

Complete problem 1 and four of problems 2-6. CLEARLY mark the problem you do not want graded. You must show your work to receive credit for problems requiring math. Report your answers with the appropriate number of significant figures. You may ignore activity coefficients in all problems.

You MUST complete problem 1. (16 pts.)

1. Find the pH of a solution prepared by dissolving all of the following compounds in water in one beaker and diluting to a volume of 0.500 L: 0.100 mol acetic acid ($pK_a = 4.76$), 0.100 mol sodium acetate, 0.030 mol HNO_3 , and 0.040 mol NaOH.

Do four of problems 2-6. Clearly mark the problem you do not want graded. (16 pts. ea.)

2. Your new employer has asked you to prepare 1.00 L of a pH 7.00 buffer with a total phosphate concentration of 0.0500 M. You have at your disposal only the following compounds

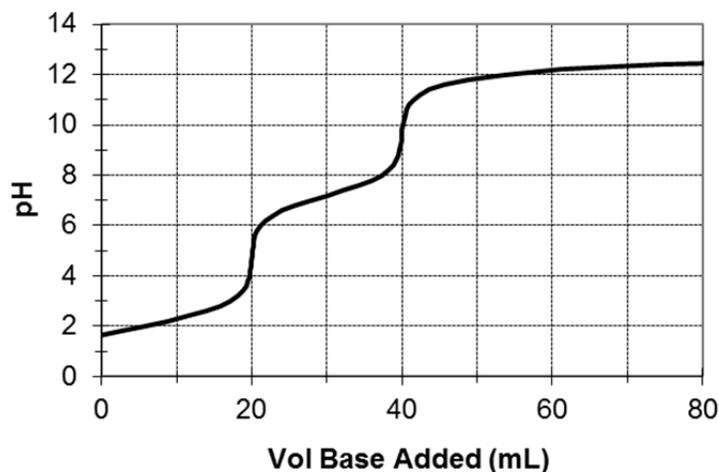
<u>Compound</u>	<u>K_a</u>	<u>Molar Mass (g/mol)</u>
H ₃ PO ₄	7.11 x 10 ⁻³	97.9950
NaH ₂ PO ₄	6.34 x 10 ⁻⁸	119.9769
Na ₂ HPO ₄	4.22 x 10 ⁻¹³	141.9588
Na ₃ PO ₄	--	163.9407

- a. Which two compounds would you use to prepare a buffer of pH 7.00 and how many grams of each of the two selected compounds would you need? (12 points)

- b. If you did exactly what you calculated in part (a), you would not get a pH of *exactly* 7.00. Why? Explain how you would really prepare this buffer in lab. (4 points)

3. 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 how you were able to rule out each of the imposters and choose the appropriate identity.

Solution	pK _a
A: 0.100 M maleic acid	1.83, 6.07
B: 0.100 M succinic acid	4.21, 5.64
C: 0.100 M phosphoric acid	2.15, 7.20, 12.35
D: 0.030 M HCl and 0.070 M acetic acid	strong, 4.76



4. Calculate the pH of 1.6×10^{-7} M calcium hydroxide (a strong base). What fraction of the total OH^- in this solution is from the calcium hydroxide?

5. You are asked to prepare 200.0 mL of a 0.150 F benzoate buffer at pH 4.50 using only pure benzoic acid (MW= 122.125 g/mol, $pK_a=4.20$), 3.00 M NaOH, and water. What mass of benzoic acid (in grams) and what volume of 3.00 M NaOH (in mL) will you need to prepare this buffer?

6. A weak diprotic acid, H_2A , has acid dissociation constants of $K_{a1} = 3.06 \times 10^{-4}$ and $K_{a2} = 3.37 \times 10^{-11}$. Calculate the pH and molar concentrations of H_2A , HA^- , and A^{2-} at equilibrium for a 0.140F solution of NaHA.

Possibly Useful Information

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

PERIODIC CHART OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES		
1 H 1.00797														18 Ar 39.948	2 He 4.0026		
3 Li 6.939	4 Be 9.0122													9 F 18.9984	10 Ne 20.183		
11 Na 22.9898	12 Mg 24.312													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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