification"**	The National Science Foundation and NBC Learn
3. **Classroom/Laboratory Activity, "Ocean Acidification and Oysters Lab"**	Hilary Palevsky, UW Oceanography, University of Washington Program on Climate Change
4. **Additional Resources**	European Project on OCean Acidification (EPOCA); Plymouth Marine Laboratory; Richard Rueb (Clackamas Community College) based on an original activity by Sheila Alfsen (Linn Benton Community College) on the InTeGrate program