Name:_____

Chemistry 232
Third Hour Exam

1. (10 points) Phthalic acid ($H_2C_8O_4H_4$) is a diprotic acid with pK_a's of 2.95 & 5.41. You are familiar with the monopotassium salt of this acid ($KHC_8O_4H_4$) because this is the KHP we have been using to titrate NaOH with in the lab. What is the pH of a .025M solution of KHP?

2. (10 points) I mix 30 mLs of 0.35 M Hypobromous acid (HOBr), pK_a 8.63, with 40 mLs of 0.31 M NaOH, what is the pH of the final solution?

3.A (10 points) Arsenic acid (H_3AsO_4) is a triprotic species with pK_a's of 2.24, 6.96, and 11.50. What is the pH of a 0.01M solution of Na_3AsO_4?

B (15 points) If I take 30 mLs of my 0.01M Na_3AsO_4 solution and add 50 mL of .013 M HCl, what is the pH of the solution?

4. (15 points) Let's try that phosphate buffer problem one more time. I wish to make a 1 L of buffer at pH 12.1 that contains a formal concentration of phosphate of .025 M. I have H_3PO_4, H_2KPO_4, HNa_2PO_4 and NaOH available. How many moles of which reagents do I need to make this buffer? (Hint - you don't need all of these reagents) pK_a's of H_3PO_4 are: 2.15, 7.20, and 12.15.

5 A (5 points) Succinic Acid is a diprotic acid with pK_a's of 4.207 and 5.636. What is the predominate species (H_2A, HA^- , or A^{2-}) at pH 5.0?

B (5 points) Assume that your total (Formal) concentration of Succinate is 1M. Use the appropriate Henderson-Haselbalch equation to show that the species you chose in part A is truly the predominate species because it has the largest concentration.

C (10 points) Now for the learning experience. Notice how close the 2 pK_a values are? When the pK_a's are this close, the simple Henderson-Haselbalch equation doesn't work because the other nearby pK_a is also working and is throwing your numbers off. The only way to do this properly is to use the α equations. For a diprotoic acid the α equations are:

$$\alpha_{H_2A} = \frac{[H^+]^2}{[H^+]^2 + K_1[H^+] + K_1K_2}$$

$$\alpha_{HA^-} = \frac{K_1[H^+]}{[H^+]^2 + K_1[H^+] + K_1K_2}$$

$$\alpha_{A^{2-}} = \frac{K_1K_2}{[H^+]^2 + K_1[H^+] + K_1K_2}$$

Use these α equations to show the true distribution of species at pH 5.0

6. (10 points) The log K_f for the Mn^{2+} EDTA complex is 13.87. If we consider that the minimum K_f' for a successful EDTA titration is 10^{+8}, what is the lowest pH at which I can perform this titration? (Use table of α_{Y4-} below)

pH	α_{Y4-}
0	1.3×10^{-23}
1	1.9×10^{-18}
2	3.3×10^{-14}
3	2.6×10^{-11}
4	3.8×10^{-9}
5	3.7×10^{-7}
6	2.3×10^{-5}
7	5.0×10^{-4}
8	5.6×10^{-3}
9	5.4×10^{-2}
10	.36
11	.85
12	.98
13	1.00
14	1.00