1. In an aqueous solution at pH 4, what is the concentration of hydroxide ions?

2. Acetic acid has a pKa of 4.8. If you are making up one liter of a concentrated stock solution of 1M sodium acetate buffer at pH 4.8, starting with acetic acid, how many ml of 10N NaOH will you have to add? [Note that "1M sodium acetate buffer" means, by convention, that the total concentration of all acetate species (HOAc plus OAc-) needs to be 1M, since that is the buffering species in solution.]

3. For the oligonucleotide pApGpC, what will its net charge be at (a) pH 7.6 (b) pH 4.0 (c) pH 10.0? You may round off to the nearest tenth of a formal charge.

4. Draw the structures of adenine, guanine, thymine, cytosine and uracil. Make sure you have shown every atom and bond, and that the bases are drawn in their correct tautomeric forms.
5. Draw the structure of the mononucleotide 7-methyl-guanosine-5'-monophosphate. Show all formal charges.

6. Draw the ionic forms of cytosine that would exist in solution at pH 4.5. Predict the relative proportions of each that would be present.

7. The four nucleoside monophosphates can be separated from each other by electrophoresis at pH 3.5. (Electrophoresis means separation of charged molecules in an electric field based on differing charges for the different molecules.) Predict the relative mobilities of the four nucleotides with respect to the cathode and anode, starting at a position equidistant from the cathode and anode. Explain why pH 3.5 is commonly used for this separation.
8. Load one of the freeware molecular graphics programs RasMol or PyMol into your computer using the links provided on the class web site. Bring up the structure of GpA, using the PDB file gpa.pdb which you can load from the class web site. Practice rotating the molecule on the screen. Practice zooming in on details and identifying individual residues and atoms. Try out the different ways to render the molecule (skeletal, ribbon diagrams, space-filling, etc).

Use the functions of RasMol or PyMol to determine the following:

a. Give the xyz coordinates for the N9 atom of the guanine in the GpA structure.

b. Measure the interatomic distance between the N3 position of the guanine and the N9 position of the adenine in the GpA structure.

c. What sort of interaction does the distance you measured in part b correspond to? (covalent, H-bond, electrostatic or van der Waals)