



Program Information	<i>[Lesson Title]</i>		TEACHER NAME		PROGRAM NAME			
	<i>Acid Upset! Too Much in Our Oceans</i>		Linda McBride		Warren County Career Center			
Program Information	<i>[Unit Title]</i>		NRS EFL(s)		TIME FRAME			
	<i>Climate Change/Ecology</i>		4 – 5		60 minutes			
Instruction	<u>ABE/ASE Standards – English Language Arts and Literacy</u>							
	Reading (R)		Writing (W)		Speaking & Listening (S)		Language (L)	
	Foundational Skills		Text Types and Purposes	W.5.2	Comprehension and Collaboration	S.4.1	Conventions of Standard English	
	Key Ideas and Details	R.5.4	Production and Distribution of Writing		Presentation of Knowledge and Ideas		Knowledge of Language	
	Craft and Structure	R.5.5	Research to Build and Present Knowledge				Vocabulary Acquisition and Use	L.4.5
	Integration of Knowledge and Ideas						<i>Benchmarks identified in RED are priority benchmarks. To view a complete list of priority benchmarks and related Ohio ABLE lesson plans, please see the Curriculum Alignments located on the Teacher Resource Center.</i>	



<p>LEARNER OUTCOME(S)</p> <ul style="list-style-type: none"> Students will be able to utilize data from an online lab simulation to describe the basic climate change chemical reactions that impact ocean ecology. (Inquiry based) 	<p>ASSESSMENT TOOLS/METHODS</p> <ul style="list-style-type: none"> Students will be able to accurately complete the Acid Ocean Guiding Questions. Write/type a summary of their experiment and what they learned and implications. Extension activity: <u>Common Core Achieve: Mastering Essential Test Readiness Skills (Science)</u>: Chapter 2: Ecosystems
<p>LEARNER PRIOR KNOWLEDGE</p> <ul style="list-style-type: none"> Basic chemistry and understanding of equations the ability to read and interpret graphs. Definition of standard deviation, replicate, hypothesis, pH, acid, base, reactant, product. 	
<p>INSTRUCTIONAL ACTIVITIES</p> <ol style="list-style-type: none"> Display What is Ocean Acidification? showing a couple of photos of changes, ask students what they think are the causes and what is happening? Students today hear a lot about climate change and its impact on the world. Explain that today we are going to use an ocean lab online to explore that topic and do some investigating ourselves. Some students may be resistant to this as they don't believe in climate change but we are using it as tool to follow procedures, be precise and perform technical tasks which are important for the GED test and in everyday life-jobs etc. Elicit responses where these details are important. Have students find a partner to work with. They will need paper to take notes on as they navigate through the lab. First start in part 1 which is an interactive slideshow, Our Acidifying Ocean, giving a 	<p>RESOURCES</p> <p>Computer with Internet access</p> <p>Projector, ability to project</p> <p>What is Ocean Acidification? (n.d.). Retrieved from http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F</p> <p>Paper for student use</p> <p>Computers with Internet access for student use</p> <p>Our Acidifying Ocean. (n.d.). Retrieved from http://www.stanford.edu/group/inquiry2insight/cgi-bin/vu-</p>



	<p>brief overview of climate change. Make sure students fill out the Acid Ocean Guiding Questions because there are additional questions.</p> <ol style="list-style-type: none"> 4. Upon completing the slide presentation have students continue onto part 2 of the lab where they will collect, record and analyze their information on the Acid Ocean Guiding Questions. As the students go through the process they will need to follow the steps carefully. 5. As groups complete all three parts they should compare notes with their partner and discuss what their results and implications and be prepared to share with the entire class. 6. Have the entire class come together and share their results and what they learned. Did anything surprise them? Be sure to discuss questions listed in part 3 of the online lab experiment. 7. For homework they can write/type a summary of their experiment and what they learned and implications. <ul style="list-style-type: none"> • Extension activity: Common Core Achieve: Mastering Essential Test Readiness Skills (Science): Chapter 2: Ecosystems 	<p>r1a/vu.php?view=acidocean</p> <p>Student copies of <i>Acid Ocean Guiding Questions</i> Guiding Questions: Acid Ocean. (n.d.). Retrieved from http://betterlesson.com/lesson/resource/3102287/guiding-questions-acid-ocean</p> <p><i>Common core achieve: Mastering essential test readiness skills</i> (Science). (2015). Columbus, OH: McGraw-Hill Education.</p>
	<p>DIFFERENTIATION</p> <p>Additional support with vocabulary may be necessary definitions could be supplied.</p> <p>Pair a high and low student together would be beneficial.</p>	
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Reflection</p>	<p>TEACHER REFLECTION/LESSON EVALUATION</p> <ul style="list-style-type: none"> • I would advise to teach a lesson on the carbon cycle and basic information about acids and bases. This could be done prior to the lesson or stop during the lesson to teach the concepts. 	



