

CHEM 212, Exam 2
Fall 2013

Name: _____

1. (15 pts) For the forward reaction at 25°C $aA + bB \rightleftharpoons cC + dD$, the $\Delta H = -35 \text{ kJ mol}^{-1}$ and $\Delta S = 70 \text{ J mol}^{-1} \text{ K}^{-1}$.

- a. Is this reaction **exothermic** or **endothermic**?
- b. Does disorder **increase** or **decrease**?
- c. Calculate Gibbs free energy
- d. Is this reaction spontaneous?
- e. Determine the equilibrium constant for this reaction.

2. (15 pts) Given that the solubility product for X_3Y_2 is 7.6×10^{-15} and the potential species in solution are X_3Y_2 , $X_2Y_2^{2-}$, XY_2^{4-} , X^{2+}
Write the reactions occurring in solution

Write the charge balance equation.

Write a mass balance equation and solve for $[X^{2+}]$.

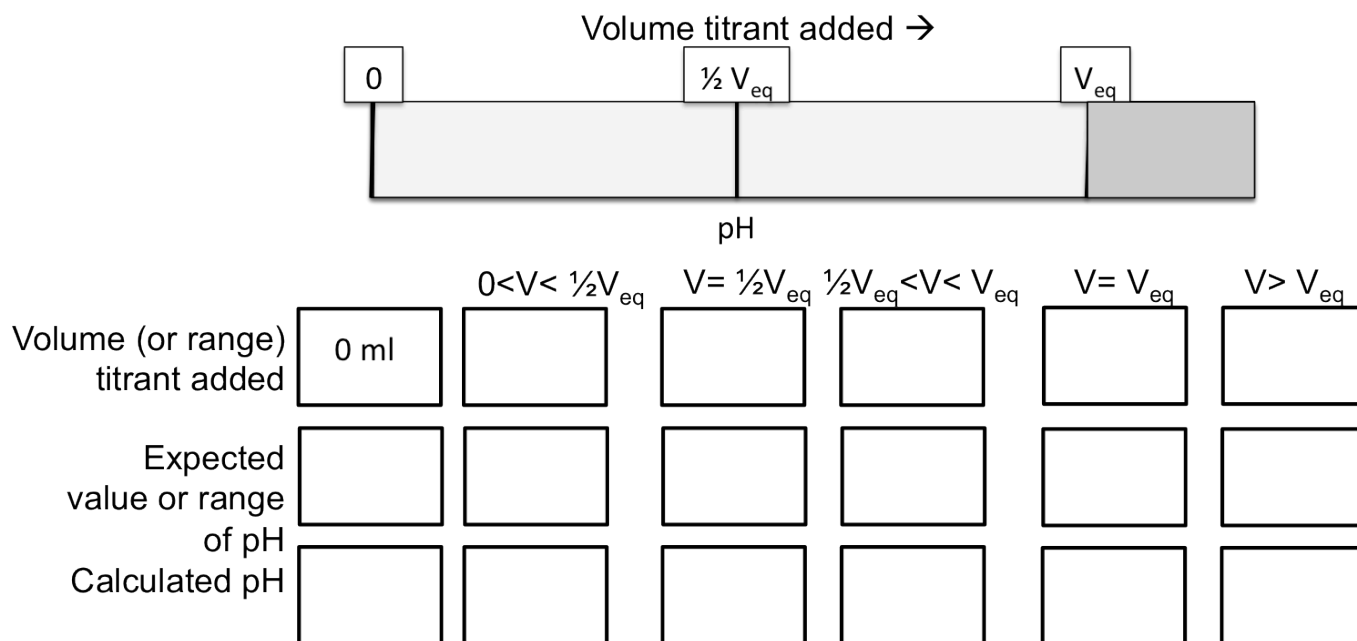
3. (15 pts) Write the reaction and solubility product equilibrium expression for slightly soluble $Y_2(CO_3)_3$ is dissolved in water.

If the K_{sp} for the above reaction is 1.03×10^{-31} , calculate the $[Y^{3+}]$ at equilibrium.

