

Acid-Base Equilibria Problems

You should be able to do these problems without a calculator

1. A 0.010 M solution of a weak acid (HA) has a pH of 3.50. What is the K_a and pK_a of the acid? (**1.0×10^{-5} and 5.00**)
2. A 0.250 mol sample of HY is dissolved in enough water to form 250 mL of solution. If the pH of the solution is 3.30, what is the K_a and pK_a of HY? (**2.5×10^{-7} and 6.60**)
3. For the diprotic acid H_2A ($pK_{a1} = 4.00$ and $pK_{a2} = 7.00$) calculate the following quantities: $[H_2A]$, $[HA^{1-}]$, $[A^{2-}]$, $[H^+]$, $[OH^-]$, pH and pOH in a 0.200 M solution of H_2A . (**$[H_2A] = 0.195 M$, $[HA^{1-}] = [H^+] = 5 \times 10^{-3} M$, $[A^{2-}] = 1 \times 10^{-7} M$, $[OH^-] = 2 \times 10^{-12} M$, pH = 2.30 and pOH = 11.70**)
4. (a) What is the pH of 0.100 M sodium phenolate, C_6H_5ONa , the sodium salt of phenol. (**11.50**)
 $K_a(\text{phenol}) = 1.0 \times 10^{-10}$
(b) What is the pH of 0.100 M aniline hydrochloride, $C_6H_5NH_3Cl$. (**2.80**) The pK_b of $C_6H_5NH_2 = 9.40$.
5. Explain with equations only whether an aqueous solution of each of the salts is acidic, basic, or neutral: (a) KBr; (b) NH_4I ; (c) KCN; (d) $CaCl_2$; (e) $Ba(CH_3COO)_2$; (f) $(CH_3)_2NH_2Br$. (**neutral, acidic, basic, neutral, basic, acidic**)
6. What are the $[H^+]$ and the pH of a solution that consists of 0.50 M HX and 0.25 M NaX (K_a of HX = 5.0×10^{-4}). (**1.0×10^{-3} and 3.00**)
7. What is the pH of a solution that consists of 0.20 M NH_3 and 0.10 M $(NH_4)_2SO_4$ (pK_b of $NH_3 = 4.75$). (**9.25**)
8. A solution consists of 0.25 M $KHCO_3$ and 0.75 M K_2CO_3 . Carbonic acid (H_2CO_3) is a diprotic acid with $pK_{a1} = 6.35$ and $pK_{a2} = 10.33$.
(a) Which pK_a is used in the calculation of the pH of the solution?
(b) What is the pH of this solution? (**10.81**)
9. What is the ratio of $[BrO^-]/[HBrO]$ of a buffer solution with a pH of 8.34 (pK_a of $HBrO = 8.64$). (**0.5**)
10. A buffer containing 0.200 M HA and 0.150 M of NaA, has a pH of 3.35. What is the pH after 12.5 mmol of NaOH is added to 500 mL of this solution? (**3.47**)
11. The indicator cresol red has a $K_a = 5.0 \times 10^{-9}$. Over what approximate pH range does the indicator change color? (**about 7.3 to 9.3**)