

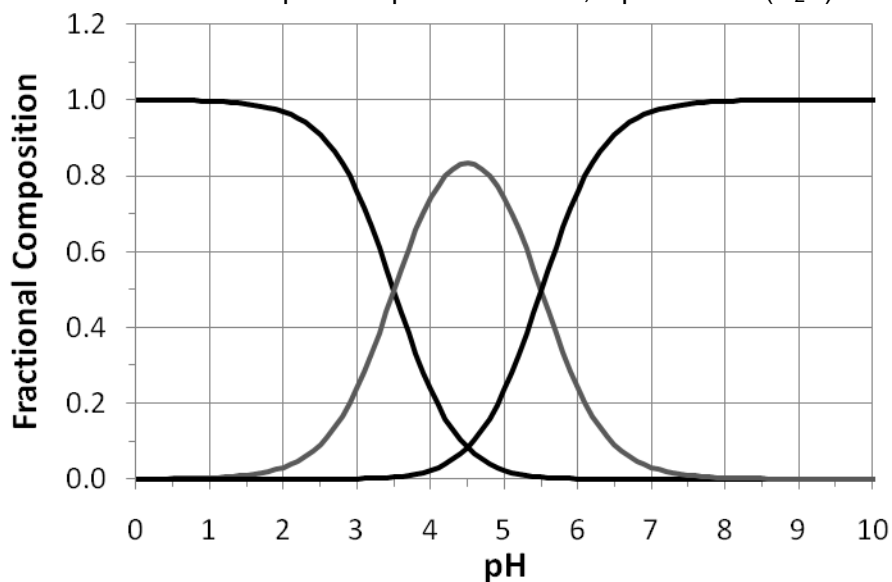
2. Why is every titration where an indicator is used to determine the endpoint subject to titration error? Describe the appropriate choice and use of an indicator help minimize titration error.

3. Calculate the pH of the following solutions: (8 points each)
- A 3.6×10^{-8} F solution of HNO_3 .

- A solution prepared by adding 7.21 mL of 2.14 M NaOH to 1.00 g of hypochlorous acid (HOCl , molar mass 52.46 g/mol, $\text{p}K_a = 7.53$), 1.00 g sodium hypochlorite (NaOCl , molar mass 74.44 g/mol) and diluting to 100.0 mL.

4. You need to prepare a pH 4.50 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, $\text{pK}_{\text{a}1} = 1.252$, $\text{pK}_{\text{a}2} = 4.266$.)

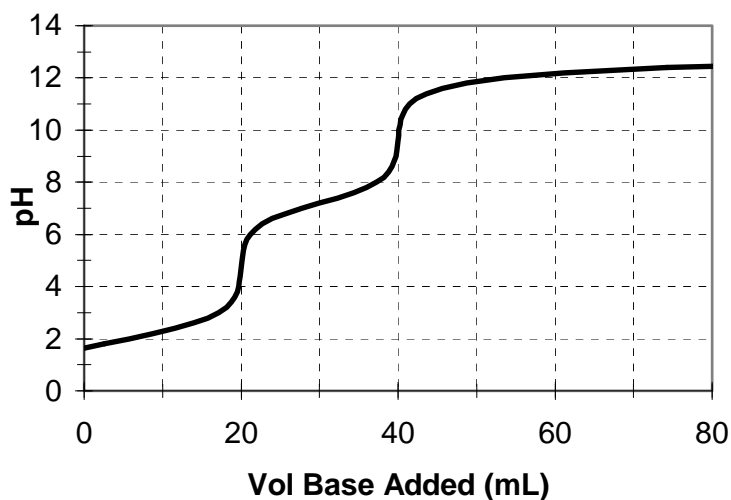
5. Consider the fractional composition plot for a weak, diprotic acid (H_2A) below.



- On the plot, clearly label the lines that correspond to α_{H_2A} , α_{HA^-} , $\alpha_{A^{2-}}$.
 - Estimate pK_{a1} and pK_{a2} and explain how you arrived at your estimates.
- c. For this acid, is it possible to prepare a solution where 99% of the acid is present as HA^- ? Justify your answer in terms of the tendencies of the equilibria occurring in solution.

6. I've asked you to go into the lab and help me prepare some unknowns for a new acid/base titration experiment we are considering. Unfortunately, I have neglected to label one solution and am nowhere to be found. To identify the solution, you construct the titration curve below by titrating 20.00 mL of the acid solution with standard 0.100 M NaOH. From the titration curve and the list of possible solution compositions below, identify the composition of the solution. Justify your reasoning by explaining why how you were able to rule out the imposters and choose the appropriate identity.

Solution	pK _a
A: 0.100 M H ₂ SO ₄	strong, 2.00
B: 0.100 M phosphoric acid	2.15, 7.20, 12.35
C: 0.100 M succinic acid	4.21, 5.64
D: 0.030 M HCl and 0.070 M acetic acid	strong, 4.76



Possibly Useful Information

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

PERIODIC CHART OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA	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
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† 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)
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