Buffer/Titration Practice Problems

1. 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? (Assume that the addition of NH_4Cl does not change the volume of the solution.)

2. Calculate the concentration of sodium benzoate that must be present in a 0.20 *M* solution of benzoic acid ($HC_7H_5O_2$) to produce a pH of 4.00. (Ans. 0.13M)

3. A buffer is made by adding 0.300 mol $HC_2H_3O_2$ and 0.300 mol $NaC_2H_3O_2$ to enough water to make 1.00 L of solution. The pH of the buffer is 4.74. **(a)** Calculate the pH of this solution after 0.020 mol of NaOH is added. **(b)** For comparison, calculate the pH that would result if 0.020 mol of NaOH was added to 1.00 L of pure water (neglect any volume changes)

4. Determine **(a)** the pH of the original buffer described in Question 3 after the addition of 0.020 mol HCl, and **(b)** the pH of the solution that would result from the addition of 0.020 mol HCl to 1.00 L of pure water. (Ans. **(a)** 4.68, **(b)** 1.70)

5. Calculate the pH when the following quantities of 0.100 *M* NaOH solution have been added to 50.0 mL of 0.100 *M* HCl solution: **(a)** 49.0 mL, **(b)** 51.0 mL.

6. Calculate the pH when the following quantities of 0.100 *M* HNO_3 have been added to 25.0 mL of 0.100 *M* KOH solution: **(a)** 24.9 mL, **(b)** 25.1 mL. (Ans. **(a)** 10.30, **(b)** 3.70)

7. Calculate the pH of the solution formed when 45.0 mL of 0.100 *M* NaOH is added to 50.0 mL of 0.100 *M* $HC_2H_3O_2$ ($K_a = 1.8 \times 10^{-5}$).

8. **(a)** Calculate the pH in the solution formed by adding 10.0 mL of 0.050 *M* NaOH to 40.0 mL of 0.0250 *M* benzoic acid ($HC_7H_5O_2$, $K_a = 6.3 \times 10^{-5}$). **(b)** Calculate the pH in the solution formed by adding 10.0 mL of 0.100 *M* HCl to 20.0 mL of 0.100 *M* NH_3. (Ans. **(a)** 4.20, **(b)** 9.26)

9. Calculate the pH at the equivalence point in the titration of 50.0 mL of 0.100 *M* $HC_2H_3O_2$ with 0.100 *M* NaOH.

10. Calculate the pH at the equivalence point when **(a)** 40.0 mL of 0.025 *M* benzoic acid ($HC_7H_5O_2$, $K_a = 6.3 \times 10^{-5}$) is titrated with 0.050 *M* NaOH; **(b)** 40.0 mL of 0.100 *M* NH_3 is titrated with 0.100 *M* HCl. (Ans. **(a)** 8.21, **(b)** 5.28)