

### **Chem 1105-2015 Summer Problem Set #5**

1. Calculate the  $[H^+(aq)]$  and the pH in the titration of 22.0 mL of 0.10 M acetic acid,  $CH_3COOH$ , with a) 15.0 mL of 0.10 M NaOH, b) 22.0 mL of 0.10 M NaOH, c) 25.0 mL of 0.10 M NaOH
2. If a buffer is made of 12.2 g of benzoic acid ( $C_6H_5COOH$ ) and 7.20 g of sodium benzoate ( $C_6H_5COONa$ ) in 500. mL of solution, what is the pH of the buffer? If the buffer is diluted to 1.5 L, what is the pH of the new solution?  $K_a$  for benzoic acid =  $6.3 \times 10^{-5}$
3. How many grams of  $NH_4Cl$  would have to be added to  $5.0 \times 10^2$  mL of 0.10 M  $NH_3$  to prepare a buffer with a pH of 9.00?
4. A 250. mL buffer consists of 0.20 M  $HNO_2$  and 0.30 M  $NaNO_2$ .  $K_a$  for  $HNO_2$  is  $4.5 \times 10^{-4}$ . Calculate the pH of a) the original buffer; b) the buffer on the addition of 10.0 mL of 4.5 M HCl; c) the buffer on the addition of 10.0 mL of 4.0 M NaOH; d) the buffer on the addition of 10.0 mL of 12.0 M HCl.
5. Consider a 250. mL sample of water. Calculate the pH of a) the original water; b) the water on the addition of 10.0 mL of 4.5 M HCl; c) the water on the addition of 10.0 mL of 4.0 M NaOH; d) the water on the addition of 10.0 mL of 12.0 M HCl.
6. Calculate the pH of a solution originally containing 20.0 mL of 0.11 M  $NH_3$ . Next calculate the pH after the addition of 5.00, 11.0, 15.0, 20.0, 22.0, and 25.0 mL of 0.10 M HCl. What is the volume of HCl added at the equivalence point? What indicator would be best to use to detect the equivalence point. See textbook.
7. For each of the following salts, a) write a balanced equation showing the equilibrium occurring when the salt is added to water and b) write the  $K_{sp}$  expression.  
a)  $ZnS$ ,      b)  $NiCO_3$ ,      c)  $SnI_2$ ,      d)  $Ag_2SO_4$
8. When solid  $CoS$  is added to water the equilibrium concentration of  $Co^{2+}$  is  $7.7 \times 10^{-11}$  M. What is the  $K_{sp}$  of  $CoS$ ?
9. Calcium hydroxide has a solubility of 0.93 g/L. What is the  $K_{sp}$  of  $Ca(OH)_2$ ?
10. Estimate the solubility of lead bromide in terms of a) moles per liter and b) grams per liter of pure water.  $K_{sp}(PbBr_2) = 6.3 \times 10^{-6}$
11. Will a precipitate of  $Mg(OH)_2$  form when 25.0 mL of 0.010 M  $NaOH(aq)$  is combined with 75.0 mL of 0.10 M  $MgCl_2(aq)$ .  $K_{sp}(Mg(OH)_2) = 1.5 \times 10^{-11}$
12. What is the molar solubility of  $BaF_2$  in a) pure water, b) water containing 0.15 M KF.  $K_{sp}(BaF_2) = 1.7 \times 10^{-6}$
13. Explain the change in solubility for question #12 in terms of LeChatelier's Principle.

### Answer Set for Chem 1105-2015 Summer Problem Set #5

1.	$[\text{H}^+(\text{aq})]$	pH
a)	$8.5 \times 10^{-6} \text{ M}$	5.07
b)	$1.9 \times 10^{-9} \text{ M}$	8.72
c)	$1.6 \times 10^{-12} \text{ M}$	12.2

2. pH = 3.90. pH does not change on the dilution of a buffer solution.

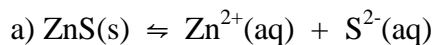
3. 4.8 g  $\text{NH}_4\text{Cl}$

4.a) 3.53, b) 2.85, c) 4.41, d) 0.76

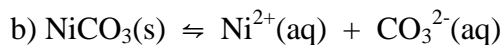
5.a) 7.00, b) 0.76, c) 13.20, d) 0.34

6. 11.15, 9.79, 9.26, 8.92, 8.26, 5.28, 2.18; 22.0 mL of 0.10 M HCl; suitable indicator would be methyl red

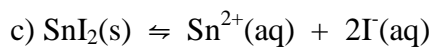
7.



$$K_{\text{sp}} = [\text{Zn}^{2+}(\text{aq})][\text{S}^{2-}(\text{aq})]$$



$$K_{\text{sp}} = [\text{Ni}^{2+}(\text{aq})][\text{CO}_3^{2-}(\text{aq})]$$



$$K_{\text{sp}} = [\text{Sn}^{2+}(\text{aq})][\text{I}^-(\text{aq})]^2$$



$$K_{\text{sp}} = [\text{Ag}^+(\text{aq})]^2[\text{SO}_4^{2-}(\text{aq})]$$

8.  $5.9 \times 10^{-21}$

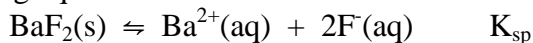
9.  $7.9 \times 10^{-6}$

10.a) 0.012 M, b) 4.4 g  $\text{PbBr}_2/\text{L}$

11.  $Q = 4.7 \times 10^{-7}$ ,  $Q > K_{\text{sp}}$  thus more precipitate will form.

12.a)  $7.5 \times 10^{-3} \text{ M}$ , b)  $7.6 \times 10^{-5} \text{ M}$

13. Considering the following equilibrium



On the addition of KF or  $\text{F}^-$  ions to the above system the equilibrium will shift to the left producing more  $\text{BaF}_2$  to use up the excess  $\text{F}^-$  ions. As a result the solubility of  $\text{BaF}_2$  will decrease in magnitude.