Science Objectives

- Students will observe what happens during a titration of a strong acid with a strong base, using a simulation accompanied by a molecular view and pH graph.
- Students will determine the volume of base needed to reach the equivalence point.
- Students will see how pH is related to an excess of H^+ ions or an excess of OH^- ions in a solution.

Vocabulary

- acid dissociation constant
- aliquot
- concentration
- equivalence point
- pH
- strong acid
- strong base
- titration

About the Lesson

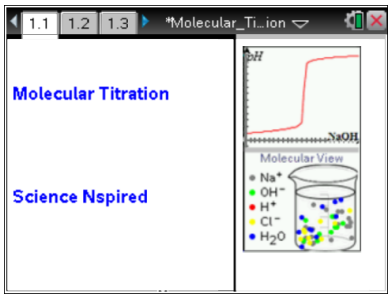
- This lesson features a simulation of a pH titration that includes a molecular view of the chemical changes that occur as a strong base (NaOH) is added to a beaker containing a strong acid (HCl) solution.
- As a result, students will have a better understanding of:
  - The nature of strong acids and strong bases.
  - The chemical species present before, after, and at the equivalence point.

TI-Nspire™ Navigator™

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

Activity Materials

- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software



Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Molecular_Titration_Student.doc
- Molecular_Titration_Student.pdf

TI-Nspire document

- Molecular_Titration.tns

Discussion Points and Possible Answers

Teacher Tip: If you are using the TI-Nspire Navigator to pick up and evaluate the .tns file you may not need to use the student activity sheet.

Move to page 1.2.

1. Students should read the introduction about the titration of a strong acid with a strong base.

Move to pages 1.3 and 1.4.

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

Q1. Referring to the titration curve on page 1.1, the equivalence point occurs _____.

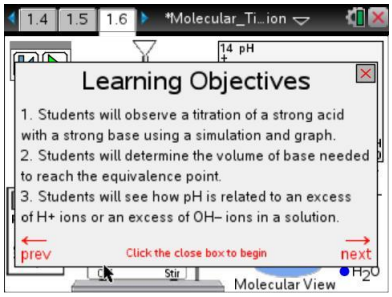
Answer: C. in the middle of the steep region

Q2. A strong acid (or a strong base) is a chemical species that _____.

Answer: B. ionizes completely in water.

Move to pages 1.5 and 1.6.

2. After students read about the titration set up on page 1.5 they should analyze the titration set up shown on page 1.6.
3. After reading the learning objectives and instructions on page 1.6, students should then close the directions box by selecting .



Tech Tip: To access the Directions again, select > **Titration** > **Show Help Screen**

Move to pages 1.7 and 1.8.

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

Q3. Initially the beaker contains _____.

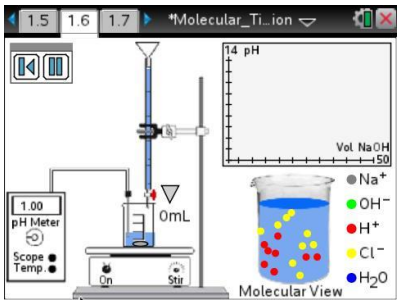
Answer: A: H^+ and Cl^- ions

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

Answer: 9

Move to page 1.9.

4. After students read the directions on page 1.9 for running the simulation, they will move back to page 1.6 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 1.10–1.12.

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

TI-Nspire Navigator Opportunities

Have students take turns being Live Presenters and have them explain how the graph and the molecular view correspond to what is happening in the titration. This will enhance student understanding of the lab simulation and how to interpret the molecular view and the titration graph

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 1.13–1.20.

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

5. After students read the directions on page 1.13, they will move back to page 1.6 and continue to add drops and observe the changes.

Tech Tip: Students need to select the Pause button to stop the action and answer the next set of questions.

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^+ ion 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: 25 mL

Q9. At the equivalence point how many H^+ ions remain in the beaker?

Answer: none

Q10. At the equivalence point how many OH^- ions remain 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

Tech Tip: There are 2 pages at the end of Problem 1, containing a spreadsheet and a graph. These are used to capture data from the titration and create the graphs. Students should not delete these pages. They can use the pages in their lab report, if they wish.

TI-Nspire Navigator Opportunities

Have students take turns being Live Presenters and have them explain how the graph and the molecular view correspond to what is happening in the titration. This will enhance student understanding of the lab simulation and how to interpret the molecular view and the titration graph

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 consists of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved by TI-Nspire Navigator. The TI-Nspire Navigator Slide Show can be utilized to give students immediate feedback on their assessment.
- Summative assessment consists of a lab report (optional), questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.