CH 302 Worksheet 10:
22 random compounds thrown into water and begging for a pH value to be calculated

Instructions: A collection of 22 acid base problems is provided in a table. Each starts with a single compound thrown in water. You are given the compound formula, the initial concentration and K values. You need to find the pH.

The good news is that there are no neutralizations or buffers to deal with here. The bad news is that you have to distinguish simple acid base approximations (slacker equations) from more complex solutions (quadratic and cubic) and have to consider polyprotic acids approximations.

Strive to do as much of this work on your calculator without writing anything down—note that once you have found the correct equation (column 5) it is a pretty simple plug and chug problem in most cases. Time spent writing things down is time not spent on other problems on an exam.

You need to fill in three columns on the worksheet:

- The compound type in Column 2 (see key below)
- The equation type in Column 5 (see key below)
- The pH in Column 6 using the equation in Column 5.

Key for Column 2: place one of these simplified acid/base terms into column 2
Choose from H^+, OH^-, HA, A^-, B, BH^+, H_2A, HA^-, $A^=$, H_3A, H^2A^-, $HA^=$, A^{-3}

Key for Column 5: indicate the equation type you will use from the K and $C_{initial}$ values provided:

A. strong approximation: $[H^+] = C_a$ or $[OH^-] = C_b$

B. weak approximation: $[H^+] = (KC)^{0.5}$ or $[OH^-] = (KC)^{0.5}$

C. amphiprotic approximation: $[H^+] = (K_lK_r)^{0.5}$ or $pH = (pK_l + pK_r)/2$

D. K too large or C too small, quadratic: $[H^+]^2 - C_a[H^+] + K_aC = 0$ or $[OH^-]^2 - C_b[OH^-] + K_bC = 0$

E. Dilute strong acid or base quadratic: $[H^+]^2 - K_a[H^+] - K_w = 0$ or $[OH^-]^2 - K_b[OH^-] - K_w = 0$

F. Dilute weak acid cubic solution: no one should solve a cubic when the answer is already ~7

G. Complex solution, the K values are too close: you should refuse to solve this kind of problem in a general chemistry class.

Note about solving quadratics: Solving quadratics is a skill you will need to learn for problem types D, E, and F.) Either learn to use your programmable calculator, or learn to solve the quadratic formula quickly (note I have put the equations in that form for your ease) or be prepared to back substitute on multiple choice tests.

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#	Compound	type	$C_{initial}$ (M)	K values	Eqn type	pH
1	NaF		0.8	K_a= 3.5x10^{-4}		
2	KH_2PO_4		0.1	$K_{a\,1}$=7.6x10^{-3} ; $K_{a\,2}$=6.2x10^{-8} ; $K_{a\,3}$=2.1x10^{-13}		
3	MgCO3		2	$K_{a\,1}$=4.3x10^{-7} ; $K_{a\,2}$= 5.6x10^{-10}		
4	HCOOH		0.003	K_a = 1.8x10^{-4}		
5	NH_4Cl		2	K_b=1.8x10^{-5}		
6	NaH_2PO_3		0.5	K_{a1}=1x10^{-2} ; $K_{a\,2}$=2.6x10^{-7} ; $K_{a\,3}$= 4.5x10^{-12}		
7	HI		0.0001	$K_a = \infty$		
8	$C_2H_4O_2(COOH)_2$		3.0	K_a 1= 6x10^{-5}, K_a 2=1.5x10^{-5}		
9	$LiHCO_3$		0.004	$K_{a\,1}$= 4.3x10^{-7}, $K_{a\,2}$= 5.6x10^{-11}		
10	H_2S		.2	$K_{a\,1}$=1.3x10^{-7}, $K_{a\,2}$=7.1x10^{-15}		
11	$Ca(HPO4)_2$		1.5	$K_{a\,1}$=7.6x10^{-3} ; $K_{a\,2}$=6.2x10^{-8} ;$K_{a\,3}$=2.1x10^{-13}		
12	Ba(OH)2		0.001	$K_{b1} = \infty$, $K_{b2} = \infty$		
13	$HClO_3$		3x10^{-7}	$K_a = \infty$		
14	$BaHSO_3$		0.04	K_{a1}=1.5x10^{-2}, K_{a2}=1.2x10^{-7}		
15	CN^-		2x10^{-8}	K_a =4.9x10^{-10}		
16	$CaBr_2$		0.9	$K_{sp} = \infty$		
17	RbOH		5 x 10^{-8}	$K_b = \infty$		
18	NaHS		0.0006	$K_{a\,1}$=1.3x10^{-7}, $K_{a\,2}$=7.1x10^{-15}		
19	H_2SO_4		0.1	$K_{a\,1}= \infty$, $K_{a\,2}$=1.2x10^{-2}		
20	CH_3COOH		5x10^{-6}	K_a =1.8x10^{-4}		
21	$LiNO_2$		10	K_a =4.3x10^{-4}		
22	H_2CO_3		1	$K_{a\,1}$= 4.3x10^{-7}, $K_{a\,2}$= 5.6x10^{-11}		