Zombie Apocalypse Part II: The Humans Strike Back

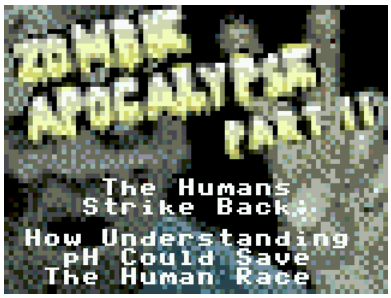
How Understanding pH Can Help Save the Human Race

Adapted from an activity © 2013 Texas Instruments

Help: http://www.cemetech.net/forum or stemzombie2@cemetech.net

Science Objectives

- Students will observe what happens during a titration of a strong acid with a strong base by using a simulation that allows them to visualize molecules in solution and a titration curve.
- Students will determine the volume of base needed to reach the equivalence point.
- Students will determine the relationship between pH and the presence of H^+ ions or OH^- ions in a solution.



Vocabulary

- Concentration
- Strong acid
- Biochemist
- Acidosis
- Acid dissociation constant
- Titration
- Prion
- Equivalence point
- Strong base
- Military Strategist
- Alkalosis
- pH
- Virologist

About the Lesson

- This lesson features a pH titration simulation that includes a molecular view of the chemical changes that occur as a strong base (NaOH) is added to a beaker containing a strong acid (HCl) solution.
- This lesson also contains a simulation of a titration of sodium bicarbonate and "zombie blood" that allows students to monitor changes in the pH of blood as baking soda is added. Students can inspect an electron microscope view of a prion subjected to a changing pH.
- As a result of this lesson, students will:
  - Understand the nature of strong acids and strong bases.
  - Be able to identify the chemical species present before, after, and at the equivalence point.

What Page Am I On?

When you see the **?** (question mark) symbol above GRAPH key, you can press it to find out what page you're on.

Tech Tips

- This activity includes screen captures taken using jsTIfied, a calculator emulator that runs in your browser (http://cemete.ch/emu)
- This lesson applies only to the TI-84 Plus C Silver Edition.

Lesson Files

- Student Activity: Zombie_Apocalypse_Pt2_Student.pdf
- Teacher Notes: Zombie_Apocalypse_Pt2_Teacher.pdf (this document)
- ZOMBIEA2.8xp and ZA2TD.8xv: Activity program files. Must be sent to handheld's Archive.
- Doors CSE 8.1, which provides necessary extra program functionality. *(Not included: download at http://dcs.cemetech.net).*

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Send files to your TI-84 Plus C Silver Edition

Using TI-Connect 4.0 or higher, or a TI-84 Plus C Silver Edition calculator that already has this activity, send the program ZOMBIEA2 (ZOMBIEA2.8xp) and the AppVar ZA2TD (ZA2TD.8xv) to your TI-84 Plus C Silver Edition. Both files should go to your calculator's Archive.

- **Using TI-Connect:** Open TI DeviceExplorer and select your calculator. Drag ZOMBIEA2.8xp into the item labeled "Flash/Archive" and wait for the transfer to complete. Drag ZA2TD.8xv into "Flash/Archive" as well.
- **From another calculator:** Put the receiving calculator in Receive mode by pressing [2nd] [XT0n] [▶] [ENTER]. On the sending calculator, go to the `Link` menu with [2nd] [XT0n], choose `2: All-…`, then find "`ZOMBIEA2 PRGM`" and "`ZA2TD AVAR`" and press [ENTER] next to each one. Each one should be marked with a square, indicating that it will be sent. Press [▶] [ENTER] to send the files over.

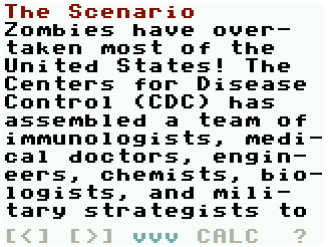
You will also need Doors CSE 8.1 or higher, which can be found at http://dcs.cemetech.net. The process of sending Doors CSE to your calculator is the same as above, and is also detailed in the Doors CSE readme document.

Discussion Points and Possible Answers

STEM CAREERS NOTE – In this activity, the student will be part of a special team of biochemists, virologists, medical doctors, programmers, engineers, and military strategists. The team is tasked with identifying the nature of an outbreak, determining a means of stopping the outbreak, and deploying the solution on a wide-spread basis. The activity focuses primarily on a fictional biochemist who is the team leader. It also exposes students to aspects of the other career fields throughout the activity.

Run the ZOMBIEA2 program; move to pages 2-11

1. Students should read the storyline and answer questions 1-2 on the activity sheet.



Q1. Changing the internal pH of a living organism could be harmful.

Answer: A. Agree. Changing the pH of a living organism can cause many negative symptoms and even death.

Q2. What is "alkalosis"?

Answer: *Answers will vary. Suggested response:* Alkalosis is the increase in body pH which causes negative symptoms and potentially death

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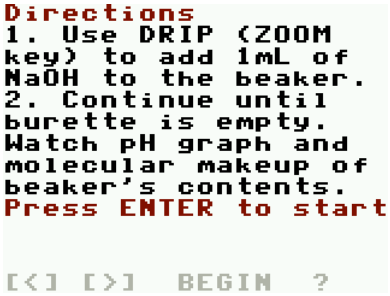
Move to pages 11-12

2. Students should read the directions for the simulation on page 1.12.



> **Teacher Tip**
>
> Before beginning this activity, teachers should make sure that students understand the definition of equivalence point. Page 11 of the activity offers a brief explanation.

