Exam I - Chemistry 341 - October 8 2000 - 100 points total - 10 bonus points

Look over the whole exam and work on what you feel more comfortable FIRST! Show all your calculations if you want to receive partial credit. Be clear and concise.

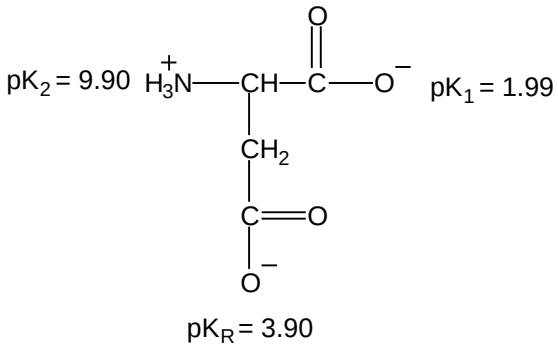
Name: _____

1) The interactions between non-polar regions of molecules and water are at the origin of what is known as the hydrophobic effect (10 points).

   i) Is the hydrophobic effect a characteristic of the molecules themselves, or is it related to the solvent (water in this case)?
   ii) Say that a certain bi-molecular non-covalent complex is stabilized by numerous inter-molecular hydrophobic interactions in aqueous solution. Would this complex still be stable in chloroform, a non-polar organic solvent? Be consistent with your answer from part (i).

2) What is the energy range in Kcal/mol for a salt bridge in water (5 points)? Will this range increase or decrease if the solvent is changed to benzene (C_6H_6), a non-polar organic solvent (5 points)?

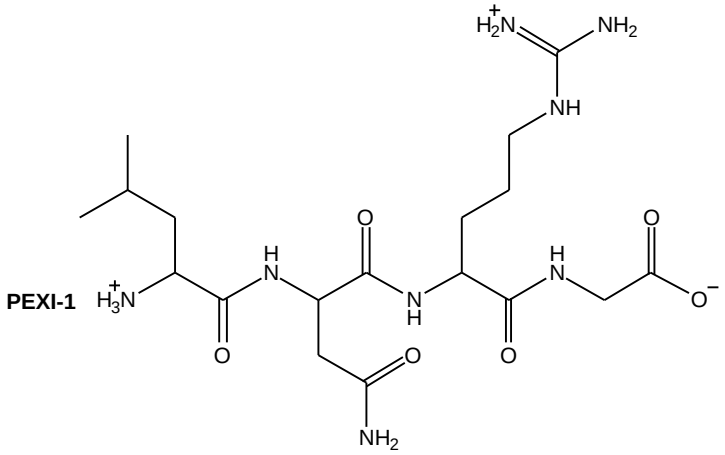
3) You have an aqueous solution that contains aspartate as its sole component (30 points).



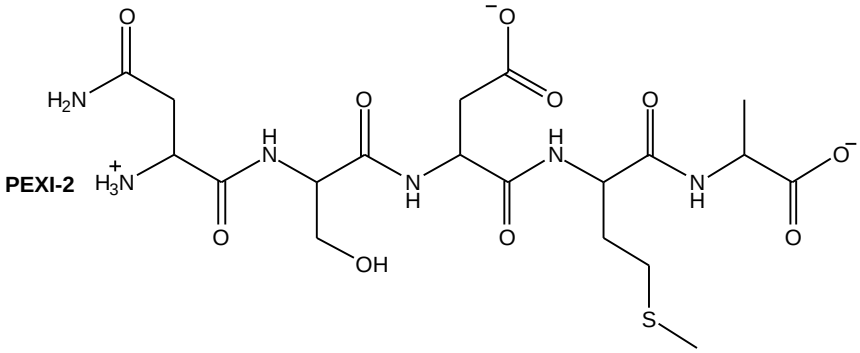
   i) Which forms of aspartate will you have at pH 2.20? **Draw them**. What will be the ratios (***just the ratios!***) between these forms at this pH value?
   ii) Same as above, but at pH 4.10.
   iii) Same as above but at pH 14.00.
   iv) Will aspartate be an effective buffer near these three pH values?

4) You have a mixture of two peptides with the following chemical structures (30 points):

PEXI-1



PEXI-2



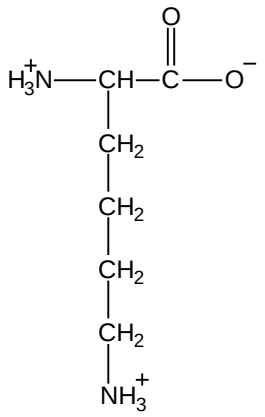
i) For each peptide:

a) Identify the amino acids and write the peptide sequences using the three-letter code.
b) Calculate their isoelectric points. Use the pK and pK_R values of the parent amino acids in your calculations.
c) Calculate their **approximate** charges at pH 1, 7, and 14.

ii) What will be the optimal pH to separate **PEXI-1** and **PEXI-2** using ion exchange chormatography if you have a cationic exchange column (5 points).

iii)On the structure of PEXI-1, indicate **clearly** two bonds that are rotatable, and two centers that are chiral.

6) The pK_R of the amino acid lysine is 10.54 (20 points).



pK_R=10.54

i) In the peptide H_2N-Lys-Lys-**Lys**-Lys-Lys-COOH, the pK_R of the Lys residue marked in bold is 8.00. Explain why the pK_R of this Lys residue is lower than the pK_R of the free amino acid.

ii) With what amino acids would you replace the flanking amino acids in the above peptide in order to increase the pK_R of the Lys residue marked in bold? Explain, and be consistent with your answer from (i).

BONUS QUESTION (10 points):

7) Design a polyeptide with 5 residues with general structure Ala-Xaa-Xaa-Xaa-Ala (Xaa can be any amino acid) with an isoelectric point (pI) of 7.96.