

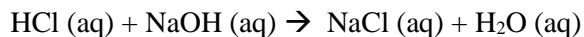
# Titration Simulation Lab & Practice

Name/Pd: \_\_\_\_\_

**Pre-Lab:** Complete the following practice problems.

1. Using titration it is found that 40.0 mL of HCl is required to neutralize 24.64 mL of 0.55 M NaOH. What is the molarity of the HCl? (Fill in the missing numbers in the gray boxes and follow the steps).

a. Step 1: Write the known quantities below the substances in the balanced chemical equation.



40.0 mL      24.64 mL

? M            0.55 M

b. Step 2: Set up dimensional analysis to solve for moles using molarity & the mole ratio as conversion factors.

$$? \text{ mol HCl} = \frac{24.64 \text{ mL NaOH}}{1000 \text{ mL NaOH}} \times \frac{1 \text{ L NaOH}}{1 \text{ L NaOH}} \times \frac{0.55 \text{ mol NaOH}}{1 \text{ L NaOH}} \times \frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} = \text{[gray box]} \text{ mol HCl}$$

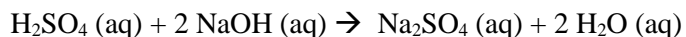
c. Step 3: Solve for molarity, using the molarity equation.

$$M = \text{mol/L}$$

$$M = \frac{\text{[gray box]} \text{ mol HCl}}{0.040 \text{ L HCl}} = \text{[gray box]} \text{ M HCl}$$

2. What volume of 1.366 M NaOH would be required to titrate 47.2 mL of 2.075 M H<sub>2</sub>SO<sub>4</sub>? (Fill in the missing numbers in the gray boxes and follow the steps).

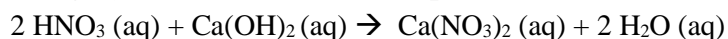
a. Step 1: Write the known quantities below the substances in the balanced chemical equation.



47.2 mL            ? mL

2.075 M            1.366 M

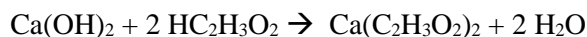
3. 20.0 mL of HNO<sub>3</sub> is titrated with 34.4 mL of 0.822 M Ca(OH)<sub>2</sub>. What is the concentration of the HNO<sub>3</sub>? (Fill in the missing numbers in the gray boxes and follow the steps).



[gray box] mL            [gray box] mL

[gray box] M            [gray box] M

4. It requires 24.6 mL of Ca(OH)<sub>2</sub> solution to neutralize 14.2 mL of 0.0140 M HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>. What is the concentration (M) of the calcium hydroxide solution? Use the problems above as a guideline. Show ALL of your work!!!



Teacher's Initials:
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**Directions:** You will complete acid-base titrations using a computer simulation. Make sure you read the entire procedure **before** you begin. The steps must be done in order.

Type the following website into the browser (case-sensitive):

[http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/acid\\_base.html](http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/acid_base.html)

**Trial 1:**

1. Select "Strong Acid vs. Strong Base"
2. Fill the burette with Base.
3. Select HNO<sub>3</sub> for the acid and KOH as the base.
  - Write the balanced equation for this reaction: \_\_\_\_\_
4. Select phenolphthalein as the indicator.
  - What is the initial color of the solution in the flask? \_\_\_\_\_
5. Record the molarity and volume of the acid in the data table.
6. Slowly add base (click and hold the slider to move it up 1-2 mL at a time, release it to add the base) until the solution begins to turn pink.
7. When the pink color begins to stay, add the base using the dropwise button.
8. When the solution stays *bubble gum pink* (you should still see the magnet), stop adding base.
  - a. This will take *PATIENCE* – do not over titrate!
  - b. If your solution turns a bright pink (and you can't see the magnet), you must reset the titration.
9. Record the final volume of base in your data table.
10. Calculate the molarity of the base (show your work in the calculations section) and enter it into the computer.
11. Click Ok.
12. If your answer is correct, you are done! If it is incorrect, click reset and begin again.

**Trial 2:**

1. Select "Strong Acid vs. Strong Base"
2. Fill the burette with Base.
3. Select any Acid and any Base from the list. Write the balanced equation for the reaction below:
4. Select phenolphthalein as the indicator.
5. Continue with steps 5-12 as above.

**Data Table:**

	<b>Trial 1</b>	<b>Trial 2</b>
<b>Volume of Acid</b>		
<b>Molarity of Acid</b>		
<b>Volume of Base</b>		

**Calculations:** Show *all* of your work below for step 10!

Trial 1:

Trial 2:

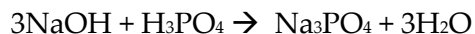
### Summing Up Questions:

1. At the end of the titration, is the solution acidic or basic? How do you know?
2. Explain the difference between the equivalence point and the end point of a titration.
3. Give the pH at the equivalence point for the following types of titrations:
  - a. Strong acid-strong base \_\_\_\_\_
  - b. Strong acid-weak base \_\_\_\_\_
  - c. Weak acid-strong base \_\_\_\_\_

**Practice:** Solve the following problems. Show all of your work! Use the problems in the pre-lab as guidelines.

1. By titration it is found that 12.4 mL of  $\text{H}_2\text{SO}_4$  is required to neutralize 19.8 mL of 0.0100M  $\text{Ca}(\text{OH})_2$ . What is the molarity of  $\text{H}_2\text{SO}_4$ ?  
$$\text{H}_2\text{SO}_4 + \text{Ca}(\text{OH})_2 \rightarrow \text{CaSO}_4 + 2\text{H}_2\text{O}$$

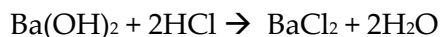
2. What is the molarity of phosphoric acid if 15.0 mL of the solution is neutralized by 38.5 mL of 0.15 M NaOH?



3. Find the volume of 0.80 M KOH needed to neutralize 15.0 mL of 0.65 M  $\text{H}_2\text{SO}_4$ .



4. What volume of 0.12 M  $\text{Ba}(\text{OH})_2$  is needed to neutralize 12.2 mL of 0.25 M HCl?



5. List the steps for setting up a titration experiment:

6. Define the following terms on the back of this lab sheet.

- |                            |                       |                      |                        |
|----------------------------|-----------------------|----------------------|------------------------|
| a. neutralization reaction | c. titration standard | e. equivalence point | g. acid-base indicator |
| b. titration               | d. buret              | f. end point         |                        |

