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CHAPTER 19 CHAPTER ASSESSMENT

Acids and Bases

Reviewing Vocabulary

Compare and contrast each of the following terms.

1. Arrhenius model, Brønsted-Lowry model

2. acid ionization constant, base ionization constant

3. conjugate acid, conjugate base, conjugate acid-base pair

4. end point, equivalence point

5. pH, pOH

6. strong acid, weak acid

7. strong base, weak base

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CHAPTER 19 **CHAPTER ASSESSMENT**

Understanding Main Ideas (Part A)

In the space at the left, write *true* if the statement is true; if the statement is false, change the italicized word or phrase to make it true.

______________ **1.** When water self-ionizes, *hydronium* and hydroxide ions form.

______________ **2.** A hydronium ion is a hydrated *hydrogen* ion.

______________ **3.** Acetic acid ($HC_2H_3O_2$) is a *polyprotic* acid.

______________ **4.** The *buffer capacity* for an acid indicates whether reactants or products are favored at equilibrium.

______________ **5.** The value of K_w at 298 K is 1.0×10^{-14}.

______________ **6.** A pH greater than 7 indicates a *standard* solution.

______________ **7.** If the pH of a solution is 10, its pOH is *4*.

______________ **8.** NaOH is a strong base. The $[OH^-]$ of a 0.10*M* NaOH solution is *0.010M*.

______________ **9.** In a neutralization reaction, an acid and a base react to produce *an oxide* and water.

______________ **10.** In a titration in which an acid-base indicator is used, the color of the indicator always changes at the *equivalence* point of the titration.

______________ **11.** A solution of a salt of a strong acid and a weak base will be *slightly acidic*.

______________ **12.** Buffers are solutions that resist changes in pH when *limited* amounts of acid or base are added.

______________ **13.** Acetic acid, a weak acid, and sodium acetate, a salt, form *an amphoteric* solution when they are dissolved in water.

______________ **14.** The process of the anions of the dissociated salt accepting hydrogen ions from water or the cations of the dissociated salt donating hydrogen ions to water is called *ion-product constant for water*.

Complete the following.

15. Write an ionization equation and an acid ionization constant expression for HF.

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16. Write a base ionization constant expression for butylamine ($C_4H_9NH_2$).

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17. Calculate the pH of a solution with a $[H^+]$ of 1.0×10^{-4}.

Understanding Main Ideas (Part B)

Below are three steps showing the ionization of arsenic acid (H_3AsO_4). Number the equations for the three steps in the order they occur. Following the equations are three values for K_a, one for each step of the ionization. Next to each equation, write the value of K_a for that step.

Steps: **K_a:**

______ **1.** $H_2AsO_4^-(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + HAsO_4^{2-}(aq)$ **4.** ______________

______ **2.** $H_3AsO_4(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + H_2AsO_4^-(aq)$ **5.** ______________

______ **3.** $HAsO_4^{2-}(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + AsO_4^{3-}(aq)$ **6.** ______________

Values for K_a:

4.5×10^{-7} 5.5×10^{-3} 5.1×10^{-12}

Answer the following questions.

7. Explain how acids and bases are important to the human body.

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8. Calcium and magnesium hydroxides are strong bases, but they are used in antacids. Why won't they harm human tissue?

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9. How many times more acidic is a solution with a pH of 5 compared with one with a pH of 8? Explain.

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Solve the following problems. Show your work.

10. What are $[H^+]$ and $[OH^-]$ for a solution that has a pH of 3.92?

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11. Find the $[H^+]$, the pOH, and the $[OH^-]$ of a solution with a pH of 4.20.

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Thinking Critically

Answer the following questions.

1. The formula for citric acid is $H_3C_6H_5O_7$.

a. Is citric acid monoprotic or polyprotic? Explain.

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b. How many ionizable hydrogen atoms does it contain? Explain.

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c. What is the name applied to acids with this number of ionizable hydrogen atoms?

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d. Use equations to show the steps involved in the complete ionization of this acid.

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2. Assume you have 0.10*M* HCl, a strong acid, and 1.00*M* $HC_2H_3O_2$, a weak acid. Which is more concentrated? Which is more acidic? Explain your answers.

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3. Assume that H_2Z is a strong acid. The ionization steps of H_2Z are as follows.

$$H_2Z(aq) + H_2O(l) \rightarrow H_3O^+(aq) + HZ^-(aq)$$

$$HZ^-(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + Z^-(aq)$$

Explain why a single arrow was used in the first equation and a double arrow was used in the second.

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4. Explain why acids found in foods such as citrus fruits are safe to eat.

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Applying Scientific Methods

Two students performed a titration to determine the concentration of a solution of acetic acid ($HC_2H_3O_2$). They used a known solution of 0.100*M* potassium hydroxide (KOH) as the standard solution.

Answer the following questions about the titration.

1. Write a balanced formula equation for this acid-base reaction.

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2. Consider the strengths of the acid and base used in the titration. Would you expect the results of the reaction to be neutral, slightly acidic, or slightly basic? Explain.

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3. Phenolphthalein was chosen as an indicator for the reaction. Why was phenolphthalein a good choice?

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4. How could using a piece of plain, white paper under the flask as the students did the titration help them determine the end point?

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5. To confirm their results, the students performed several trials, the results of which are shown in Table 19-1. Use the buret readings to determine the volume of KOH used for each trial. Place these values in the table.

Table 19-1

Titration Data				
Trial	**Buret reading (mL)**		**Volume used (mL)**	
	Initial	**Final**	**KOH**	**$HC_2H_3O_2$**
1	0.00	30.01	**a.**	25.00 mL
2	10.23	40.18	**b.**	25.00 mL
3	5.37	32.87	**c.**	25.00 mL
4	2.25	32.30	**d.**	25.00 mL
5	4.28	34.30	**e.**	25.00 mL
6	0.00	32.64	**f.**	25.00 mL

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Applying Scientific Methods, *continued*

6. During one trial, the students forgot to swirl the solution as the titration was being done. Do you think the volume of KOH used would be greater or less than if it was swirled? Explain. From the data, which trial wasn't swirled?

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7. In one trial, the solution was overtitrated, which means that too much standard solution was added. Without computing volumes of KOH used, how did the students know this occurred? From the data, during which trial did this overtitration take place?

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Use the data and calculations from Table 19-1 to answer the following questions related to Table 19-2.

Table 19-2

Titration Calculations

Trial	Amount (mol)		(*M*)
	KOH	$HC_2H_3O_2$	
1	**8a.**	**10a.**	**11a.**
2	**8b.**	**10b.**	**11b.**
3	**8c.**	**10c.**	**11c.**
4	**8d.**	**10d.**	**11d.**
5	**8e.**	**10e.**	**11e.**
6	**8f.**	**10f.**	**11f.**

8. Calculate the number of moles of KOH used in each trial. Place each answer in Table 19-2.

9. From the balanced equation for this reaction, what is the mole ratio of the acid and the base?

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10. From this mole ratio and the numbers of moles of KOH used, determine the number of moles of $HC_2H_3O_2$ used in each trial. Place each answer in Table 19-2.

11. Use the volume and mole values from the tables to find the concentration of $HC_2H_3O_2$ used in each trial. Place each answer in Table 19-2.

12. What is the average value of the concentration of $HC_2H_3O_2$?

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