Chemistry 204: Quiz #4

1. Consider a 100.0 mL solution of 2.00*M* HCN. How many moles of NaOH(s) must be added to obtain a pH of 9.00? Neglect any volume change from the addition of the solid NaOH.

   a) 1.00×10^{-6} mol b) 1.00×10^{-5} mol c) 0.0765 mol d) 0.163 mol e) 0.2001 mol

2. Consider a 100.0 mL solution of 0.100*M* NaCN. What volume of 0.100*M* HCl must be added to obtain a solution with a pH of 3.00?

   a) 82.5 mL b) 100.0 mL c) 102.0 mL d) 108.0 mL e) 150.0 mL

3. Consider four beakers, each with 100.0 mL of an aqueous solution of 1.00*M* HCN. You add the following to the beakers:

   - Beaker 1: 100.0 mL of 1.00 *M* $HC_2H_3O_2$
   - Beaker 2: 100.0 mL of 1.00 *M* HF
   - Beaker 3: 100.0 mL of 1.00 *M* NH_3
   - Beaker 4: 100.0 mL of water

   Which beaker, at equilibrium, will contain the lowest concentration of $CN^-(aq)$?

   a) Beaker 1 b) Beaker 2 c) Beaker 3 d) Beaker 4 e) They are all the same.

4. Order the bases F^-, NO_3^-, NH_3, $C_2H_3O_2^-$, and H_2O from strongest to weakest. Which comes third in this ranking?

   a) F^- b) NO_3^- c) NH_3 d) $C_2H_3O_2^-$ e) H_2O

5. How many of the following decrease as an aqueous weak acid is diluted with water?

   I. The pH of the solution.
   II. The percent dissociation of the solution.
   III. The concentration of $OH^-(aq)$.
   IV. The K_a value of the acid.

   a) 0 b) 1 c) 2 d) 3 e) 4

6. You titrate a solution of acetic acid ($HC_2H_3O_2$) with the same concentration as a solution of NaOH to the "quarter-equivalence" point (that is, you add a volume of the base that is one-quarter, or ¼, the volume of the acid). Which of the following best estimates the pH of the solution at the quarter-equivalence point?

   a) 3.56 b) 4.14 c) 4.27 d) 4.53 e) 4.74

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7. You have 2.00*M* solutions of HF, HNO_2, HCl, HCN, and $HC_2H_3O_2$. You make four solutions by mixing equal volumes of two of the acids as follows:

   Beaker A: HCl and HF
   Beaker B: $HC_2H_3O_2$ and HCN
   Beaker C: HNO_2 and HF
   Beaker D: HCl and HCN

   For how many of the solutions can you determine the pH to two significant figures by considering only one acid in the mixture?

   a) 0 b) 1 c) 2 d) 3 e) 4

8. We discussed in lecture (and I said in the videos) that we generally make assumptions in acid-base problems, and that this isn't bad – as long as we know what our assumptions are and how to deal with situations when they don't apply. Let's look into this a bit.

   a. Suppose you have a 10.00 mL sample of HCl(*aq*) which has a pH = 3.00, and you dilute it to 1.000 L with water. What is the pH of the resulting solution?
      i. The easiest way to do this problem is to assume that water merely increases the volume of the solution. Making this assumption, what is the pH of the resulting solution? **Show all work**. Why is this assumption reasonable to make in this case? **Explain your answer**.
      ii. Water, though, is an amphoteric substance (that is, it can act as an acid or a base) and this means that it might have some effect on the pH of the solution. Suppose we had this fantastic pH meter so that we could read the pH to nine digits after the decimal point. Would you expect the pH to be a bit lower, a bit higher, or exactly the same as what you determined above in part i? **Do not calculate** this (unless you want to do so on scratch paper to check your thinking), but **explain why** this would be true.
   b. Suppose you have a 10.00 mL sample of HCl(*aq*) which has a pH = 3.00, and you dilute it to 75.00 L with water. Can you still make the assumption that you did in the first part of question 8a? **Determine the pH in two ways**: once with making the assumption that water simply changes the volume and once with consideration of the acid-base properties of water. **Show all work.** Are these values the same if reported to two digits after the decimal point? **Explain why or why not** (do not simply use the results of the calculations – **explain your answer**).
   c. Suppose you have 10.00 mL of a weak acid aqueous solution with pH of 3.00. You decide to add enough water so that the solution has the same pH as you calculated in question 8a. Would you need to dilute the solution to a total volume of less than 1.00 L, greater than 1.00 L, or exactly 1.00 L? **Do not calculate** this (unless you want to do so on scratch paper to check your thinking), but **explain why** this would be true.

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KEY:

MC: 1. c, 2. c, 3. b, 4. a, 5. a, 6. c, 7. d

8. a. pH = 5.00, lower; b. pH = 6.88, pH = 6.73; c. Greater volume