**Problem Set 2: Due Sunday Sept 6, 2015** Total Time required: ~ 70 min

1. (4 pts, 5 min) Two thin hollow tubes are held up-right in a basin of water. The first tube is made of a plastic (polyethylene) and the second tube is made of glass. The water rises in the tube made of glass, but does not in the plastic tube. Why? What is the likely difference between the surface of the plastic tube and the glass tube?

2. (2 pts, 5 min) Two solutions have pH values of 7 and 10, respectively. What is their ratio of hydrogen ion (hydronium ion) concentrations? Which has the higher concentration of hydrogen ions?

3. (4 pts, 5 min) Nitrogen typically forms three covalent bonds. Explain how nitrogen can form four bonds in the ammonium ion, NH4+.

4\*. (5 pts, 5 min) The structure of the drug Benzedrine is shown on the right. It is absorbed more readily in the small intestine, where the pH=8, than in the stomach, where the pH=2.0. Why? [Hint. Identify the ionizable group on Benzedrine, and consider how its ionization state would differ at the different pH values?]



5. (12 pts, 20 min)

i) Sketch, *on the same graph*, the curves for the fraction protonated versus pH for all of the ionizable groups on the amino acid aspartic acid. Your x-axis should go from pH=0 to 12. You can assume that the pKa values are 2, 4, and 9 for the mainchain carboxyl, the sidechain carboxyl and the amino group, respectively.

ii) Draw the amino acid aspartic acid in its correct ionization state at pH=0 and at pH=7.

iii) Add a water molecule to your sketch at pH = 0, oriented so that it could form a hydrogen bond with the sidechain atoms of aspartic acid. Indicate the donor and acceptor groups in your diagram.



6. (5 pts, 10 min) Indicate possible hydrogen bond donors and acceptors on the compound on the right.

7. (5 pts, 10 min) A short protein (peptide) consists of 5 amino acids. How many different proteins of this length are possible?

**Jmol Problem:**

8. (6 points, 10 min) Go to the Jmol page for this problem set and answer the following questions:

i) Draw the chemical structure of the compound.

ii) How would you classify this compound – polar, non-polar, or both? Justify your answer.

iii) What amino acid has this functional group as part of its structure?