

pH, CO₂, and Ocean Acidification

Lesson Summary:

When carbon dioxide is dissolved in water it lowers the pH as carbonic acid is formed. Increases in carbon dioxide to our atmosphere threaten to change our climate through global warming, however evidence suggests that this increase in carbon dioxide can lead to a lowering of pH in our oceans, a process called **ocean acidification**. This lesson looks at the process, the factors involved in ,and the effects of ocean acidification on marine organisms.

Key Concepts:

The major concepts in this lesson include

- pH
- Chemical change
- Ocean acidification
- The affects of a lower pH on aquatic creatures
- Climate change

Objectives :

- Demonstrate how pH in water is lowered with the addition of CO₂ .
- Demonstrate the effects of a lower pH on the carbonate exoskeletons and cell walls of marine animals.
- Examine CO₂ ocean data for evidence of ocean acidification

Activity: Egg in Vinegar Demonstration

This demonstration shows the effects of a lowered pH on organisms.

Materials: Large Jar , Egg, and Vinegar (Acetic Acid)

Procedure:

1. Place an egg in vinegar and seal it in a jar
2. Observe what happens.... (*bubbles form as shell begins breaking down*)

Next Day

3. Open jar , remove egg, and place it in a dish. What's happened to the materials that make up the egg ?

Discussion:

What happened to the Calcium Carbonate shell of the egg?

What is the effect of a lower pH on the shell ?

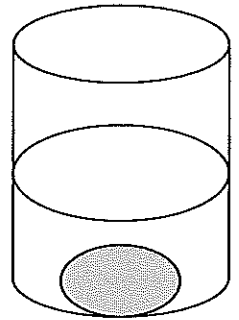
Where do we find calcium carbonate shells in the marine environment?

What could happen to those shells (exoskeletons) if the pH of the Ocean were to be lowered.

What does a lower pH do to the materials that make up living things ?

Follow up Activities:

What happens to a sea shell in vinegar?

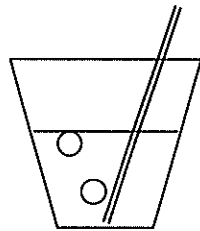


What happens to the pH of the vinegar before and after the addition of an egg or seashell ?

Activity : Carbon Dioxide and pH in Water

What can change the pH in an aquatic ecosystem ?

Materials: water beaker or clear plastic cup drinking straw
Aquarium pH test kit crushed coral or seashells



Procedure:

Pour about 50 ml of water to a clear plastic cup or beaker

Next, add 10 - 20 drops of pH indicator solution (from an aquarium pH test kit) to the water and mix it with a straw.

Record the color of the solution _____

Slowly!!! exhale through the straw into the water with pH Indicator solution until you notice a color change?

Describe the color change of the solution

What is happening to the pH of the solution? _____

What gas are you adding to the solution as you exhale? _____

Explain how this gas becomes part of the air that you exhale. _____

What does the addition of carbon dioxide gas do to the pH of water?

What process in living things might remove carbon dioxide gas from water? _____

Add some crushed coral or seashells to this solution and swirl it around slowly for several minutes. (Eventually you will notice a color change) .

What is happening to the pH of the solution as the coral or seashells are added ?

What material are these exoskeletons made of ?

What do you suppose has happened to the sea shells for them to change the pH of this solution?

Follow-up Activities

Measure the change in mass of sea shells before and after placing them in an acid.

