

Lesson 22: Acids and Bases I

text: 324-339

what to know:

- Bronsted theory of acids and bases, hydronium ion, (hydrated proton, H_3O^+), §8-1
- concept of the ion product of water, K_w , and its use, §8-2
- concept of pH, how to measure and use pH, §8-2
- weak acids and bases and their dissociation equilibria (K_a , K_b , $\text{p}K_a$ & $\text{p}K_b$), §8-3
- what the magnitude of K_a tells us and how it relates to the % ionization, §8-3
- what indicators are and how they work, §8-3
- concept of amphoterism, §8-1

questions:

1. What is the conjugate acid of H_2S ? HCO_3^- ? H_2O ? CN^- ?
2. What is the conjugate base of HPO_4^{2-} ? H_2S ? OH^- ? NH_4^+ ?
3. What is the a) $[\text{OH}^-]$ b) pH of a solution in which the $[\text{H}^+]$ is 2.0×10^{-4} ?
4. What is the $[\text{H}^+]$ of a 0.0176 M HCl solution? a NaOH solution with a pH of 12.79?
5. What is the a) $[\text{H}^+]$ b) pOH of a solution if its pH is 2.77? c) the strongest base that can exist in water?
6. Which hydroxide is the strongest acid? $\text{SO}_2(\text{OH})_2$, $\text{Ba}(\text{OH})_2$, $\text{SO}(\text{OH})_2$
7. Which of the following would make aqueous solutions basic? CN^- , Cl^- , NO_3^- , CO_3^{2-} , SO_4^{2-} , NH_4^+
8. Acids HA, HB and HC have K_a s of 10^{-3} , 10^{-4} , and 10^{-5} respectively.
 - a. Which is the weakest acid?
 - b. Which is the strongest base, A^- , B^- or C^- ?
 - d. Which anion in b above would form the aqueous solution with the highest pH (be the most hydrolyzed)?
9. Which would form the most a. basic aqueous solution? b. acidic aqueous solution? c. neutral aqueous solution? NaCl , Na_2S , NH_4Cl , $(\text{NH}_4)_2\text{S}$
10. Relate the strength of an acid with the magnitude of its K_a . What is the K_a for aqueous HCl?
11. If acid, HA, has a K_a of 2.5×10^{-5} , what is the $\text{p}K_b$ for A^- ?
12. Given solution A with a pH of 6.0 and solution B with a pH of 8.0. What is the ratio of the hydrogen ion concentration in solution B as compared to solution A?
13. Given a water solution of bromothymol blue. Bromothymol blue has a K_a of about 1×10^{-7} and is yellow in acid and blue in base. What do you know about the ratio of $[\text{HIn}]$ to $[\text{In}^-]$ and the pH when the solution is green? is blue? is yellow?
14. Given the following acids: HCl, HF ($K_a = 7 \times 10^{-4}$), HCO_3^- ($K_a = 5 \times 10^{-11}$)
 - a. Which is the strongest acid?
 - b. Which anion is the strongest base, Cl^- , F^- , or CO_3^{2-} ?
 - c. Which acid has the highest $\text{p}K_a$?
 - d. Which anion has the smallest K_b , Cl^- , F^- , or CO_3^{2-} ?
 - e. Write the reaction of F^- with water.
 - f. What is the value for the K_b for F^- ion?

Lesson 22 continued: Acids and Bases II

text: 339-351

what to know:

- weak acids and bases and their dissociation equilibria, §8-4
- acid-base properties of salts (ions)(hydrolysis), §8-4
- concept of buffers and how they work, §8-5

questions:

1. Propanoic acid has a K_a of 1.3×10^{-5} .
 - a. What is the pH of a 0.20 M solution?
 - b. What is the % ionization?
2. What is the a) K_a b) pK_a for 0.20 M HA(aq) with a pH of 3.00?
3. What is the a) pH b) K_a for a 0.30 M acid solution which is 0.20% ionized?
4. The K_a for acetic acid is 1.8×10^{-5} .
 - a. What is the $[H^+]$ of a 0.10 M sodium acetate solution?
 - b. How many moles of acetic acid would have to be added to 1.0 L of 0.100 molar sodium acetate solution to prepare a buffer of pH 5.00?
5. Is aqueous NH_4CN acidic or basic? Justify your answer.
6. Consider weak acid HB with a pK_a of 5.0. What is the ratio of $[B^-]$ to $[HB]$ in each of the following cases?
 - a. 0.10 M HB
 - b. 50.0 mL of 0.30 M HB plus 50.0 mL of 0.20 M NaB
 - c. 50.0 mL of 0.30 M HB plus 50.0 mL of 0.20 M NaOH
 - d. 50.0 mL of 0.30 M NaB plus 50.0 mL of 0.20 M HCl
7. What is the $[H^+]$ of a solution prepared by mixing 50.0 mL of 0.100 M NaOH with each of the following assuming that volumes are additive?
 - a. 50.0 mL of 0.075 M HCl?
 - b. 50.0 mL of 0.100 M HCl?
 - c. 50.0 mL of 0.200 M acetic acid?
 - d. 50.0 mL of 0.100 M acetic acid?
 - e. 50.0 mL of 0.050 M acetic acid?
8. Which statement(s) is/are true regarding a 0.10 M solution of:
 - a. strong acid 1) pH = 1.00 2) $[H^+] = [A^-]$ 3) $[HA]$ approximates 0. 4) K_a is large
 - b. very weak acid HA 1) pH is above 1.00 2) $[H^+] = [A^-]$ 3) $[HA]$ approximates 0.10 4) $K_a < 1$
 - c. weak acid HA which has been exactly one half neutralized with NaOH.
 - 1) $[H^+] = [A^-]$ 2) $[A^-] > [H^+]$ 3) $[A^-]/[HA] = 1.0$ 4) $[A^-]/[HA] = 2$ 5) $[H^+] = K_a$
9. The protonated form of pyridine, $C_5H_5NH^+$ (HP^+), has a K_a of 6×10^{-6} . Within what pH range could buffers be made from pyridine?
10. What would you add to an ammonium chloride solution to prepare a buffer?
11. Which combination of equal volumes would result in the formation of a buffer?
 - a. 0.1 M CH_3COOH and 0.05 M $NaCH_3COO$
 - b. 0.1 M CH_3COOH and 0.05 M NaOH
 - c. 0.1 M $NaCH_3COO$ and 0.05 M HCl