OUT-OF-CLASS PROBLEMS –SEPARATION SCIENCE
EQUILIBRIUM UNIT

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Out-of-class assignment #1 - Due ______________

1. Calculate the pH of a solution that is 0.077 M in potassium valerate.

2. Calculate the pH of a solution that is 0.432 M in toluic (4-) acid.

3. Calculate the pH of a solution that is 0.765 M in quinoline.

4. Calculate the pH of a solution that is 0.065 M in ethylammonium nitrate.

5. Call the members of your study group and set up a time to go over these problems to see that you have done them correctly.

Out-of-class assignment #2 - Due ______________

1. Calculate the pH of a solution that is prepared by mixing 85 ml of 0.321 M chloroacetic acid with 45 mL of 0.224 M quinoline.

2. Calculate the pH of a solution that is prepared by mixing 65 mL of 0.288 M sodium chlorophenolate (4-) with 25 mL of 0.123 M aminopyridinium (3-) bromide.

3. Calculate the pH of a solution that is prepared by mixing 70 mL of 0.155 M aminopyridinium (4-) chloride with 40 mL of 0.098 M potassium fluoroacetate.

4. Call the members of your study group and set up a time to go over these problems to see that you have done them correctly.

Out-of-class assignment #3 - Due ______________

1. Repeat the calculation and plot in the In-class problem set #2 except that the starting solution is 0.1 M in nitrophenol (2-) and the titrant is 0.1 M sodium hydroxide.

   Has 99.9% of the nitrophenol been titrated at the equivalence point?

Out-of-class assignment #4 - Due ______________

1. Calculate the pH of a solution prepared by adding 35 mL of 0.054 M sodium aspartate to 45 mL of 0.028 M aspartic acid hydrochloride.

2. Starting with 30 mL of 0.1 M citric acid, calculate the initial pH and the pH at each 5 mL increment of 0.1 M NaOH until you are 10 mL past the last equivalence point. Plot the data and determine whether 99.9% of the citric acid has been neutralized at the last equivalence point. Also calculate the concentration of all species in solution at the second equivalence point.

3. Calculate the pH of a 0.345 M solution of sodium glutamate.

4. Calculate the pH of a 0.167 M solution of glycylglycine hydrochloride.

5. Calculate the pH of a solution prepared by adding 8.76 grams of sodium hydrogen iminodiacetate to a 250 mL volumetric flask and diluting to the mark with water.

6. Calculate the pH of a solution prepared by adding 18 mL of 0.111 M sodium EDTA to 26 mL of 0.036 M EDTA (Be careful that you have the right two species based on the naming procedure we have adopted).

7. Starting with 30 mL of 0.1 M ethylenediamine, calculate the initial pH and the pH at each 5 mL increment of 0.1 M HCl until you are 10 mL past the last equivalence point. Plot the data and determine whether 99.9% of the ethylenediamine has been neutralized at the last equivalence point. Also calculate the concentration of all species in solution at the second equivalence point.

8. Meet with your group to go over your answers to problems 1-7.

Out-of-class assignment #5 - Due ______________

1. Is it possible to find a pH range (limit this to integer values) in which it is possible to have 99.9% of Fe(III) complexed with the ligand DCTA (see Table 12.1 on our equilibrium constant handout) but 99.9% of Ba(II) in its uncomplexed form? The initial concentrations are 0.020 M Fe(III), 0.020 M Ba(II), and 0.10 M total DCTA.

2. Is 99.99% of the Pb(II) complexed with DTPA if 30 ml of 0.05 M Pb(II) is mixed with 30 ml of 0.05 M total DTPA and the final solution is buffered at pH 4?

3. A common method of analysis is to measure the fluorescence of a substance. The compound phthalic (2-) acid can be measured this way but the fluorescence of phthalic acid (H_2P), the monophthalate ion (HP^-) and phthalate (P^{2-}) are distinctly different. For analytical purposes, the monophthalate ion is the most useful. Is there a particular pH at which you could buffer the solution and be assured that at least 99.9% of the phthalic acid is in the form of the monophthalate ion?

Out-of-class Assignment #6 - Due ______________________

1. Write mass and charge balances for each of the following solutions.

    a) 0.05 mole of ammonium chloride diluted to 500 mL with water.

    b) 0.020 mole of ammonium chloride and 0.010 mole of HCl diluted to 250 mL with water.

    c) 0.03 mole of potassium hydrogen phthalate and 0.01 mole of sodium hydroxide diluted to 500 mL with water.

    d) 0.010 mole of sodium dihydrogen phosphate diluted to 1.0 liter with water.

2. Will a precipitate form if 25 ml of 0.010 M silver(I)nitrate is mixed with 25 ml of 0.0010 M sodium phosphate and the pH is adjusted to 5?

3. One way to separate two substances is to selectively precipitate one in the presence of the other. Is it possible to selectively precipitate 99.9% of one or more (you could potentially precipitate one ion, filter it off, and then precipitate another) of Cu(II), Pb(II), and Tl(I) as their sulfide salts? The salts will be precipitated by adding a solution of sodium sulfide. The concentrations of the metal ions in the initial solution are all 0.050 M.

4. Calculate the solubility of silver arsenate in a solution buffered at pH 6. The buffered solution to which the silver arsenate is added also contains potassium iodide at a concentration of 0.10 M.

   NOTE: Silver ion is capable of forming soluble complexes with two different ligands in this problem.

   NOTE: Silver ion can also form a precipitate with iodide.

6 Calculate the concentration of all copper species in a solution prepared by mixing 25 mL of 0.020 M copper(II)nitrate with 25 mL of 0.20 M salicylic acid (the complex that forms in this case is somewhat unusual in that it occurs with the HA^- form of the ligand). The final solution is buffered at pH 3.