1. If an atom were magnified 1 million times, which of the following would most closely match its size?
    a. An invisible speck
    b. A grain of salt
    c. A pea
    d. A tennis ball
    e. A basketball

2. True or False?
    a. The ability of water to form hydrogen bonds is an important factor contributing to the hydrophobic effect.
    b. The stronger an acid, the higher its pKa.
    c. The Henderson-Hasselbalch equation relates the protonation state of a buffer to the pH of the buffer solution.
    d. Water is an amphoteric molecule.
    e. A liquid's boiling point reflects its molecular cohesiveness.
    f. A weak base is predominately protonated at pH's above its pKa.
    g. A buffer's concentration does not influence its effectiveness.

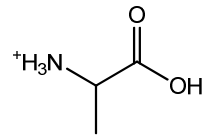
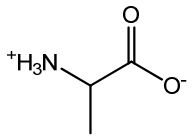
3. Which of the following statements is correct?
    a. Water has a high dielectric constant and is able to dissolve polar substances well.
    b. Water has a low dielectic constant and is able to dissolve polar substances well.
    c. Water has a high dielectric constant and is able to dissolve apolar substances well.
    d. Water has a low dielectric constant and is able to dissolve apolar substances well.

4. Water is essential for life, and that many of the reasons for this stem from its unusual properties. List three unusual properties of water and briefly explain how each contributed to the evolution and viability of life.

5. Given two acids, HA and HB, with pKa's 4 and 6, respectively.
    a. Which has the higher proton affinity?
    b. Which will be more protonated at pH 7?
    c. Which will dissociate more when added to water?
    d. For each, what is the major (predominant) protonation state at pH 3, pH 4, and pH 7?
    e. Calculate the ratio of protonated to deprotonated forms for each at pH 4 and pH 7.
    f. Calculate the fraction protonated for each at pH 4 and pH 7.
    g. For each, what is the major (predominant) charge state at pH 3, pH 4, and pH 7?
    h. Calculate the fraction charged for each at pH 4 and pH 7.
    i. For each, what is the average charge at pH 4 and pH 7.
    j. For each, at what pH is the ratio of protonated to deprotonated 3:1?
    k. For each, at what pH is the acid ~25%; ~10%; and ~1% deprotonated?
    l. For each, over what pH range does the neutral charge state predominate?
    m. For each, at what pH is the average charge -0.8?
    n. What is the effective buffering range for each?
    o. Which would be the better buffer at pH 5?

6. A weak acid with pKa = 5.9 is dissolved in 100 mL of water to a concentration of 0.1 M. At what pH will the concentration of the protonated form be approximately 0.1 mM?

7. For each of the following pairs of compounds, choose the stronger acid, and provide a structural explanation for why it is stronger.
   a. HCl versus HF
   b. Cysteine's sulfhydryl group versus serine's hydroxyl group
   c. Tyrosine's hydroxyl group versus serine's hydroxyl group
   d. Arginine's guanidino group versus lysine's side-chain amino group

8. Given a solution of alanine at pH 5:
   a. What is the ratio of  to  ?

   A. 1:1000
   B. 1:100
   C. 1:10
   D. 1:1
   E. 10:1
   F. 100:1
   G. 1000:1
   H. None of the above

   b. Is alanine a good general buffer at pH 5.0? Briefly explain why or why not. If you answered no, include in your explanation the pH(s) at which alanine *would* be a good buffer. (30 words or fewer.)

9. Of the letters of the English alphabet (shown below), which are *not* used as an abbreviation for a particular protein amino acid?

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z