- I recommend going through the lab prior to class just to see what it is and you can anticipate any problems. It was fun!!
- Two suggestions if a student has difficulty with the lab.
 - When students have successfully completed a procedure step, they will be able to move to the next step. If they come to you saying the website won't let them move on, that means they haven't completed that step correctly yet.
 - If students struggle to figure out how to complete the step correctly, hints are displayed in a box on the bottom of the screen to assist them. When they have made the necessary adjustments, the next step of the procedure will be highlighted and they will be able to complete the next task in the sequence.

ADDITIONAL INFORMATION

This lesson was adapted from *Acid Alert! The Effects of Climate Change on Ocean Ecology*
Laws, M. (n.d.). Acid Alert! The Effects of Climate Change on Ocean Ecology. Retrieved from
<http://betterlesson.com/lesson/619740/acid-alert-the-effects-of-climate-change-on-ocean-ecology>

Acid Ocean

Purpose: *Acid Ocean* is an inquiry-based virtual lab designed to investigate how ocean acidification could impact marine organisms.

Objectives:

- 1) Students will be able to explain how increasing levels of carbon dioxide in the air is resulting in the acidification of our oceans.
- 2) Students will use a virtual lab bench to set up an experiment to compare the development of sea urchin larva in pH 8.2, the average pH in today's oceans, and pH 7.7, the pH projected for 2100. They will "conduct" an experiment that could not be done in a typical high school lab setting.
- 3) Students will analyze authentic research data and measure changes larva to see possible effects of climate change.
- 4) Students will evaluate the significance of individual and class data.

Vocabulary: hypothesis, pH, acid, base, reactant, product, scenario, replicate, standard deviation

Procedure: Use the virtual lab to answer these questions as you navigate through parts 1, 2, and 3

Part 1

1. What does the graph of data from the Moana Loa lab indicate about the level of CO₂ in the atmosphere in 1960 compared to the present?
2. The more concentrated the carbon dioxide in the atmosphere, the more CO₂ will dissolve in the oceans, and the more acidic the oceans will become. That means that the pH will be:
a) lower b) higher c) remain the same

3. On the pH scale: _____ is neutral. The most acidic is _____.

The most basic/alkaline is _____.

4. The chemical equation $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$ shows the reaction that influences ocean acidification. Here is the equation in words:

Carbon dioxide + water produces carbonic acid.

What is/are the reactant(s)? _____

What is/are the products? _____

4. Please use the page “Exploring carbon levels and effects” to answer these questions.

How old will you be in 2050? _____

The most pessimistic scenario predicts an ocean pH of _____ in 2050.

The most optimistic scenario predicts an ocean pH of _____ in 2050.

What things will determine which scenario will be correct?

5. Use the drawing of the ocean chemistry “Carbon in water” to predict the effect of increasing acidification on calcifying organisms.