Move to pages 14 and 15

Q3. Initially the beaker contains _____.

Answer: A. H^+ and Cl^- ions

Q4. How many H^+ ions are present in the beaker initially?

Answer: 9

Move to page 16

3. After students read the directions on page 16 for running the simulation, they will move back to page 12 and start the titration. The first stage is to add 5 drops and observe the changes. They then answer the next set of questions.

Move to pages 17-19

4. Have students answer the questions on the activity sheet.

Q5. As NaOH is added, the pH _____.

Answer: B. increases

Q6. As NaOH is added, the number of H^+ ions _____.

Answer: A. decreases

Q7. As NaOH is added, the number of Cl^- ions _____.

Answer: C. is unchanged

Move to pages 20-27

5. Have students answer the questions on the activity sheet. After students read the directions on page 20, they will move back to page 12 and continue to add drops and observe the changes. They can leave the simulation at any time as needed and answer the next set of questions, then return to it.

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Teacher Tip

The model neglects the self-dissociation of water, which is a weak acid. You may wish to tell students that there is actually a very small (10^{-7} mol/L) concentration of H^+ ions at the equivalence point, and review the definition of pH. You may wish to point out that the original solution has an H^+ concentration one million times greater than pure water.

Q8. How many mL of NaOH are needed to reach the equivalence point?

Answer: 25mL

Q9. At the equivalence point, how many Cl^- ions are present in the beaker?

Answer: None

Q10. At the equivalence point, how many H^+ ions are present in the beaker?

Answer: None

Q11. Write a net ionic equation to show what happened to the H^+ ions.

Answer: $H^+ + OH^- \rightarrow H_2O$

Q12. At the equivalence point, the number of Cl^- ions is _____ the number of Na^+ ions.

Answer: B. equal to

Q13. For a strong acid-strong base titration, what is the pH at the equivalence point?

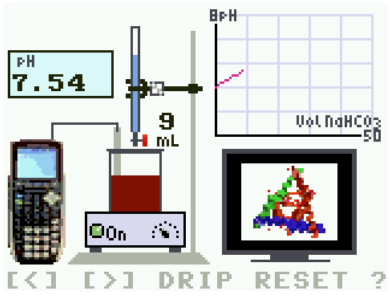
Answer: 7.0

Q14. As more NaOH is added, beyond the equivalence point, the pH increases because of the increase in the number of _____.

Answer: B. OH^- ions

Move to pages 28-32

6. Have students explore the modified titration set up and observe the graph that is created. Students will see that the ZVIT team has switched from NaOH to $NaHCO_3$ instead since it is much less caustic. Page 29 will give them the opportunity to experiment with fictional zombie blood and baking soda. They will see that the blood pH increases slowly with the addition of bicarbonate.



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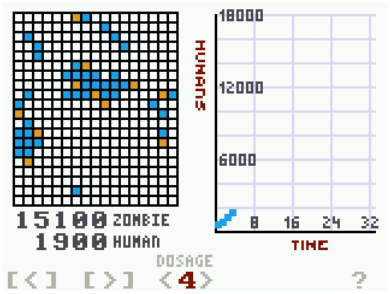
Move to pages 33-35

7. Students will see a simulation of zombie vs. human population. They can change dosage levels of the bicarbonate serum to see the effects on the rate of healing in the population.



Move to the Extension Questions on pages 36-40.

8. Students will have an opportunity to answer questions related to STEM careers.

Q15. Which of the following do you think could limit the effectiveness of the proposed treatment?

Answer: A, B, C, and D.

Q16. If you explored the first Zombie Apocalypse activity found at **http://cemete.ch/pr53**, you noticed that the prion caused major damage to the brain. Is it likely the new treatment would cause a full recovery of the patient?

Answer: B. No, regeneration of lost/badly damaged tissue is unlikely

Q17. Zombies are known as "the living dead" because their normal body systems don't function properly. Bicarbonate would be administered intravenously (IV). Some have argued that this form of treatment would not allow the drug to hit the targeted areas. Do you agree or disagree with this concern?

Answer: Agree (Not only because zombies are fictitious but, as generally defined, they do not possess a functional cardiovascular system which would be required to transport the serum to the target area).

Q18. The military strategists on the team are responsible for determining ways to administer the treatment to the zombie population. They are the deep thinkers that plan on how the resources of the military will be used most effectively to meet goals. Explain how you believe an understanding of science and math would be advantageous to this team of military experts.
Answer: A military strategist will need to be aware of the technology available as well as the conditions of the situation. A strong grasp of math and science will help the strategist.

Q19. Dr. Stephanie Mann is a biochemist. What do you think a biochemist does?
Answer: *Answers will vary. Suggested response* - A biochemist investigates the ways in which various chemical structures & compounds behave in a living system.

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Assessment

- Formative assessment consists of questions on the student worksheet.
- Summative assessment consists of a lab report (optional), questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.

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