

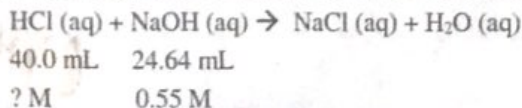
Titration Simulation Lab & Practice

Name/Pd: KEY

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.



16pts

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

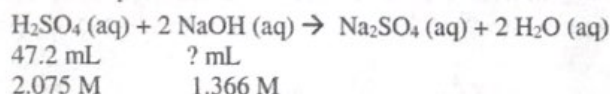
$$? \text{ mol HCl} = \frac{24.64 \text{ mL NaOH}}{1000 \text{ mL NaOH}} \times \frac{1 \text{ L NaOH}}{1 \text{ L NaOH}} \times \frac{0.55 \text{ mol NaOH}}{1 \text{ L NaOH}} \times \frac{1 \text{ mol HCl}}{1 \text{ mol NaOH}} = 0.0136 \text{ mol HCl}$$

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

$$M = \frac{\text{mol}}{\text{L}} \quad M = \frac{0.0136 \text{ mol HCl}}{0.040 \text{ L HCl}} = 0.339 \text{ M HCl}$$

2. What volume of 1.366 M NaOH would be required to titrate 47.2 mL of 2.075 M H₂SO₄? (Fill in the missing numbers in the gray boxes and follow the steps).

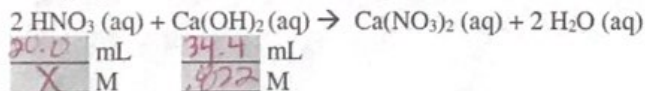
a. Step 1: Write the known quantities below the substances in the balanced chemical equation.



$$47.2 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{2.075 \text{ mol H}_2\text{SO}_4}{1 \text{ L}} \times \frac{2 \text{ mol NaOH}}{1 \text{ mol H}_2\text{SO}_4} = 0.196 \text{ mol NaOH}$$

$$= 0.143 \text{ L} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 143 \text{ mL}$$

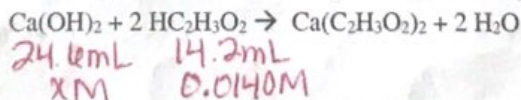
3. 20.0 mL of HNO₃ is titrated with 34.4 mL of 0.822 M Ca(OH)₂. What is the concentration of the HNO₃? (Fill in the missing numbers in the gray boxes and follow the steps).



$$34.4 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.822 \text{ mol Ca(OH)}_2}{1 \text{ L}} \times \frac{2 \text{ mol HNO}_3}{1 \text{ mol Ca(OH)}_2} = 0.0566 \text{ mol}$$

$$= 2.83 \text{ M HNO}_3$$

4. It requires 24.6 mL of Ca(OH)₂ solution to neutralize 14.2 mL of 0.0140 M HC₂H₃O₂. What is the concentration (M) of the calcium hydroxide solution? Use the problems above as a guideline. Show ALL of your work!!!



$$14.2 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.0140 \text{ mol HC}_2\text{H}_3\text{O}_2}{1 \text{ L}} \times \frac{1 \text{ mol Ca(OH)}_2}{2 \text{ mol HC}_2\text{H}_3\text{O}_2} = 9.94 \times 10^{-5}$$

$$= 0.0040 \text{ M Ca(OH)}_2$$

Teacher's Initials:

4pts

Summing Up Questions:

1. At the end of the titration, is the solution acidic or basic? How do you know? (1 pt)

basic, pink color

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 7

b. Strong acid-weak base < 7

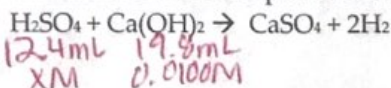
c. Weak acid-strong base > 7

less 7

greater 7

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

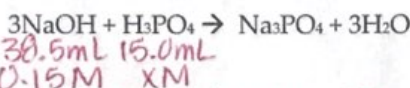
1. By titration it is found that 12.4 mL of H_2SO_4 is required to neutralize 19.8 mL of 0.0100M $\text{Ca}(\text{OH})_2$. What is the molarity of H_2SO_4 ? (2 pts)



(2 pts) = 0.0110M

$$19.8 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.0100 \text{ mol Ca}(\text{OH})_2}{1 \text{ L}} \times \frac{1 \text{ mol H}_2\text{SO}_4}{1 \text{ mol Ca}(\text{OH})_2} = \frac{1.98 \times 10^{-4} \text{ mol H}_2\text{SO}_4}{0.0124 \text{ L}}$$

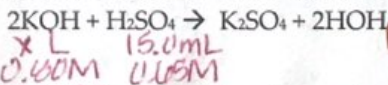
2. What is the molarity of phosphoric acid if 15.0 mL of the solution is neutralized by 38.5 mL of 0.15 M NaOH? (2 pts)



(2 pts) = 0.128M H_3PO_4

$$38.5 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.15 \text{ mol NaOH}}{1 \text{ L}} \times \frac{1 \text{ mol H}_3\text{PO}_4}{3 \text{ mol NaOH}} = \frac{0.00193 \text{ mol H}_3\text{PO}_4}{0.0150 \text{ L}}$$

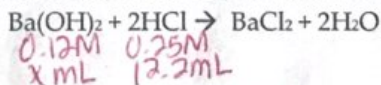
3. Find the volume of 0.80 M KOH needed to neutralize 15.0 mL of 0.65 M H_2SO_4 . (2 pts)



(2 pts) = 24.4 mL

$$15.0 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.65 \text{ mol H}_2\text{SO}_4}{1 \text{ L}} \times \frac{2 \text{ mol KOH}}{1 \text{ mol H}_2\text{SO}_4} = \frac{0.0195 \text{ mol KOH}}{x \text{ L}} = 0.80 \text{ M}$$

4. What volume of 0.12 M $\text{Ba}(\text{OH})_2$ is needed to neutralize 12.2 mL of 0.25 M HCl? (2 pts)



(2 pts) = 12.7 mL

$$12.2 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.25 \text{ mol HCl}}{1 \text{ L}} \times \frac{1 \text{ mol Ba}(\text{OH})_2}{2 \text{ mol HCl}} = \frac{0.00153 \text{ mol Ba}(\text{OH})_2}{x \text{ L}} = 0.12 \text{ M}$$

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