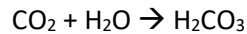




Background

When carbon dioxide (CO₂) dissolves in water (H₂O), it forms carbonic acid (H₂CO₃).



Since the Industrial Revolution, humans have been burning fossil fuels that release carbon dioxide into the atmosphere. Much of this carbon dioxide dissolves in the oceans, forming carbonic acid. This has changed the pH of the oceans from 8.2 to 8.1. Although this appears to be a small change, the pH scale is logarithmic. The change is a 30% increase in acidity.

In this activity, you will create carbon dioxide by the chemical reaction of vinegar and bicarbonate. The indicator will allow you to see if the carbon dioxide dissolves in water and changes the pH.

Materials (per person)

- Red cabbage indicator diluted to pale purple colour
- 3 clear glasses or beakers
- 3 small cups
- 3 cardboard pieces (to cover top of glass)
- Bicarbonate of soda
- White vinegar
- Masking tape
- 1 teaspoon measure

Activity

- Pour 1 cm of indicator into each glass
- Record your observations of the starting colour
- Tape a small cup just below the rim inside each larger glass
- Measure the following into the cups:
 - 1 – 1 teaspoon of bicarbonate of soda
 - 2 – 1 teaspoon of vinegar
 - 3 – 1 teaspoon of bicarbonate of soda and 1 teaspoon of vinegar
- Place cardboard over each of the cups immediately
- Lift the cardboard and add 1 more teaspoon of vinegar to the bicarbonate and vinegar mix after approx. 20 seconds (cup 3)
- Observe any changes in the solutions and record the colour of the indicator after 5 minutes

Results

Cup	Starting colour	Colour after 5 minutes
1 - Bicarbonate only		
2 - Vinegar only		
3 - Bicarbonate + vinegar		

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Questions

1. What is the purpose of the cups with bicarbonate only and vinegar only? _____

2. What does a colour change indicate? (Hint – you can try dropping some vinegar (acid) into the indicator to see what that does.) _____
3. How does this activity model what is happening in the world's oceans? _____

4. Many ocean species make shells and skeletons out of calcium carbonate. Carbonate ions (CO_3^{2-}) are less available as pH becomes more acidic. How will this affect shell builders? _____

Extension

The ocean has been more acidic in the past. Find out about the Mid Miocene (14 million years ago) and end Cretaceous (66 million years ago) acidification events. What caused the acidification? What happened to marine life?

References:

This activity is a modification of *Ocean Acidification in a Cup* from the Exploratorium Teacher Institute <https://www.exploratorium.edu/snacks/ocean-acidification-in-cup>
NOAA (2020). Ocean acidification from <https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification>

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