STEM Sims™

Buffers

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Do you need an idea for a scientific study?
Try out one of our ideas or make one of your own.

Start learning right now about how buffers impact your life. Take the following brief quiz to see how much you already know about buffers. See the bottom of page 4 to check your answers.

1. What is the internal pH of most living cells?
   a. 6.4
   b. 7.0
   c. 7.4
   d. 8.0

2. What is the normal pH of human blood?
   a. 6.4
   b. 7.0
   c. 7.4
   d. 8.0

3. A change in pH of a human's blood by about ± 0.4 pH units can cause death in minutes.
   a. true
   b. false

4. The kidneys play a pivotal role in maintaining the blood's proper pH range in the human body.
   a. true
   b. false

5. All of the following are possible causes of acidosis *except*:
   a. hyperventilating.
   b. obstruction in the windpipe.
   c. starvation.
   d. extreme exercising.

Oh, My Aching Stomach!

The stomach contains a relatively strong solution of hydrochloric acid that aids in the digestion of food. Occasionally, the concentration of the acid in the stomach becomes too high, which may result in a stomach ache. If the acid level remains too high for an extended time, the acid may eat away at the lining of the stomach resulting in an ulcer. In this activity, you will investigate what steps can be taken to reduce stomach acidity and hopefully, relieve stomach pain.

Materials Required

- 500-mL beaker or small cup
- 100 mL vinegar
- pH paper
- small can lemon-lime soda
- dropper
- Alka-Seltzer™ tablet
- distilled water
- stirring rod

Procedure

1. Be sure to have adult supervision when conducting any experiments in the home.
2. Wear safety glasses and other safety equipment.
3. Place about 20 mL of vinegar in the beaker. (The vinegar acts as the stomach acid here.)
4. Dip the stirring rod into the vinegar and touch the dipped end to a small piece of pH paper. Note and record the results in Table 1.
5. Add 5 drops of distilled water to the vinegar. Repeat step 4.
6. Repeat step 5 until a total of 25 drops have been added to the vinegar.
7. Wash the beaker with clean water and rinse the beaker with distilled water.
8. Place about 20 mL of vinegar in the beaker.
9. Repeat steps 5 - 7 with lemon-lime soda instead of distilled water.
10. Place about 20 mL of vinegar in the beaker.
11. Add the Alka-Seltzer™ tablet to the vinegar.
12. Repeat steps 5 - 7.

Table 1

Substance	pH
Vinegar only	
Vinegar + 5 drops distilled water	
Vinegar + 10 drops distilled water	
Vinegar + 15 drops distilled water	
Vinegar + 20 drops distilled water	
Vinegar + 25 drops distilled water	
Vinegar + 5 drops lemon-lime soda	
Vinegar + 10 drops lemon-lime soda	
Vinegar + 15 drops lemon-lime soda	
Vinegar + 20 drops lemon-lime soda	
Vinegar + 25 drops lemon-lime soda	
Vinegar + Alka-Seltzer™ tablet	

1. Which substance was the best at reducing the acidity of the vinegar? Which did not help?

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Leave It Up to Nature…Up to a Point

As the concentrations of sulfur and nitrogen oxides in the atmosphere increase due to the burning of fossil fuels and from vehicle and industrial wastes, the acidity of rainwater also increases. This increase in acidity is due to the combination of the oxides with water to form sulfuric, sulfurous, nitric, and nitrous acids, which rain down onto the earth. As the rain runoff collects in rivers and lakes, the pH of those bodies of water lowers. In extreme cases, the water becomes so acidic that life can no longer exist in those waters.

The good news is that some bodies of water have built-in natural buffers that resist changes in pH even upon the addition of acid rain. Rivers and lakes that have high concentrations of limestone in their geological foundation can keep the pH from lowering. Limestone is hard sedimentary rock that is primarily composed of calcium carbonate ($CaCO_3$). The $CaCO_3$ reacts with the acid in the body of water through a series of steps to eventually produce calcium ions and water. The chemical reaction removes the excess acid added to the water from the acid rain and maintains the pH in a healthy range for the living things in the water. Small bodies of water not possessing this natural buffered system can have limestone added to them for protection from acid rain. As with any buffered system, the addition of too large of a quantity of acid can overwhelm the system where the buffering action no longer protects the system from changes in pH. That's why buffered bodies of water are safe from acid rain…but only up to a point.

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Answers: **Page 2 Answers:** 1) b, 2) c, 3) a, 4) a, 5) a. **Page 3 Answer:** 1) The Alka-Seltzer tablet should be the best at buffering the system upon the addition of acid. The distilled water and lemon-lime soda should not be effective buffers.

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