Chemistry 204: Quiz #6

1. Consider the titration of 100.0 mL of a 0.100*M* weak acid solution with 0.100*M* NaOH. After 31.4 mL of 0.100M NaOH is added, the pH is noted to be 7.12. Identify the weak acid.

   a) HF b) HOCl c) HCN d) $HC_2H_3O_2$ e) HNO_2

2,3. Recall the demonstration in which we added Universal indicator (which is actually a mixture of indicators such that we see several colors from pH values of 0 to 14) to different salt solutions. As a rough estimate these colors are as follows:

- pH 1-3: red-orange
- pH 4-5: orange-yellow
- pH 6-8: green
- pH 9-11: green-blue
- pH 12-14: purple

What color would the following solutions appear when we add some Universal indicator?

2. 1.00*M* $NH_4F(aq)$

   a) red-orange b) orange-yellow c) green d) green-blue e) purple

3. 1.00*M* $NH_4CN(aq)$

   a) red-orange b) orange-yellow c) green d) green-blue e) purple

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4,5. Consider the formation of the complex ion $Ag(NH_3)_2^+$ (*aq*) when Ag^+ (*aq*) and NH_3 (*aq*) react:

$$Ag^+ (aq) + NH_3 (aq) \rightleftharpoons Ag(NH_3)^+ (aq) \qquad K_1 = 2.1 \times 10^3$$
$$Ag(NH_3)^+ (aq) + NH_3 (aq) \rightleftharpoons Ag(NH_3)_2^+ (aq) \qquad K_2 = 8.2 \times 10^3$$

50.0 mL of 2.00×10^{-3} *M* $AgNO_3$ is reacted with 50.0 mL of 5.00 *M* NH_3.

4. Determine the equilibrium concentration of $Ag(NH_3)^+$.

   a) 9.31×10^{-12} *M*
   b) 4.88×10^{-8} *M*
   c) 1.00×10^{-3} *M*
   d) 2.00×10^{-3} *M*
   e) 5.00 *M*

5. Which of the following is true at equilibrium?

   a) $[Ag(NH_3)_2^+] > [Ag(NH_3)^+] > [Ag^+]$
   b) $[Ag^+] > [Ag(NH_3)^+] > [Ag(NH_3)_2^+]$
   c) $[Ag(NH_3)^+] > [Ag(NH_3)_2^+] > [Ag^+]$
   d) $[Ag(NH_3)^+] > [Ag^+] > [Ag(NH_3)_2^+]$
   e) $[Ag(NH_3)_2^+] > [Ag^+] > [Ag(NH_3)^+]$

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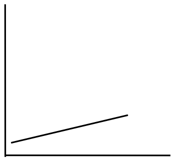
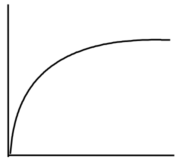
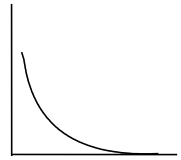
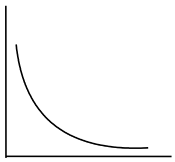
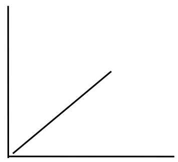
6,7. Indicate which of the graphs below **best** represents each plot described. A graph may be used once, more than once, or not at all.

a) 

b) 

c) 

d) 

e) 

6. pH (y) vs. pK_a (x) for a series of aqueous 1.00*M* weak acid solutions at constant temperature.

7. pH (y) vs. pOH (x) for pure water at different temperatures.

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8. Recall the demonstration where we added 3*M* HCl to Milk of Magnesia (which is a saturated solution/suspension of magnesium hydroxide). It looked so “milky” because it is not terribly soluble. In fact, you may remember that one of the solubility rules states that “most hydroxide salts are only slightly soluble”. Slightly soluble, of course, is a bit vague, so let’s quantify this. For each of the following three hydroxide solutions, **determine the concentration of the metal ion at equilibrium** (the hydroxides are added to pure water at 25°C).

   Justify any assumptions/simplifications and **show all work**. If for any of these simplifications cannot be made and the problem is too complex to solve, **determine an estimate** for the answer (a **range** is fine), **explain why it is too complex to solve,** and **determine the equation** you would need to solve.

   a. Magnesium hydroxide has a K_{sp} value of 8.90 x 10^{-12}. Determine the concentration of the Mg^{2+} ion in a saturated solution.
   b. Cobalt(III) hydroxide has a K_{sp} value of 2.50 x 10^{-43}. Determine the concentration of the Co^{3+} ion in a saturated solution.
   c. Copper(II) hydroxide has a K_{sp} value of 1.60 x 10^{-20}. Determine the concentration of the Cu^{2+} ion in a saturated solution.

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KEY:

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

8. a. $[Mg^{2+}]$ = 1.31 x 10^{-4} *M*, b. $[Co^{3+}]$ = 2.50 x 10^{-22} *M*, c. $[Cu^{2+}]$ = 1.49 x 10^{-7} *M*., (this one is a cubic equation and can be estimated to be between 1.00 x 10^{-7} and 1.59 x 10^{-7})