Chemistry 222 **Name**____

Spring 2017 **80 Points**

Exam 3: Chapters 8-10

Complete five (5) of problems 1-6. CLEARLY mark the problem you do not want graded. Report your answers with the appropriate number of significant figures and with the appropriate units. (16 points each)

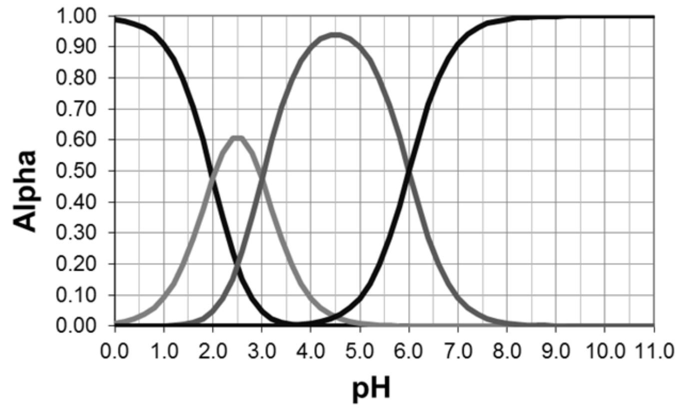
1. You need to prepare a pH 1.50 buffer by adjusting the pH of 200.0 mL of a 0.200 M solution of monosodium oxalate ($NaHC_2O_4$). The only acid and base solutions you have available are 100 mL of 0.100 M NaOH, and 100 mL of 0.100 M HCl. Given these solutions, can you make your buffer? *Justify your answer with appropriate calculations*.

   (For oxalic acid, pK_{a1} = 1.25, pK_{a2} = 4.26.)

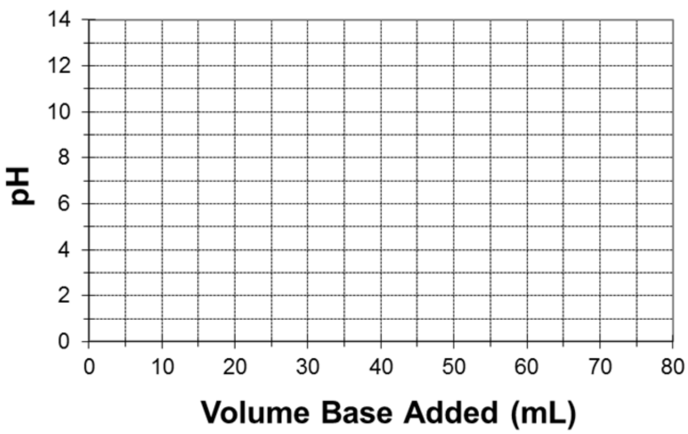
2. Answer the following: (8 points each)
    a. Why is the pH of a buffer effectively independent of dilution, while the capacity of the buffer diminishes as it becomes more dilute?

    b. Why is a buffer solution most effective at a pH within ±1 of the pK_a for the acid used to make the buffer?

3. For this problem consider the newly discovered *trumanic acid*, a triprotic weak acid of the form H_3A.
   a. The plot below represents the fraction of dissociation for trumanic acid. Label the four curves with their corresponding alphas (α_{H3A}, α_{H2A-}, α_{HA2-}, α_{A3-}) and determine the values for pK_{a1}, pK_{a2}, and $pK_{a3.}$ (6 points)



   b. Based in your results from part a, use the axes below to sketch the titration curve for the titration of 20.0 mL of a 0.100 M solution of trumanic acid with 0.100 M NaOH. Specify the pH at a minimum of five points on the plot. (10 points)



4. Complete the following: (8 points each)
   a. Calculate the pH of a 4.5×10^{-8} F solution of HCl.

   b. A 0.020 F solution of phthalic acid (pK_{a1} = 2.95, pK_{a2} = 5.41) is buffered at pH 4.50. What fraction of the phthalic acid is present as the amphiprotic form at this pH?

5. What is the pH of a solution prepared by adding 52.00 mL of 0.1759 M NaOH to 51.00 mL of 0.1111 M H_3PO_4? For phosphoric acid: $K_{a1} = 7.11 \times 10^{-3}$, $K_{a2} = 6.32 \times 10^{-8}$, $K_{a3} = 4.5 \times 10^{-13}$.

6. A new quant. student Ty Trate is struggling to select an indicator appropriate for his titration of a 0.010 M solution of the weak base pyridine (pK_b = 8.77) with 0.010 F HCl using an appropriate indicator. Help Ty select an appropriate indicator from the list below and point out the problems that would arise if an inappropriate indicator was chosen.
(*Note: your justification and explanation is more valuable than picking the "right" indicator*)

Indicator	**Transition Range**
Thymol Blue	1.2-2.8
Bromocresol Green	3.8-5.4
Chlorophenol Red	4.8-6.4
Phenolphthalein	8.0-9.6

Possibly Useful Information

$\left[H^+\right] = \sqrt{\dfrac{K_{a1}K_{a2}F + K_{a1}K_w}{K_{a1} + F}} \approx \sqrt{K_{a1}K_{a2}}$	$pH = \dfrac{1}{2}\left(pK_{a1} + pK_{a2}\right)$
$pH = pK_a + \log\dfrac{[\text{conjugate base}]}{[\text{weak acid}]}$	$\alpha_{H_2A} = \dfrac{\left[H^+\right]^2}{\left[H^+\right]^2 + \left[H^+\right]K_{a1} + K_{a1}K_{a2}}$
$\alpha_{A^{2-}} = \dfrac{K_{a1}K_{a2}}{\left[H^+\right]^2 + \left[H^+\right]K_{a1} + K_{a1}K_{a2}}$	$K_aK_b = K_w$
$K_w = 1.0 \times 10^{14} = [H^+][OH^-]$	$x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

PERIODIC CHART OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES
1 H 1.00797																1 H 1.00797	2 He 4.0026
3 Li 6.939	4 Be 9.0122											5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183
11 Na 22.9898	12 Mg 24.312											13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	*57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	†89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 ? (271)	111 ? (272)	112 ? (277)						

Numbers in parenthesis are mass numbers of most stable or most common isotope.

Atomic weights corrected to conform to the 1963 values of the Commission on Atomic Weights.

The group designations used here are the former Chemical Abstract Service numbers.

* Lanthanide Series

58 Ce 140.12	59 Pr 140.907	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.924	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97

† Actinide Series

90 Th 232.038	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (256)	103 Lr (257)

FoxTrot Classics by Bill Amend