ANSWER KEY.

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8.3 Weak Acid and Base Equilibria

AP Chemistry | ANSWER KEY

Show your work. Use $K_w = 1.0 \times 10^{-14}$ at 25 °C. You may use the 5% rule to simplify.

1. Write the equilibrium expression for each reaction.

(a) $HNO_2(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + NO_2^-(aq)$ $K_a = ?$

(b) $CH_3NH_2(aq) + H_2O(l) \rightleftharpoons CH_3NH_3^+(aq) + OH^-(aq)$ $K_b = ?$

(a) $\boldsymbol{K_a = [H_3O^+][NO_2^-] / [HNO_2]}$

(b) $\boldsymbol{K_b = [CH_3NH_3^+][OH^-] / [CH_3NH_2]}$ (water is a liquid, so it is left out)

2. Acetic acid has $K_a = 1.8 \times 10^{-5}$. For a 0.100 *M* CH_3COOH solution, calculate the pH and the percent ionization. Use an ICE table.

	CH_3COOH	H_3O^+	CH_3COO^-
I (*M*)	0.100	0	0
C (*M*)	$-x$	$+x$	$+x$
E (*M*)	$0.100 - x$	x	x

$K_a = x^2 / (0.100 - x) \approx x^2 / 0.100 = 1.8 \times 10^{-5}$, so $x = 1.34 \times 10^{-3}$ *M* $= [H_3O^+]$

pH $= -\log(1.34 \times 10^{-3}) =$ **2.87** Percent ionization $= (1.34 \times 10^{-3} / 0.100) \times 100 =$ **1.3%**

Check: 1.3% is less than 5%, so the approximation is valid.

3. Ammonia has $K_b = 1.8 \times 10^{-5}$. Calculate the pH of a 0.200 *M* NH_3 solution at 25 °C.

	NH_3	NH_4^+	OH^-
I (*M*)	0.200	0	0
C (*M*)	$-x$	$+x$	$+x$
E (*M*)	$0.200 - x$	x	x

$K_b = x^2 / 0.200 = 1.8 \times 10^{-5}$, so $x = [OH^-] = 1.90 \times 10^{-3}$ *M*

pOH $= -\log(1.90 \times 10^{-3}) = 2.72$ pH $= 14.00 - 2.72 =$ **11.28**

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4. A 0.250 *M* solution of a weak monoprotic acid, HA, has a pH of 2.80. Calculate K_a for HA.

$[H_3O^+] = 10^{-2.80} = 1.58 \times 10^{-3}\ M = [A^-]$; $[HA] = 0.250 - 1.58 \times 10^{-3} \approx 0.248\ M$

$K_a = [H_3O^+][A^-] / [HA] = (1.58 \times 10^{-3})^2 / 0.248 =$ **1.0×10^{-5}**

5. Compare a 0.100 *M* CH_3COOH solution (1.3% ionized) with a 0.0100 *M* CH_3COOH solution. Calculate the percent ionization of the 0.0100 *M* solution, then explain the trend.

$x = \sqrt{(1.8 \times 10^{-5} \times 0.0100)} = 4.24 \times 10^{-4}\ M$; percent ionization = $(4.24 \times 10^{-4} / 0.0100) \times 100 =$ **4.2%**

More dilute acid ionizes to a greater percent. Diluting shifts the equilibrium toward more particles (more ions), so a larger fraction of the HA ionizes.

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