

**CHAPTER 15 REVIEW***Acid-Base Titration and pH***SECTION 1****SHORT ANSWER** Answer the following questions in the space provided.**1.** Calculate the following values without using a calculator.

- \_\_\_\_\_ a. The  $[\text{H}_3\text{O}^+]$  is  $1 \times 10^{-6}$  M in a solution. Calculate the  $[\text{OH}^-]$ .
- \_\_\_\_\_ b. The  $[\text{H}_3\text{O}^+]$  is  $1 \times 10^{-9}$  M in a solution. Calculate the  $[\text{OH}^-]$ .
- \_\_\_\_\_ c. The  $[\text{OH}^-]$  is  $1 \times 10^{-12}$  M in a solution. Calculate the  $[\text{H}_3\text{O}^+]$ .
- \_\_\_\_\_ d. The  $[\text{OH}^-]$  in part c is reduced by half, to  $0.5 \times 10^{-12}$  M. Calculate the  $[\text{H}_3\text{O}^+]$ .
- \_\_\_\_\_ e. The  $[\text{H}_3\text{O}^+]$  and  $[\text{OH}^-]$  are \_\_\_\_ (directly, inversely, or not) proportional in any system involving water.

**2.** Calculate the following values without using a calculator.

- \_\_\_\_\_ a. The pH of a solution is 2.0. Calculate the pOH.
- \_\_\_\_\_ b. The pOH of a solution is 4.73. Calculate the pH.
- \_\_\_\_\_ c. The  $[\text{H}_3\text{O}^+]$  in a solution is  $1 \times 10^{-3}$  M. Calculate the pH.
- \_\_\_\_\_ d. The pOH of a solution is 5.0. Calculate the  $[\text{OH}^-]$ .
- \_\_\_\_\_ e. The pH of a solution is 1.0. Calculate the  $[\text{OH}^-]$ .

**3.** Calculate the following values.

- \_\_\_\_\_ a. The  $[\text{H}_3\text{O}^+]$  is  $2.34 \times 10^{-5}$  M in a solution. Calculate the pH.
- \_\_\_\_\_ b. The pOH of a solution is 3.5. Calculate the  $[\text{OH}^-]$ .
- \_\_\_\_\_ c. The  $[\text{H}_3\text{O}^+]$  is  $4.6 \times 10^{-8}$  M in a solution. Calculate the  $[\text{OH}^-]$ .

**PROBLEMS** Write the answer on the line to the left. Show all your work in the space provided.**4.**  $[\text{H}_3\text{O}^+]$  in an aqueous solution =  $2.3 \times 10^{-3}$  M.

- \_\_\_\_\_ a. Calculate  $[\text{OH}^-]$  in this solution.

SECTION 1 continued

\_\_\_\_\_ b. Calculate the pH of this solution.

\_\_\_\_\_ c. Calculate the pOH of this solution.

d. Is the solution acidic, basic, or neutral? Explain your answer.

\_\_\_\_\_

5. Consider a dilute solution of 0.025 M  $\text{Ba}(\text{OH})_2$  in answering the following questions.

a. What is the  $[\text{OH}^-]$  in this solution? Explain your answer.

\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_ b. What is the pH of this solution?

6. Vinegar purchased in a store may contain 6 g of  $\text{CH}_3\text{COOH}$  per 100 mL of solution.

\_\_\_\_\_ a. What is the molarity of the solute?

b. The actual  $[\text{H}_3\text{O}^+]$  in the vinegar solution in part a is  $4.2 \times 10^{-3}$  M. In this solution, has more than 1% or less than 1% of the acetic acid ionized? Explain your answer.

\_\_\_\_\_  
\_\_\_\_\_

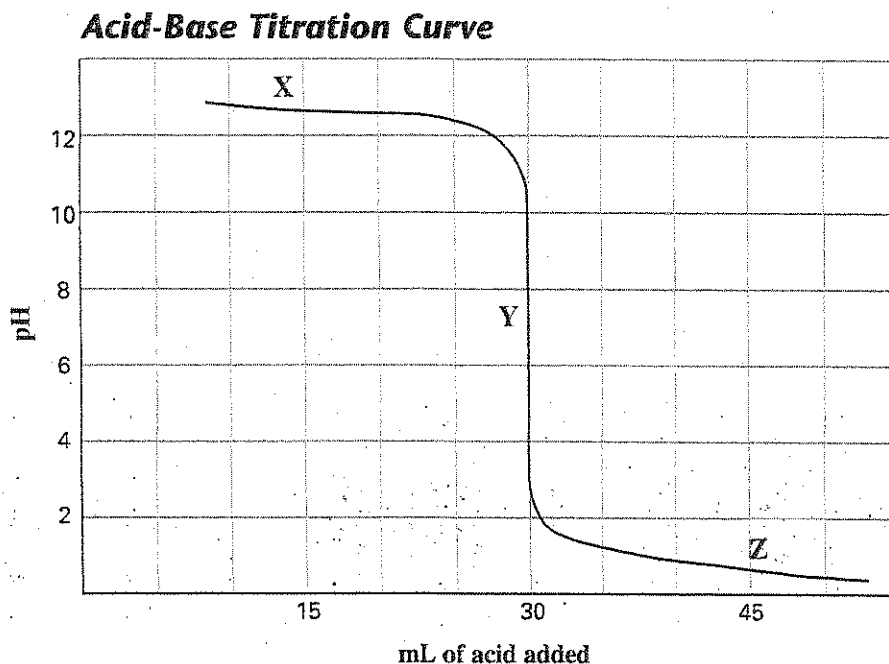
\_\_\_\_\_ c. Is acetic acid strong or weak, based on the ionization information from part b?

