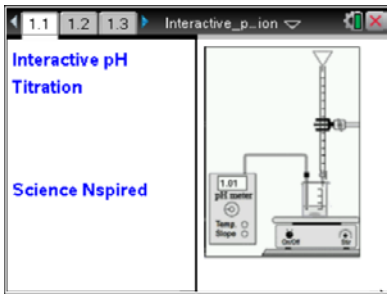
Science Objectives

- Students will observe how the features of a weak acid-strong base titration curve change when varying the acid ionization constant and/or the concentrations of the weak acid and strong base.
- Students will determine an equation for the volume of base added at the equivalence point.
- Students will relate pH to pKa at the "halfway" point in a titration. They will see that pH changes slowly with volume of base in the region around the halfway point. This is the buffer region.



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Use a minimized slider

Vocabulary

- acid ionization constant
- buffer
- equivalence point
- halfway point
- pH
- pKa
- titration curve

Tech Tips:

Make sure that students understand how to adjust a minimized slider by clicking ▲ or ▼.

About the Lesson

- This lesson features an interactive titration curve for a weak acid-strong base titration.
- As a result, students will have a better understanding of:
  - How acid concentration, acid ionization constant, and base concentration affect the titration.
  - The pH of a weak acid is not 7.0 at the equivalence point.
  - The pH at the halfway point is equal to the pKa of the acid.

Lesson Materials:

Student Activity

- Interactive_pH_Titration _Student.doc
- Interactive_pH_Titration _Student.pdf

TI-Nspire document

- Interactive_pH_Titration.tns

TI-Nspire™ Navigator™

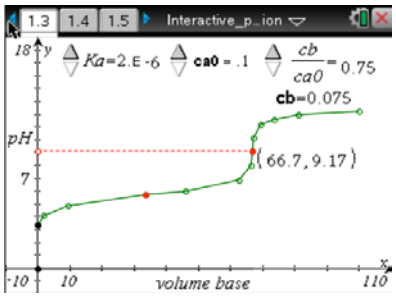
- Send out the *Interactive_pH_Titration.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *Interactive_pH_Titration.tns* document
- TI-Nspire™ Technology

Discussion Points and Possible Answers

Move to pages 1.2 and 1.3.



Students should read the introduction on page 1.2 to familiarize themselves with the variable names and parameters for the titration: **Ka** is the ionization constant of the weak acid, **ca0** is the initial concentration of the weak acid, **cb** is the concentration of the strong base (**cb** is set by multiplying **ca0** by a factor 0.75, 1.0, or 2.0). The initial volume of the weak acid solution is 50. mL. If your students are unfamiliar with the concept of pKa, you may want to go over this with them.

Move to pages 1.3–1.11.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q1. Adjust the three sliders on page 1.3 one at a time. Observe how the pH titration curve changes with each parameter. In the space below, record your observations on how changing the various parameters affect the curve?

Answer: Answers will vary but should be in line with the changes in the graph based on the increase or decrease in a given parameter's value.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter and have the student demonstrate how the pH curve changes as the sliders are changed. This will enhance the class discussion of the features of the pH titration curve.

Q2. What is the significance of the solid data point in the steep part of the titration curve (connected to the dotted horizontal line)?

Answer: This point is the equivalence point.

Q3. The initial pH _____.

Answer: C. depends on **Ka** and **ca0**

Q4. Increasing Ka corresponds to a _____ acid and a _____ initial pH.

Answer: B. stronger, lower

Q5. The pH at the equivalence point _____.

Answer: D. depends on **Ka**, **cao**, and **cb**

Q6. Write an equation to determine the volume of base **vbeq** at the equivalence point in terms of **ca0**, **cb**, and the initial volume of acid **va0**.

Answer: vbeq = (ca0)(va0)/cb)

Q7. What is the significance of the pH at the solid data point in the flat part of the titration curve? Hint: pKa = – log Ka.

Answer: This is the halfway point (halfway to the equivalence point). The pH at this point equals the pKa.

Q8. What volume of base corresponds to this data point?

Answer: ***vb* = ½(*vbeq*)**

Q9. In the region around this data point, the pH changes _____ with the volume of base. This region is known as the "buffer region" of the titration curve.

Answer: B. slowly

TI-Nspire Navigator Opportunities

If students answer the questions within the .tns file, the files can be collected at the end of class and graded electronically and added to the Portfolio.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the tns file is retrieved by TI-Nspire Navigator^{M}. The TI-Nspire Navigator^{M} Slide Show can be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.