A joint collaborative project of:
Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration
Ocean Acidification Program
National Oceanic and Atmospheric Administration

Education

Ocean Acidification: pH and the Ocean's Balance

Grade Level

- 5-8

Timeframe

- 20-30 minutes

Materials

- 8x11" sheets of paper (15 sheets)
- 5x7" index card
- Everyday household objects and edibles with different pH values
- An object to represent the ocean (i.e. snowglobes, vessel of water, a model marine creature)
- pH values for everyday objects (in "Materials" section below)
- pH scale

Key Words

- pH
- Carbon dioxide
- Acid
- Base

Essential Question

What does a shift in the ocean's pH mean for marine organisms?

Activity Summary

About a quarter of the carbon dioxide emitted into the atmosphere from the burning of fossil fuels, ends up in our ocean. Carbon dioxide is an "acid gas" and causes the ocean to become more acidic, which is represented by a lower pH. Although pH is just one piece of the acidification chemistry puzzle, understanding the pH scale, which tells us how basic or acidic a liquid is a great first step in understanding how our ocean's waters stay in balance. Even though the ocean waters aren't acidic, a small shift in this balance in pH, can make a big difference for marine organisms, just as it does in the human body.

Learning Objectives

Students will be able to:

- Recognize that pH is one way scientists measure ocean acidification
- Understand the pH scale, acids and bases
- Understand that a small shift in the pH scale represents a much large shift in the chemical balance

Key Messages

- The ocean is a vital part in the Earth's ecosystem and are a home to marine life that contribute to the health of human life on our planet.
- Human actions are changing the balance of the ocean's chemistry
- Small shifts in pH can make a big difference in the health of marine organisms health (in humans acidosis is a 0.05 decrease in pH, which causes illness)

Values

- Interconnected: Marine organisms and humans both maintain a delicate pH balance to remain healthy

- Simplifying models: A small increase or decrease on the pH scale is an exponentially larger shift in ocean chemistry

- Causal chain : burning fossil fuels emits CO_2 → the ocean absorbs CO_2→ CO_2 is an "acid gas"→it causes the ocean to become more acidic →a small decrease in pH (0.1 pH units) can tip the scale from healthy to not so well in marine organisms, just as it does in the human body

Solutions

The less "acid gas" (CO_2) humans emit into the atmosphere, the less will end up the ocean, ultimately. There are many innovations in alternative and efficient energy and transportation that can be made not just by an individual household, but by entire communities and cities.

- Look in to what options are available in your town and get involved:
    - Host a barn raiser type event to green a home (your own or your neighbor's) with more energy efficient appliances, windows or insulation.
    - Use public transportation, bike or walk if possible
    - If public transportation isn't readily accessible or there aren't bike lanes in your area talk to your local government representative and get the conversation started in your community

Activity Outline:

Preparation: Prior to activity write the numbers "1" through "14" of different 8"x11" sheets of papers. Place sheets with numbers 1-14 in numerical order in line from left to right (along a table, or along floor depending on setting). Write "8.1 on 5"x7" index and place on right upper corner of "8" paper.

Activity Outline (cont'd)

1) Inquire with student? Do you know what an acid is? A base? Would you like to learn about it?

- **a)** Introduce the pH scale (0-14):
- **b)** Anything above 7 is a basic (alkaline) anything below 7 is acidic, 7 is neither an acid or a base, but neutral
- **c)** 0= the strongest acid
  - **i)** Acid: usually sour, stings if touched, reacts or degrades metals
- **d)** 14= strongest base
  - **i)** Base is bitter, slippery if touched, dissolves fats and oils

2) Did you know there are acidic and basic substances we use and possibly eat each day?

- **a)** Ask student to pick household item (or offer them one) and ask them to place it on the scale to make their best guess at the pH of the item. Refer to "pH values of everyday objects" below. Can encourage them by telling them they are getting "hotter" or "cooler," or closer or further away if they are looking for direction. Or ask question about the substance such as "Does it taste sour?"
  - **i)** If student places the item on the correct place on the scales offer congratulations (correct pH values for items are referenced above). Explore as many items as time and interest allow saving the "ocean" for the last.
- **b)** When handing student the "ocean" let them know how special the ocean is and offer a prize for placing this is the right place on the scale (if available).
  - **i)** Can discuss the decrease in our ocean's pH over past century. One hundred years ago the ocean was at pH =8.1 and our ocean today at pH of 8.0 May be hard to believe that a 0.1 difference means much but…
  - **ii)** If the pH changes by ½ of that in our blood (just 0.05 decrease), it can cause headaches, confusion, feeling tired, tremors, sleepiness, and make it hard for the brain function. ("healthy blood pH= 7.45, called "acidosis" when blood pH = 7.4). Scientists have seen some of these same effects in some of the fish that live in the ocean (i.e. clownfish [Nemo], who may become confused and swim towards a predator in a more acidic ocean.

3) Do you know what is causing this change in ocean pH?

a) Carbon dioxide is an "acid gas" and causes the ocean to become more acidic (represented by a decrease on the pH scale).

- **b)** Carbon dioxide emissions/pollution into our atmosphere from things like:

  -driving our cars, boats, planes, trains
  -using electricity in our home
  -removing trees (deforestation) that hold Carbon dioxide in their leaves, preventing it from ending up in the ocean

Follow up Discussion

- Can you think of anything you can do to help lower the amount of carbon dioxide we release in to the atmosphere, which eventually ends up in the ocean?
- Discuss solutions (some community scale solutions are outlined above) which are appropriate when discussing with families and middle and high school students
    - For younger audience, individual solutions may be more appropriate:
        - turning off the lights when you leave the room
        - unplugging any vampire electronics (computers, chargers, etc.)

Materials:

Approximate pH of Everyday or Household Objects

- larger battery =2.2
- vinegar= 2.8
- coca-cola = 2.5 (classic) can range up to 4.2 with other brands
- lemon=2.3
- grapefruit = 3.0-3.3
- orange= 3.0-4.0
- apple= 3.5
- banana= 5.0
- milk= 6.5
- water bottle pH= 7 (6.5-8 depending on brand)
- human blood= 7.4
- ocean pH= 8.1 now 8.0
- baking soda= 8.4
- Tums, antacid= 10.5
- bleach= 12.6
- drain cleaner = 14

Resources

http://www.cisanctuary.org/ocean-acidification/

http://oceanacidification.noaa.gov/

Credit: Original lesson created by NOAA Ocean Acidification Program. Email noaa.oceanacidification@noaa.gov with any questions.