Name _____ Date _____ Period _____

ZornScience
zornscience.org

Titration Virtual Lab

Chemistry and AP Chemistry

Open **activities.zornscience.org/titration-lab/** and follow each step. Show your work with units.

Objective

Titrate a **strong acid** and a **weak acid** with a strong base. Use the pH curves to find the **equivalence point**, the **pK_a** of the weak acid, and the best **indicator**.

NGSS alignment: HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Practices and concepts: Analyzing and interpreting data; Using mathematics and computational thinking; Patterns; Cause and effect.

AP alignment: 4.6 Introduction to Titration; 8.5 Acid-Base Titrations; 8.7 pH and pK_a. Skills 3.A (represent data with graphs) and 5.D (identify information presented graphically to solve a problem).

Meet the simulation

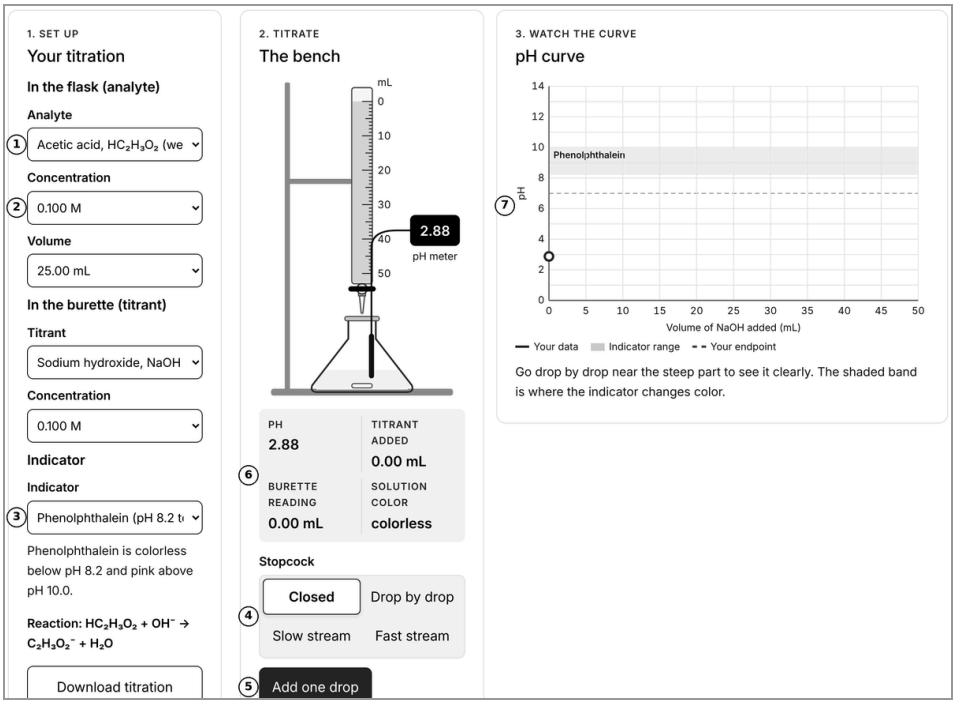


Figure 1. The Virtual Titration Simulator.

(1) Analyte: the acid or base in the flask.

(2) Concentration of the analyte. (Volume and the titrant are set below it.)

(3) Indicator. Its range is the shaded band on the graph.

(4) Stopcock: closed, drop by drop, slow stream or fast stream.

(5) Adds exactly one drop (0.05 mL).

(6) Readouts: pH, titrant added, burette reading, solution color.

(7) The pH curve your data draws.

Pre-lab

1. Define **analyte**, **titrant**, **equivalence point**, and **endpoint**.

2. What volume of 0.100 M NaOH exactly neutralizes 25.00 mL of 0.100 M HCl?

CC BY-NC-SA 4.0 | zornscience.org

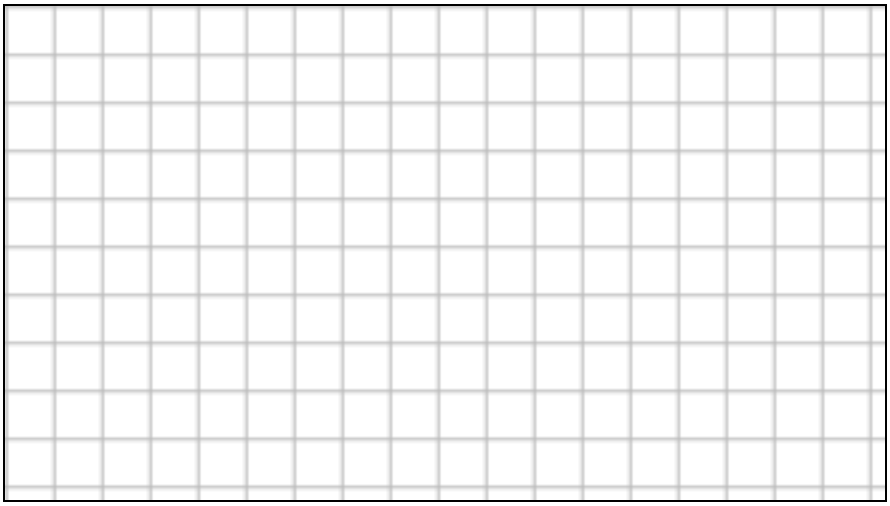
3. Predict: will the pH at the equivalence point be 7, above 7, or below 7 for (a) HCl with NaOH and (b) acetic acid with NaOH?