\_\_\_\_\_ d. What is the pH of this vinegar solution?

## CHAPTER 15 REVIEW

*Acid-Base Titration and pH***SECTION 2****SHORT ANSWER** Answer the following questions in the space provided.

1. Below is a pH curve from an acid-base titration. On it are labeled three points: X, Y, and Z.



- \_\_\_\_\_ a. Which point represents the equivalence point?
- \_\_\_\_\_ b. At which point is there excess acid in the system?
- \_\_\_\_\_ c. At which point is there excess base in the system?
- \_\_\_\_\_ d. If the base solution is 0.250 M and there is one equivalent of  $\text{OH}^-$  ions for each mole of base, how many moles of  $\text{OH}^-$  ions are consumed at the end point of the titration?

**PROBLEMS** Write the answer on the line to the left. Show all your work in the space provided.

2. A standardized solution of 0.065 M HCl is titrated with a saturated solution of calcium hydroxide to determine its molarity and its solubility. It takes 25.0 mL of the base to neutralize 10.0 mL of the acid.
- a. Write the balanced molecular equation for this neutralization reaction.
- \_\_\_\_\_

## SECTION 2 continued

\_\_\_\_\_ b. Determine the molarity of the  $\text{Ca}(\text{OH})_2$  solution.

\_\_\_\_\_ c. Based on your answer to part **b**, calculate the solubility of the base in grams per liter of solution. (Hint: What is the concentration of  $\text{Ca}(\text{OH})_2$  in the saturated solution?)

3. It is possible to carry out a titration without any indicator. Instead, a pH probe is immersed in a beaker containing the solution of unknown molarity, and a solution of known molarity is slowly added from a buret. Use the titration data below to answer the following questions.

Volume of  $\text{KOH}(\text{aq})$  in the beaker = 30.0 mL

Molarity of  $\text{HCl}(\text{aq})$  in the buret = 0.50 M

At the instant pH falls from 10 to 4, the volume of acid added to  $\text{KOH}$  = 27.8 mL.

\_\_\_\_\_ a. What is the mole-ratio of chemical equivalents in this system?

\_\_\_\_\_ b. Calculate the molarity of the  $\text{KOH}$  solution, based on the above data.

**CHAPTER 15 REVIEW***Acid-Base Titration and pH***MIXED REVIEW****SHORT ANSWER** Answer the following questions in the space provided.

1. Calculate the following values without using a calculator.

\_\_\_\_\_ a. The  $[\text{H}_3\text{O}^+]$  in a solution is  $1 \times 10^{-4}$  M. Calculate the pH.\_\_\_\_\_ b. The pH of a solution is 13.0. Calculate the  $[\text{H}_3\text{O}^+]$ .\_\_\_\_\_ c. The  $[\text{OH}^-]$  in a solution is  $1 \times 10^{-5}$  M. Calculate the  $[\text{H}_3\text{O}^+]$ .

\_\_\_\_\_ d. The pH of a solution is 4.72. Calculate the pOH.

\_\_\_\_\_ e. The  $[\text{OH}^-]$  in a solution is 1.0 M. Calculate the pH.

2. Calculate the following values.

\_\_\_\_\_ a. The  $[\text{H}_3\text{O}^+]$  in a solution is  $6.25 \times 10^{-9}$  M. Calculate the pH.\_\_\_\_\_ b. The pOH of a solution is 2.34. Calculate the  $[\text{OH}^-]$ .\_\_\_\_\_ c. The pH of milk of magnesia is approximately 10.5. Calculate the  $[\text{OH}^-]$ .**PROBLEMS** Write the answer on the line to the left. Show all your work in the space provided.3. A 0.0012 M solution of  $\text{H}_2\text{SO}_4$  is 100% ionized.\_\_\_\_\_ a. What is the  $[\text{H}_3\text{O}^+]$  in the  $\text{H}_2\text{SO}_4$  solution?\_\_\_\_\_ b. What is the  $[\text{OH}^-]$  in this solution?

\_\_\_\_\_ c. What is the pH of this solution?

**MIXED REVIEW** continued

4. In a titration, a 25.0 mL sample of 0.150 M HCl is neutralized with 44.45 mL of Ba(OH)<sub>2</sub>.

a. Write the balanced molecular equation for this reaction.

\_\_\_\_\_

\_\_\_\_\_ b. What is the molarity of the base solution?

5. 3.09 g of boric acid, H<sub>3</sub>BO<sub>3</sub>, are dissolved in 200 mL of solution.

\_\_\_\_\_ a. Calculate the molarity of the solution.

b. H<sub>3</sub>BO<sub>3</sub> ionizes in solution in three stages. Write the equation showing the ionization for each stage. Which stage proceeds furthest to completion?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ c. What is the [H<sub>3</sub>O<sup>+</sup>] in this boric acid solution if the pH = 4.90?

\_\_\_\_\_ d. Is the percentage ionization of this H<sub>3</sub>BO<sub>3</sub> solution more than or less than 1%?