Activity: Ocean Acidification

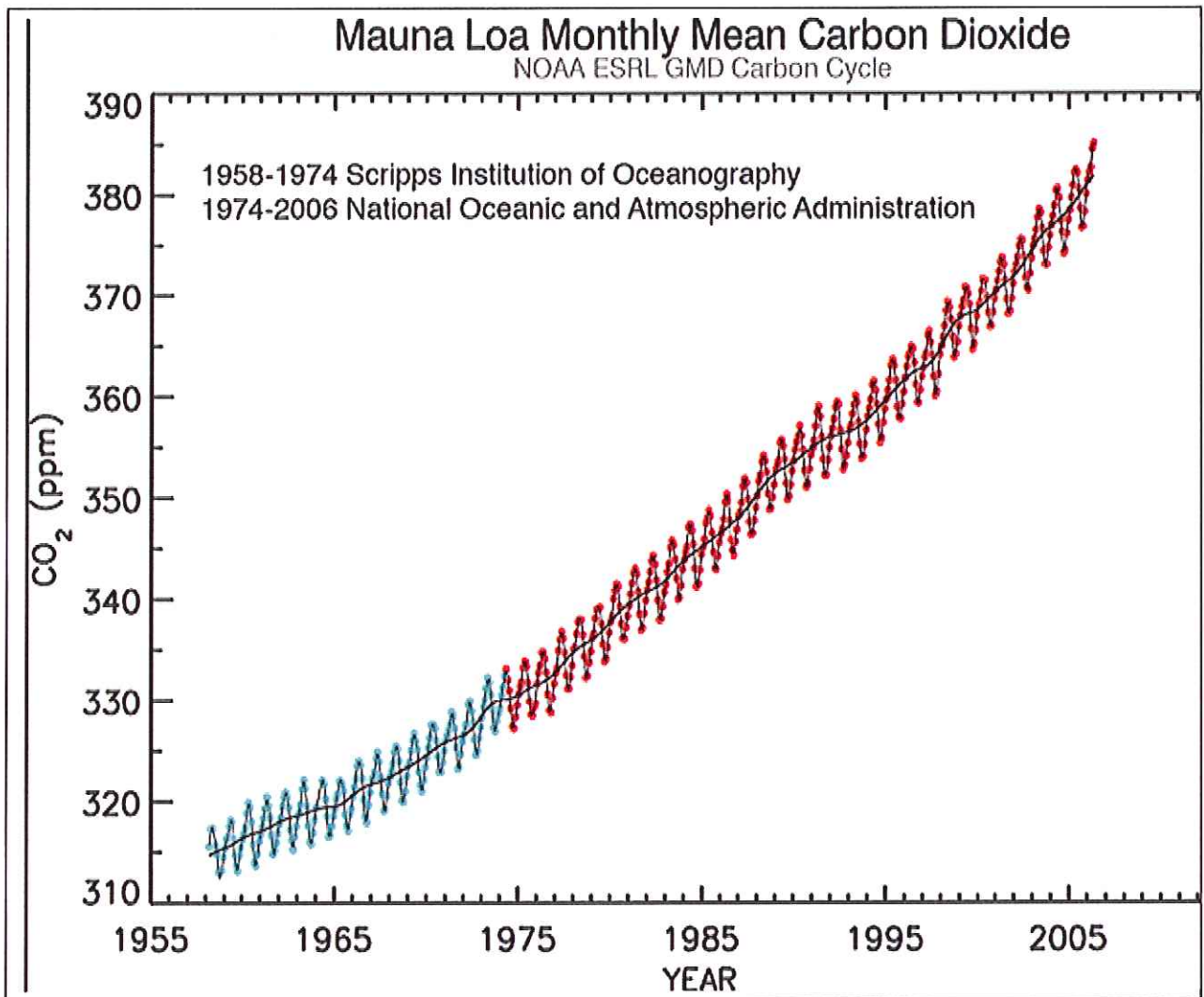
What do you think is meant by the term ocean acidification?

What does the addition of carbon dioxide do to the pH of a solution ?

What processes can add CO₂ to the environment?

What processes in living things can remove CO₂ from the environment?

Examine the graph from the Mauna Loa Atmospheric Observatory in Hawaii on the next page.



Graph copied from : <http://celebrating200years.noaa.gov/datasets/mauna/welcome.html#record>

What information is displayed in the X axis ? _____

How long of a time period has this been measured ? _____

"ppm" stands for _____

The definition of "mean" is _____

What does this graph show ?

What has happened to carbon dioxide levels in the atmosphere since 1955 ?

How can we explain this trend?

What happens to CO₂ levels during a one year period ?

Is this consistent each year ? _____

Explain this change in CO₂ levels within any given year... think about seasons.

As carbon dioxide levels increase in the atmosphere what may happen to the amount of CO₂ in the oceans?

What affects might this have on the pH of the oceans ?

What affects might this have on marine life?

The following is a graph from Bermuda Institute of Ocean Science.
The data came from the Bermuda Atlantic Time Series (BATS) as reported in the
Study of Interannual to Decadal Variability of Ocean Carbon Cycle. .

http://www.bbsr.edu/Labs/co2lab/research/IntDecVar_OCC.html

Study the graphs comparing CO₂ levels and pH in the series.

Is there a relationship between CO₂ levels and seawater pH ? Explain.

What is happening to the CO₂ levels since 1988 ? _____

If this trend continues what may happen to the pH of the marine environment in
this area ?

How will this affect the marine life ? _____