4. (40 pts) A 50 ml solution of 0.142 M ethylammonia ($\text{CH}_3\text{CH}_2\text{NH}_2$) was titrated with 0.25 M HCl. $\text{p}K_a = 10.6$

a. (5) Determine the volume acid added at the equivalence point.

b. (5) Label the volumes and pH's or range of pH you would expect to calculate at each point on the diagram below.



Begin by writing the reaction governing the solution and equilibrium expression in each case:

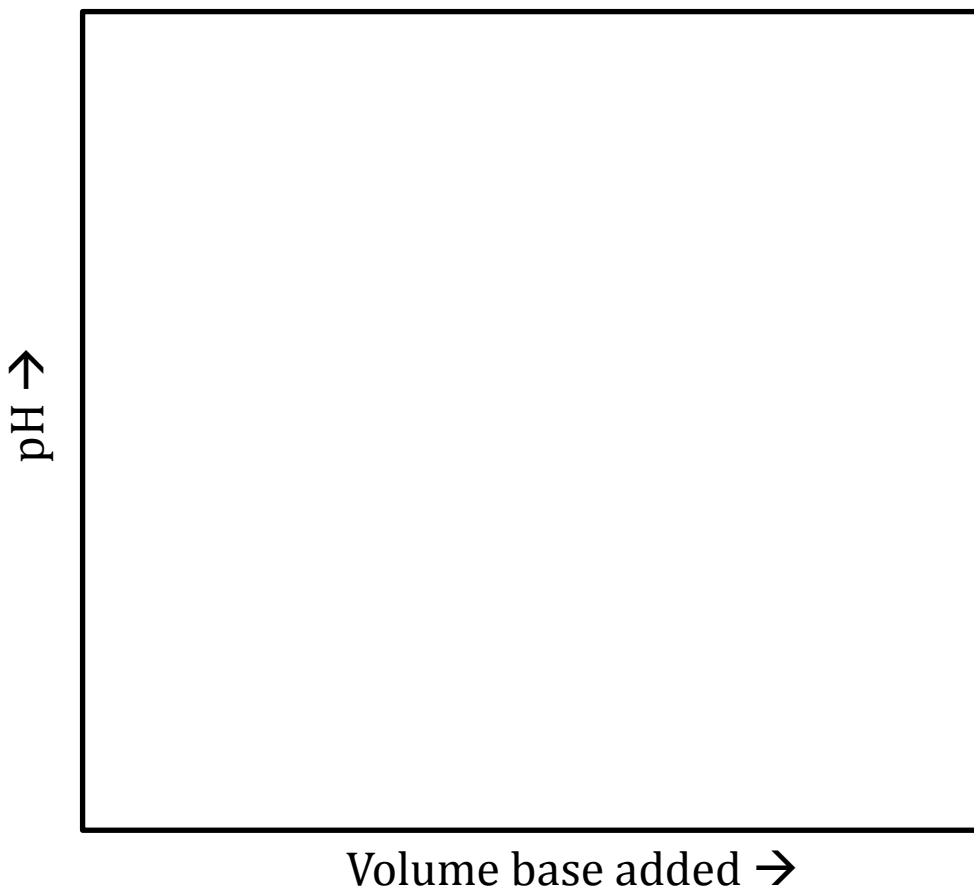
c. (5) Determine the pH of the initial solution before the titration begins

d. (5) Determine the pH after 14.2 mL of acid is added

e. (5) Determine the pH of the solution after 25 ml acid is added

- f. (5) Determine the pH at the equivalence point
- g. (5) Determine the pH after 34 mL of acid is added
- h. (5) Examine the figure you annotated in part C. Add your calculated values to the figure. Do the values you calculated agree with your expectations?

5. (15 pts) Draw a titration curve for a diprotic weak acid with a strong base. Label **pK1, pK2, Veq, and 2Veq**. In the box below, **label the dominant phase (H₂A, HA⁻, A²⁻)** in solution.



What is the dominant species in solution?