Chem1B, General Chemistry II

1.) Both $H_2PO_4^-$ ($K_a = 4.2 \times 10^{-13}$) and HSO_3^- ($K_a = 6.2 \times 10^{-8}$) are amphiprotic (amphoteric). Write out the expected equilibrium formed between these compounds, clearly indicating which will behave as the acid and which as the base.

2.) Consider a buffer solution created by mixing formic acid with formate by the following equilibrium.

$$HCHO_2(aq) + H_2O(l) \leftrightharpoons CHO^{2-}(aq) + H_3O^+(aq) \qquad K_a = 1.8 \times 10^{-4}$$

a.) Calculate the grams of magnesium formate ($Mg(CHO_2)_2$, 114.35 g/mol) needed to be dissolved in 1.50 L of 0.25 M formic acid to obtain a pH of 4.23.

b.) To the buffer solution in (a), 0.125 moles of sodium hydroxide (NaOH) are added without changing the volume of the solution. Calculate the new pH of the buffer.

c.) To the buffer solution in (a), 0.135 moles of hydrobromic acid (HBr) are added without changing the volume of the solution. Calculate the new pH of the buffer.

3.) Consider the following compounds all at 0.100 M: HNO_3, NaOH, NH_3 ($K_b = 1.8 \times 10^{-5}$), $HClO_2$ ($K_a = 1.1 \times 10^{-2}$).

a.) Arrange the above in order of **increasing pH**, from lowest to highest.

b.) Arrange the above in order of **increasing % ionization**, from lowest to highest.

4.) Should a precipitate of $Mg(OH)_2(s)$ form in a solution made from 0.010 M $MgCl_2$ and 0.10 M NH_3? The K_b for NH_3 is 1.8×10^{-5}, and the K_{sp} for $Mg(OH)_2$ is 1.8×10^{-11}.

5.) Consider the titration of a 30.0 mL portion of 0.20 M HF ($K_a = 6.6 \times 10^{-4}$) with 0.10 M NaOH.

a.) Calculate the initial pH of the solution when 0 mL of NaOH has been added.

b.) Calculate the pH of the solution after 10.0 mL of NaOH have been added.

c.) Calculate the pH of the solution at equivalence point.

6.) Calculate the total change in entropy (ΔS_{total}) for 18.3 g of $H_2O(s)$ (18.016 g/mol) at 273 K to melt in a container held at 315 K, given that the heat of fusion (ΔH_{fus}) for water is 6.02 kJ/mol at 0 K. Assume complete heat transfer from the ice to the surrounding air.

7.) Consider the following equilibrium:

$$Al(OH)_3(s) \leftrightharpoons Al^{3+}(aq) + 3\ OH^-(aq) \qquad K_{sp} = 1.3 \times 10^{-33}$$

A solution has $[Al^{3+}] = 0.075$ M and $[HC_2H_3O_2] = 1.00$ M. What is the maximum quantity, in g, of $NaC_2H_3O_2$ (82.03 g/mol) that can be added to 250.0 mL of this solution before precipitation of $Al(OH)_3(s)$ begins? The K_a for acetic acid is 1.8×10^{-5}.