Part A and Part B. Build two pH curves

1. **Part A:** Set Analyte = **Hydrochloric acid**, Concentration = **0.100 M**, Volume = **25.00 mL**, Titrant = **Sodium hydroxide**, titrant Concentration = **0.100 M**, Indicator = **Phenolphthalein**.
2. Use **Slow stream** to get close to each volume in the table, select **Closed**, then select **Add one drop** until **Titrant added** is within 0.05 mL of the volume. Record the pH.
3. From 24 mL on, add one drop at a time. When the solution turns pale pink and stays pink, select **Record endpoint**. Then finish to 30 mL.
4. Select **Show key points** and record the pH at the equivalence point. Select **Hide key points**.
5. **Part B:** Change the Analyte to **Acetic acid** (all other settings the same). The flask starts over. Repeat steps 2 to 4, but leave the key points showing.

NaOH added (mL)	0.00	10.00	12.50	20.00	24.00	26.00	30.00	Endpoint (mL)	pH at equivalence
Part A pH, HCl									
Part B pH, acetic acid									

4. Plot both curves on the grid (pH on the y-axis, NaOH added on the x-axis). Label each curve and both axes.



5. Compare the two curves. Give three differences, using numbers from your table.

CC BY-NC-SA 4.0 | zornscience.org

Part C. Key points and indicators (acetic acid)

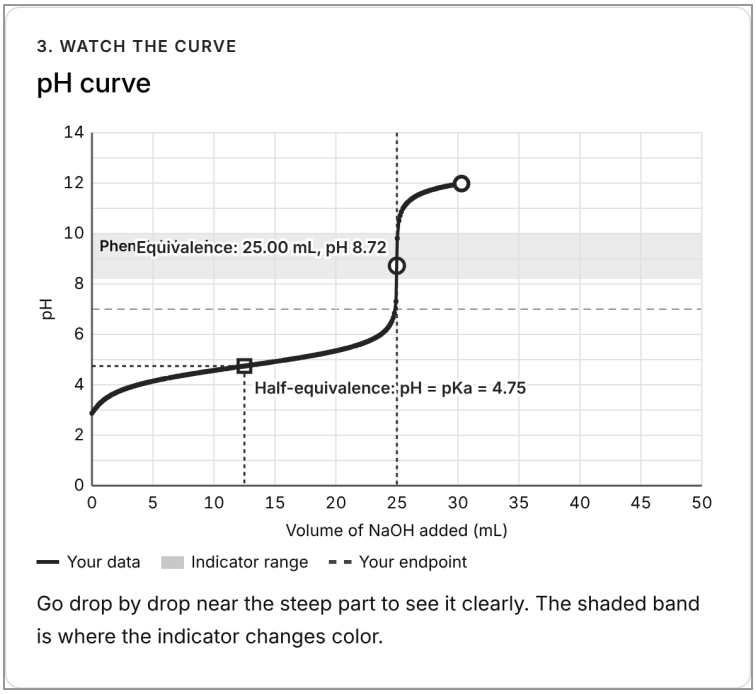


Figure 2. Show key points marks the equivalence point (circle) and the half-equivalence point (square).

1. Keep your acetic acid titration from Part B on screen.
2. Make sure **Show key points** is on. Read the equivalence and half-equivalence points on the graph and in the Key points list below it.
3. Change only the Indicator to each one in the table. Your data stay. Read the indicator sentence in the Key points list each time.

Indicator	Color change range (pH)	Changes color at about (mL)	Good or poor choice?
Phenolphthalein	8.2 to 10.0		
Bromothymol blue	6.0 to 7.6		
Methyl red	4.4 to 6.2		
Methyl orange	3.1 to 4.4		

6. Record the equivalence point and the half-equivalence point (volume and pH). What is the pK_a of acetic acid from your curve?

7. Use your indicator table to state a rule for choosing an indicator. Why is methyl red fine for HCl but poor for acetic acid?

8. Write the net ionic equation for the Part B reaction, with states. Then explain why the pH at the equivalence point is above 7.

CC BY-NC-SA 4.0 | zornscience.org

Analysis

9. A student titrates 25.00 mL of acetic acid of unknown concentration with 0.100 M NaOH. The equivalence point is at 31.20 mL. Find the concentration of the acid.

10. (AP extension) Use your pK_a to find K_a. Then calculate the starting pH of 0.100 M acetic acid and compare it to your reading at 0.00 mL.

11. (AP extension) Use the Henderson-Hasselbalch equation to predict the pH after 20.00 mL of NaOH is added to the acetic acid. Compare with your table.

12. Give two ways a real titration in a school lab could give a less accurate equivalence volume than this simulation.

Conclusion

13. Write a claim that answers the objective: how do the titration curves of a strong acid and a weak acid differ, and how can a curve give the pK_a and the right indicator? Support it with evidence (numbers) and reasoning.

CC BY-NC-SA 4.0 | zornscience.org