NAME: _____

Problem Set 7 due December 2, 2009

1. Calculate the pH for each of the following solutions (show your work and sig figs):

   a. $[H]^{+} = 3.47 \times 10^{-5}$ M

   b. $[OH]^{-} = 3.47 \times 10^{-5}$ M

   c. A solution made from 1 L of a. and 1 L of b.

   d. A solution made from 100 mL of a. and 900 mL of b.

2. Weak acids and bases play a large role in biological processes.

   a. Write down the structures of the following weak acids (and their conjugate bases).

      i. formic acid ($K_a = 1.77 \times 10^{-4}$ M)

      ii. acetic acid ($K_a = 1.77 \times 10^{-5}$)

      iii. benzoic acid ($K_a = 6.3 \times 10^{-5}$ M)

   b. Calculate the pKas for each of the acids above.

   c. Arrange the weak acids in order of increasing strength of their conjugate bases.

3. Phosphoric Acid and its conjugate bases are important in intracellular pH buffering. With three titratable protons, phosphoric acid has the chemical structure H_3PO_4. Write down the acid dissociation reactions and the equilibrium expressions associated with each pKa listed below.

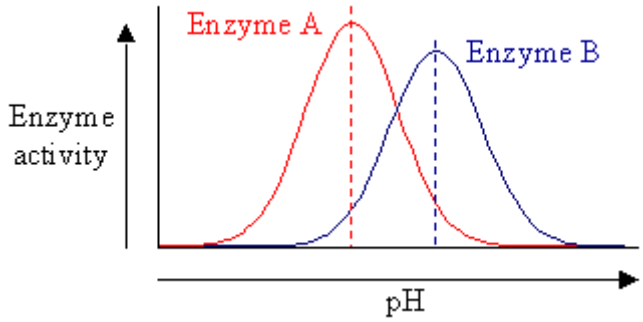
   pKa1 = 2.75

   pKa2 = 7.20

   pKa3 = 12.35

b. Which of the equilibrium reactions above is most relevant to acid/base reactions that occur within the cytoplasm? Why?

4. Shown below is the activity versus pH profile for two enzymes.



a. Why does the activity of each enzyme increase as the pH rises?

b. Why does the activity of each enzyme decrease as the pH rises?

c. Which enzyme would most likely be active in the stomach (and not the gut), and which would be active in the gut (and not the stomach) and why

d. Draw the structure of the acid and conjugate base ONLY for the side groups of the amino acids Asp (pKa 3.75) and Glu (pKa 4.75). Include charges ONLY for the side group in each form.

e. Draw the structures of the conjugate acid and base ONLY for the side groups of the amino acids His (pKa 7.5), Lys (pKa 11.5), and Arg (pKa 13.0). Include charges ONLY for the side group in each form.

f. If the peak in the activation activity for Enzyme A is 5, which is the most likely amino acid side group responsible for the increase in activity and why.

g. If the peak in the activation activity for Enzyme B occurs at pH 7, which is the most likely amino acid side group responsible for the increase in activity and why.