Chemistry 1154 Fall 2011 test 3

Thursday, November 24, 2011 Time: 1 hour 50 minutes

Name: _____ Student number: _____

*This test consists of **nine** pages of questions, the formula sheet, and a periodic table. Please ensure that you have a complete paper and, if you do not, obtain one from me **immediately**. There are **42** marks available. Good luck!*

***Note:** Unless specifically stated otherwise, you may assume a temperature of 25°C for all questions.*

1) **[2 marks]** Calculate the solubility of Ag_2CO_3 (K_{sp} = 8.46 x 10^{-12}) in 0.010 M $AgNO_3$.

2) **[4 marks]** A solution has [Al^{+3}] = 0.010 M, and [Ca^{+2}] = 1.0 x 10^{-3} M. Solid Na_3PO_4 is slowly added to the solution. If the K_{sp} of $AlPO_4$ is 9.84 x 10^{-21} and of $Ca_3(PO_4)_2$ is 2.07 x 10^{-33}:

   a) Which cation will be the first to precipitate from solution?

   b) At the point of maximum separation, what percent of the ion from (a) will remain in solution?

3) **[5 marks total]** Calculate the pH of the following solutions. HA is a weak acid with $K_a = 2.5 \times 10^{-6}$

a) **[2 marks]** 0.40 M HA

b) **[3 marks]** 80.0 mL of 0.10 M HA mixed with 20.0 mL of 0.10 M KA

4) **[5 marks total]** Calculate the pH of the following solutions. H_3A is a weak acid with $pK_{a1} = 3.00$, $pK_{a2} = 7.00$, and $pK_{a3} = 11.00$

a) **[3 marks]** 10.00 mL of 3.00 M H_3A mixed with 30.00 mL of 1.50 M NaOH

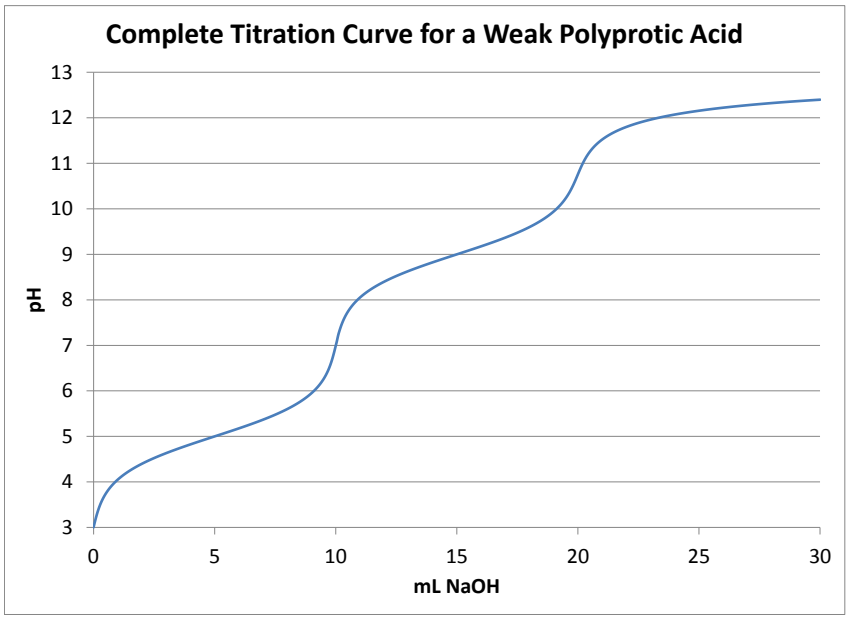
b) **[2 marks]** 10.00 mL of 3.00 M H_3A mixed with 40.00 mL of 1.50 M NaOH

5) **[6 marks total]** Calculate the pH of the following solutions. B is a weak base with $K_b = 1.00 \times 10^{-5}$ at a temperature where $\mathbf{K_w = 1.0 \times 10^{-13}}$.

a) **[4 marks]** 10.00 mL of 1.00 M B mixed with 40.00 mL of 0.250 M HNO_3.

b) **[2 marks]** 10.00 mL of 1.00 M B mixed with 50.00 mL of 0.250 M HNO_3.

6) **[3 marks]** The following diagram is the complete titration curve for a weak polyprotic acid with a strong base.



a) How many acidic protons does the weak polyprotic acid have?

b) What are the pK_a values for the weak polyprotic acid?

c) What would be a good pK_{ind} for an indicator to be used in this titration? How do you know?

7) **[4 marks total]** A 10.00-mL aliquot of 1.00×10^{-3} M HCl is to be titrated with 1.10×10^{-3} M NaOH. An indicator with a $pK_{ind} = 10.00$ is to be used.

a) **[3 marks]** How many mL of NaOH will be required to reach the end point?

b) **[1 mark]** Is the indicator a good one for use in this titration? How do you know?

8) **[2 marks]** A balloon is expanded from 2.00 L to 4.00 L at a constant external pressure of 1.50 atm. In the process, it absorbs 2.0 kJ of heat from the surroundings. Calculate q, w, ΔE, and ΔH for the process.

9) **[2 marks]** Given the following:

$NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s)$ $\Delta H° = -176.0$ kJ
$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$ $\Delta H° = -92.22$ kJ
$N_2(g) + 4H_2(g) + Cl_2(g) \longrightarrow 2NH_4Cl(s)$ $\Delta H° = -628.86$ kJ

Calculate ΔH° for the reaction

$H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$

10) **[2 marks]** Given that the enthalpy of formation for $AlCl_3(s)$ is -674.8 kJ/mol, and that ΔH° for the reaction

$2AlBr_3(s) + 3Cl_2(g) \longrightarrow 2AlCl_3(s) + 3Br_2(l)$

is -327.04 kJ, what is the molar enthalpy of formation of $AlBr_3(s)$?

11) **[3 marks]** The molar heat capacity of liquid "Compound X" is 50.0 $\frac{J}{mol \cdot K}$, and of gaseous "Compound X" is 25 $\frac{J}{mol \cdot K}$. The boiling point of "Compound X" is 75.0°C. If it took 65 kJ of heat to warm 2.0 moles of "Compound X" from a liquid at 50.0°C to a gas at 90.0°C, what is the molar enthalpy of vaporization of "Compound X"?

12) **[4 marks]** A 0.9412-g sample of phenol (94.12 g/mol) was burned in a bomb calorimeter with a heat capacity of 10.00 kJ/°C:

$C_6H_6O(l) + 7O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(l)$

The temperature of the calorimeter increased by 3.056°C. Calculate ΔH° for this reaction at 25°C.