CHEM-1105 ACID- BASE PROBLEMS

1. Calculate the pH of each of the following solutions.

   a) 0.10 M HCl
   b) 5.0 M $HClO_4$
   c) 0.20 M $Ba(OH)_2$
   d) 0.20 M H_2SO_4

2. A solution is prepared by adding 50.0 mL of 0.300 M HCl and 20.0 mL of 0.250 M $Ca(OH)_2$. Calculate the pH.

3. A solution is prepared by adding 50.0 mL of concentrated hydrochloric acid and 20.0 mL of concentrated nitric acid to 300 mL of water. More water is added until the final volume is 1.00 L. Concentrated hydrochloric acid is 38% HCl by mass and has a density of 1.19 g/mL; concentrated nitric acid is 70% HNO_3 by mass and has a density of 1.42 g/mL. Calculate the pH of the solution.

4. Calculate the concentrations of all species, pH and % ionization for each of the following.

   a) 0.20 M $HC_2H_3O_2$ b) 1.5 M HNO_2 c) 0.10 M NH_3

5. A solution is prepared by dissolving 2.44 g of benzoic acid ($HC_7H_5O_2$, $K_a = 6.4 \times 10^{-5}$) in enough water to make 1.0 L of solution. Calculate its pH.

6. The pH of a 0.063 M solution of hypobromous acid, HBrO, is 4.95. Calculate K_a.

7. A solution of formic acid ($HCHO_2$, $K_a = 1.8 \times 10^{-4}$) has a pH of 2.70. Calculate the initial concentration of formic acid.

8. Calculate the pH for the following salt solutions.

   a) 0.10 M NaCl b) 0.10 M KF

9. Calculate the pH of a solution made by mixing 600 mL of 0.20 M $HC_2H_3O_2$ and 400 mL of 0.15 M $NaC_2H_3O_2$.

10. A buffer is made by adding 75.0 g of sodium acetate, $NaC_2H_3O_2$, to 500 mL of a 0.64 M solution of acetic acid, $HC_2H_3O_2$. What is the pH of the solution?

11. Calculate the pH of a buffer that is 0.25 M NH_3 and 0.20 M NH_4Cl.

12. An aqueous solution contains dissolved NH_4Cl and NH_3. The concentration of NH_3 is 0.50 M, and the pH is 8.95. Calculate the equilibrium concentration of NH_4^+.

13. Consider the titration of 40.0 mL of 0.20 M $HClO_4$ by 0.10 M NaOH. Calculate the pH of the resulting solution after the following volumes of NaOH have been added.

    a) 0.0 mL b) 40.0 mL

    c) 60.0 mL d) 80.0 mL

14. Consider the titration of 100.0 mL of 0.200 M acetic acid, $HC_2H_3O_2$, by 0.100 M KOH. Calculate the pH of the resulting solution after each of the following volumes of KOH has been added.

    a) 0.0 mL b) 50.0 mL c) 100.0 mL

    d) 200.0 mL e) 250.0 mL

15. Consider the titration of 100.0 mL of 0.100 M H_2NNH_2 ($K_b = 3.0 \times 10^{-6}$) by 0.200 M HNO_3. Calculate the pH of the resulting solution after the following volumes of HNO_3 have been added.

    a) 0.0 mL 25.0 mL

    c) 50.0 mL 60.0 mL

CHEM-1105 ANSWERS TO ACID-BASE PROBLEMS

1. a) 1.00 b) 0.70 c) 13.60 d) 0.40

2. 1.15

3. 0.029

4. $[H_3O^+] = [C_2H_3O_2^-] = 1.9 \times 10^{-3}$ $[HC_2H_3O_2] = 0.20$

   pH = 2.72 % ionization = 0.95

5. 2.94

6. 2.0×10^{-9}

7. 2.2×10^{-2}

8. a) 7.00 b) 8.07

9. 4.44

10. 5.20

11. 9.35

12. 1.00 M

13. a) 0.70 b) 1.30 c) 1.70 d) 7.00

14. a) 2.72 b) 4.27 c) 4.74 d) 8.78 e) 12.15

15. a) 10.47 b) 8.48 c) 4.83 d) 1.90