Chemistry 1B, Fall 2015 Quiz #5A Key

You must show **your work for full credit.**

Exp 3 and 4 Questions

1. A NH_3 solution is being titrated by HCl. (**2 pt**)
a) Write the reaction that can be used to determine the pH **at the equivalence point**.
$NH_4^+(aq) \leftrightarrow NH_3(aq) + H^+(aq)$

b) Is the solution at the equivalence point acidic, neutral or basic?
acidic – *above reaction produces H^+*

2. If an unknown weak acid is being titrated by a strong base and a sharp increase in pH occurs at 24.1 mL. A student suspects this corresponds to a second equivalence point for a diprotic acid. Where would he expect the first equivalence point (whether it can be observed or not) to be? (**1 pt**)

The first equivalence point should occur at half of the second equivalence point. If the acid is diprotic, the first equivalence point would be at **12.05 mL**.

Additional Titration problems

3. An acetic acid solution (25.0 mL of 0.0750 M) is being titrated by 0.0500 M NaOH.
a) What is the volume of NaOH needed to reach equivalence point in this titration? (**1 pt**)

$n(HC_2H_3O_2) = n(NaOH)$ *or* $[HC_2H_3O_2]V(HC_2H_3O_2) = [NaOH]V(NaOH)$
or $V(NaOH) = (25.0)(0.0750\ M)/(0.0500\ M) =$ ***37.5 mL***

b) Calculate the pH (to 3 sig fig) after adding 20.0 mL of NaOH. ($K_a = 1.76 \times 10^{-5}$) (**3 pts**)

Because 20.0 mL < 37.5 mL, this is before the equivalence point in the "buffer" region. We need to determine the moles of and through a mole table and use the H-H equation to determine the pH.

Reaction	$HC_2H_3O_2(aq)$	$+ OH^-(aq)$	$\leftrightarrow$	$C_2H_3O_2^-(aq) + H_2O(l)$	$pH = pK_a + \log[n(A^-)/n(HA)]$
initial	*0.001875*	*0.00100*		*0*	$pK_a = -\log(1.8 \times 10^{-5})$
change	*-0.00100*	*-0.00100*		*+0.00100*	$pK_a = 4.754$
full right	*0.000875*	*0*		*0.00100*	$pH = 4.754 + \log[(0.00100)/(0.000875)]$

$pH = 4.754 + \log(1.143) =$ **4.81**

grading: give partial credit if correctly calculate moles, set up mole table or use the H-H equation

(continued on back)

c) Which of these indicators is best for observing the equivalence point? You do not need to calculate the equivalence point pH, but explain your answer (**1 pt**)

Bromcresol Green ($pK_a = 4.7$) Bromthymol Blue ($pK_a = 6.7$) o-Cresolphthalein ($pK_a = 9.1$)

At the equivalence point, we are left with $C_2H_3O_2^-$, which is a weak base. Thus, we expect a pH > 7.

Solubility Problem

4. Calculate the molar solubility of silver chromate in water. $K_{sp}(Ag_2CrO_4) = 1.12 \times 10^{-12}$ (**2 pts**)

Reaction: $Ag_2CrO_4(s) \leftrightarrow 2Ag^+(aq) + CrO_4^-(aq)$ which can be solved by using an ICE table

initial	0	0
change	+2S	+S (where S = molar solubility)
equil.	2S	S

$K_{sp} = 1.12 \times 10^{-12} = [Ag^+]^2[CrO_4^-] = (2x)^2x$ or $x = (1.12 \times 10^{-12}/4)^{1/3} = 6.54 \times 10^{-5}$ M

can give partial credit for setting up ICE table or for using the correct equilibrium equation (K_{sp} equation).