Part 2

6. What is the model organism in the virtual experiment, & why was this organism chosen?

7. Why are the pH's 8.1 and 7.7 selected for this experiment?

8. State a possible hypothesis for this experiment.

9. Why are there 3 replicates of cultures for each pH?

10. Why is the water drained from the samples and then re-added?

Part 3

11. List your data and the complete data set in the charts below.

Your data

	pH 7.7	pH 8.1
Replicate A		
Replicate B		
Replicate C		
Average		
Standard deviation		

	Your data		Complete data set	
Treatment	pH 7.7	pH 8.1	pH 7.7	pH 8.1
Average				
Standard deviation				

12. Please explain the importance of the data in this experiment. How do the arms of the larva in pH 7.7 compare to the larva in 8.1?

Why might it be significant that larva in one group have shorter arms than those in the other group?

13. What can we do to decrease the trend of acidification in the world's oceans.

15/15

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Procedure: Use the virtual lab to answer these questions as you navigate through parts 1, 2, and 3

Part 1

1. What does the graph of data from the Moana Loa lab indicate about the level of CO₂ in the atmosphere in 1960 compared to the present?

The level of CO₂ was much lower than it is today, as the Moana Loa lab shows.

2. The more concentrated the carbon dioxide in the atmosphere, the more CO₂ will dissolve in the oceans, and the more acidic the oceans will become. That means that the pH will be:

(a) lower b) higher c) remain the same

3. On the pH scale: 7 is neutral. The most acidic is 0.

The most basic/alkaline is 14.

4. The chemical equation $CO_2 + H_2O \rightarrow H_2CO_3$ shows the reaction that influences ocean acidification. Here is the equation in words:

Carbon dioxide + water produces carbonic acid.

What is/are the reactant(s)? Carbon dioxide, water

What is/are the products? Carbonic acid

Part 3

11. List your data and the complete data set in the charts below.

Your data

	pH 7.7	pH 8.1
Replicate A	420	520
Replicate B	480	500
Replicate C	440	500
Average	447	507
Standard deviation	30.6	11.6

* all data in μm

Treatment	Your data		Complete data set	
	pH 7.7	pH 8.1	pH 7.7	pH 8.1
Average	447	507	451.2	533.6
Standard deviation	30.6	11.6	48.2	29.2

* all data in μm

12. Please explain the importance of the data in this experiment. How do the arms of the larva in pH 7.7 compare to the larva in 8.1?

The arms of the larva in the pH 7.7 are much shorter on average $60\mu\text{m}$, than the larva from pH 8.1.

Why might it be significant that larva in one group have shorter arms than those in the other group?

It is significant because it proves that if the level of pH changes, it affects the larva. This means that a more acidic ocean will negatively affect the larva.

13. What can we do to decrease the trend of acidification in the world's oceans.

We can decrease our admission of CO_2 by traveling by boat or bicycle more often, and changing our lifestyles to decrease this trend of acidification.

4. Please use the page "Exploring carbon levels and effects" to answer these questions.

How old will you be in 2050? 50

The most pessimistic scenario predicts an ocean pH of 7.9 in 2050.

The most optimistic scenario predicts an ocean pH of 7.96 in 2050.

What things will determine which scenario will be correct?

The amount of CO₂ produced, whether the amount increases or decreases, will determine which scenario will be right.

5. Use the drawing of the ocean chemistry "Carbon in water" to predict the effect of increasing acidification on calcifying organisms.

The organisms would be negatively affected because if there is less carbonate in the water, they won't be able to produce calcium carbonate which leads to weaker shells and possibly a slower growth.

Part 2

6. What is the model organism in the virtual experiment, & why was this organism chosen?

The model organism is the sea urchin and it was chosen because it lives in the ocean, and needs calcium to live.

7. Why are the pH's 8.1 and 7.7 selected for this experiment?

They are selected because 8.1 is the mean pH value in the ocean and 7.7 is what the mean pH value could be at the end of this century.

8. State a possible hypothesis for this experiment.

Sea urchins in a higher pH value will be better off while sea urchins in a lower pH value will die.

9. Why are there 3 replicates of cultures for each pH?

There are the three replicates for each pH because it provides more concrete results by using more than one replicate.

10. Why is the water drained from the samples and then re-added?

The water is drained then re-added to make sure the water is clean, and so that it stays at the correct pH value.

