Exercise 15.2

Common Ion Effect & Buffers

Name: ________________________

Date:_________________ Per:________

Part A – The Common Ion Effect

1. Consider the following equilibrium system:

$$PbCl_2\ (s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^{-}(aq)$$

Explain what happens to the solubility of $PbCl_2$ when the following substances are added to the solution.

a. $Pb(NO_3)_2$ ____

b. NaCl ____

c. H_2O ____

d. $AgNO_3$ ____

2. Consider the following equilibrium system:

$$AgBr(s) \rightleftharpoons Ag^{+}(aq) + Br^{-}(aq)$$

Explain what happens to the solubility of AgBr(s) when the following substances are added to the solution.

a. $Pb(NO_3)_2$ ____

b. $AgNO_3$ ____

c. NaCl ____

d. NaBr ____

3. A certain buffer is made by dissolving $NaHCO_3$ and Na_2CO_3 in some water. Write equations to show how this buffer neutralizes added H^+ and OH^-.

4. Explain why more $Zn(OH)_2$ dissolves when 3*M* HCl is added to a saturated solution of $Zn(OH)_2$. Start by writing the correct equilibrium equation.

Part B – Calculating the pH of Buffer Solutions (Use ICE Tables for 5-8.)

5. Calculate the pH of a solution containing 0.085 M nitrous acid (HNO_2, $K_a = 4.5 \times 10^{-4}$) and 0.10 *M* potassium nitrite (KNO_2). *(Answer: 3.42)*

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6. Calculate the pH of a solution that is 0.295 M in sodium formate ($NaHCO_2$) and 0.205 M in formic acid (HCO_2H). The Ka of formic acid is 1.77×10^{-4}. *(Answer: 3.910)*

7. A buffered solution is made by adding 50.0 g NH_4Cl to 1.00 L of a 0.750 M solution of NH_3. Calculate the pH of the final solution. Assume no volume change. (K_a of $NH_4^+ = 5.6 \times 10^{-10}$.)

8. Determine the pH of a buffer that is 0.12 *M* in lactic acid $HC_3H_5O_3$ and 0.10 *M* in sodium lactate $NaC_3H_5O_3$? For lactic acid, $K_a = 1.4 \times 10^{-4}$. *(Answer: 3.77)*

9. Using the Henderson-Hasselbalch formula, calculate the pH of a buffer that contains 0.270 M hydrofluoric acid (HF) and 0.180 M cesium fluoride (CsF). The K_a of hydrofluoric acid is 6.80×10^{-4}. *(Answer: 2.99)*

10. Using the Henderson-Hasselbalch formula, calculate the pH of a buffer solution that contains 0.820 grams of sodium acetate and 0.010 moles of acetic acid in 100 ml of water. The K_a of acetic acid is 1.77×10^{-5}. *(Answer: 4.75)*

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Part C – Preparing Buffer Solutions

11. How many moles of NH_4Cl must be added to 2.0 L of 0.10 *M* NH_3 to form a buffer whose pH is 9.00? K_b of NH_3 is 1.8 x 10^{-5}. (Assume that the addition of NH_4Cl does not change the volume of the solution.) (*Answer: 0.36 mol* NH_4Cl*)*

12. Calculate the concentration of sodium benzoate that must be present in a 0.20 *M* solution of benzoic acid (C_6H_5COOH) to produce a pH of 4.00. K_a of benzoic acid is 6.3 x 10^{-5}. *(Answer: 0.13 M)*

13. Calculate the mass of sodium acetate that must be added to 500.0 mL of 0.200 M acetic acid to form a pH = 5.00 buffer solution.

14. Consider a solution containing 0.100 M fluoride ions and 0.126 M hydrogen fluoride. Calculate the concentration of hydrogen fluoride after addition of 8.00 mL of 0.0100 M HCl to 25.0 mL of this solution. *(Answer: 0.0979)*

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15. Calculate the percent ionization of nitrous acid in a solution that is 0.249 M in nitrous acid. The acid dissociation constant of nitrous acid is 4.50×10^{-4}. *(Answer: 4.25)*

16. Calculate the formate ion ($COOH^-$) concentration and pH of a solution that is 0.050 *M* in formic acid ($HCOOH$, $K_a = 1.8 \times 10^{-4}$) and 0.10 *M* in HNO_3. *(Answer: [$HCOO^-$] = 9.0×10^{-5}, pH = 1.00)*

17. Consider the bases in the table provided. Which base would be the best choice for preparing a pH = 5.00 buffer? Explain how to make 1.0 L of this buffer.

Table 14.3 | Values of K_b for Some Common Weak Bases

Name	Formula	Conjugate Acid	K_b
Ammonia	NH_3	NH_4^+	1.8×10^{-5}
Methylamine	CH_3NH_2	$CH_3NH_3^+$	4.38×10^{-4}
Ethylamine	$C_2H_5NH_2$	$C_2H_5NH_3^+$	5.6×10^{-4}
Aniline	$C_6H_5NH_2$	$C_6H_5NH_3^+$	3.8×10^{-10}
Pyridine	C_5H_5N	$C_5H_5NH^+$	1.7×10^{-9}