Designing a Titration

Name _____

STUDENT ACTIVITY

Class _____

This is a project based STEM activity that will require you to understand and perform the processes of engineering design:

- Identify
- Research
- Design
- Create
- Evaluate
- Communicate

Vocabulary

- Acid and Base
- pH
- Titration
- Equivalence point

Activity Materials for Titration Lab

- Compatible TI Technologies: TI-Nspire™ Apps for iPad®
- Vernier™ Go Wireless® pH Sensor
- .10M HCl solution
- .10M NaOH solution
- Phenolphthalein
- 250 mL beakers
- Burets and Clamps
- Ring stands
- Stir plates and magnetic stir bars, if available
- Safety googles

Procedure

- Open the document called “GoWireless Molecular Titration.tns” on your iPad.
- Work your way through all of the pages in the document. Make sure you pay close attention to the Background Information and the instructions that are included. Use this information as you experiment with the titration simulation that is in the document. Pay attention to the graph and the contents of the beaker during the titration.

The Engineering Problem

Your Company designs and produces medicines. Your project manager has tasked you with designing a new medicine that will relieve acid indigestion for people who suffer acid reflux disease. Your task is to design a new antacid that will neutralize excess stomach acid and to support you product with test data.

What happens at the molecular level during a titration of a strong acid with a strong base?

Safety Tip: Always use safety goggle and always wash hands when working through this activity.

Safety Tip: Although recommended acids and bases are weak concentrations, be sure to know the appropriate procedures for spillage in the lab.

1. **Identify:** State your engineering goal here. What are you trying to make? What does it need to accomplish? How will you evaluate how well it works?

2. **Research:** Use appropriate internet resources to learn about your engineering goal. Your research may include building processes, constraints, potential problems, sources of error, materials, time limits, and scientific principles that apply to your design.

A titration is a volumetric analysis used to measure the amount (moles) of an unknown acid or base.

Next, you will set up a data collection experiment using a titration apparatus and a GoWireless pH Sensor

- Follow the instructions on how to set up the GoWireless pH Sensor.
- Put 25 mL of .10 M HCl into a 250 mL beaker.
- Put a few drops of phenolphthalein into the beaker with the HCl.
- Set up the Sensor to collect data in Events with Entry mode. Rather than simply having "Event" as the descriptor, you can change it to "drops" or "mL".
- Collect your first data reading in the beaker of acid and phenolphthalein.
- Add a squirt of .10 M NaOH to the beaker, swirl the contents of the beaker and then collect another data reading once the pH reading has stabilized on your iPad.
- Continue to add squirts and take collect data readings until the pH has leveled off.
- At this point, you can stop the data collection and begin the analysis of your data..

a) Describe the shape of your graph.

b) What was the initial pH?

c) What was the final pH?

d) Describe what was happening, molecularly, during the steepest part of the graph.

e) In which section of your graph was the [H+] greater than the [OH-]?

f) In which section of your graph was the [H+] less than the [OH-]?

g) In which section of your graph was the [H+] pretty equal to the [OH-]?

h) What was the approximate pH of the solution in the beaker before starting the titration?

i) Was the original solution in the beaker an acid or a base? How do you know?

j) What chemical was in the buret?

k) Approximately how many mL of NaOH needed to be added to the beaker before a dramatic change in pH was noticed?

l) Besides the dramatic jump in pH, what else did you notice at that point?

m) Besides a color change, how did the contents of the beaker differ at the end of the titration compared to the beginning?

3. **Design/Prototype:** Once you have researched the engineering goal, create a plan for making your design. Your design may include drawings, labels, materials lists, cost lists, etc. The prototype may be a first-time attempt at making the final product to learn how to put it together. Share your design and prototype with others, listen to their suggestions and decide for yourself the very best design.

4. **Create/Build:** Use your design and prototype experience to make your product to your specifications.

5. **Evaluate/Test:** Use the titration setup and the Vernier Go Wireless™ pH probe to justify which one is the best. Be sure the instructor approves each setup and mixture before proceeding at this step

6. **Analyze:** Analyze the performance of each antacid. An appropriate analysis might be the number of mL of .10M HCl that is neutralized per gram of antacid.

a) Write a balanced chemical equation for the neutralization of each of the potential antacid bases.

b) Consider the amount (number of moles) of HCl in 50mL of .1M HCl solution, along with the mole ratios from the above balanced equations. Calculate the amount of each antacid that should be used in your test titrations.

c) How will you know when the acid is neutralized?

d) List all of the factors that you think would make a good antacid.

e) Based on the result of your test, what would you change about your antacid?

7. **Refine:** After you have made your design and tested it, think about what you like and do not like about the design. Show your product to your friends and family and listen carefully to their comments. Include the best suggestions from your customer feedback into your design and rebuild your deign to make it better!

8. **Present:** Prepare a brief presentation of your creation in a cloud-based collaborative environment such as Google Drive. Share your presentation with your teacher, family and friends.