15/15

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Vocabulary: hypothesis, pH, acid, base, reactant, product, scenario, replicate, standard deviation

Procedure: Use the virtual lab to answer these questions as you navigate through parts 1, 2, and 3

Part 1

1. What does the graph of data from the Moana Loa lab indicate about the level of CO₂ in the atmosphere in 1960 compared to the present?

The level of CO₂ in the atmosphere in 1960 is significantly lower than that of the present.

2. The more concentrated the carbon dioxide in the atmosphere, the more CO₂ will dissolve in the oceans, and the more acidic the oceans will become. That means that the pH will be:

(a) lower b) higher c) remain the same

3. On the pH scale: 7 is neutral. The most acidic is 0.

The most basic/alkaline is 14.

4. The chemical equation $CO_2 + H_2O \rightarrow H_2CO_3$ shows the reaction that influences ocean acidification. Here is the equation in words:

Carbon dioxide + water produces carbonic acid.

What is/are the reactant(s)? Carbon dioxide & water

What is/are the products? Carbonic acid

4. Please use the page "Exploring carbon levels and effects" to answer these questions.

How old will you be in 2050? 49

The most pessimistic scenario predicts an ocean pH of 7.90 in 2050.

The most optimistic scenario predicts an ocean pH of 7.96 in 2050.

What things will determine which scenario will be correct?

Whether or not the world decides to be "integrated & ecologically friendly in the future, or keep using up energy sources & proceeding to fill the atmosphere with an excess of CO_2 .

5. Use the drawing of the ocean chemistry "Carbon in water" to predict the effect of increasing acidification on calcifying organisms.

There would be lower carbonate levels, so less calcium carbonate can be formed by animals who make their shells with this. The organisms would be in danger of weaker shells, and slower growth, generally hurting the organisms that depend on calcium carbonate to survive.

Part 2

6. What is the model organism in the virtual experiment, & why was this organism chosen?

The model organism is the larvae of sea urchins, chosen so that scientist could see the effects of acidifying sea water on an organism that depends on calcium carbonate to survive.

7. Why are the pH's 8.1 and 7.7 selected for this experiment?

Because pH 8.1 is the acidity of the ocean today, and pH 7.7 could be the pH of ocean water at the end of the century.

8. State a possible hypothesis for this experiment.

The larvae will have less stable skeletons and will be less developed if exposed to sea water with a lower pH as opposed to a higher pH.

9. Why are there 3 replicates of cultures for each pH?

So we could make sure that all of the jars had the same sea water in it.

10. Why is the water drained from the samples and then re-added?

So that the pH levels in the water goes back to the normal level, the dirty water can be drained, and the dead algae can be removed.

Part 3

11. List your data and the complete data set in the charts below.

Your data

	pH 7.7	pH 8.1
Replicate A	410	525
Replicate B	480	540
Replicate C	440	520
Average	443	528
Standard deviation	35.1 μm	10.4 μm

Treatment	Your data		Complete data set	
	pH 7.7	pH 8.1	pH 7.7	pH 8.1
Average	443	528	451.2	533.6
Standard deviation	35.1 μm	10.4 μm	48.2 μm	29.2 μm

12. Please explain the importance of the data in this experiment. How do the arms of the larva in pH 7.7 compare to the larva in 8.1?

The importance of the data is that you can clearly see the difference between the length of the larva's arms in pH 7.7 and in pH 8.1. In the higher pH, the legs of the larva's legs are considerably longer, because of the balance of carbon dioxide in the ocean water.

Why might it be significant that larva in one group have shorter arms than those in the other group?

They might have shorter legs because the carbon dioxide in the water is affecting their ability to grow, so a lower pH makes the larva's legs shorter. In a more stable condition with less CO_2 and high pH, the larva are able to develop & grow normally.

13. What can we do to decrease the trend of acidification in the world's oceans?

We can reduce the amount of CO_2 that we put into the atmosphere & the ocean. By doing this, I mean that we can reduce our carbon footprint by using our cars less, turning lights off when we leave rooms in our house, and using our AC/heating less.