2. Find the pH and fraction of dissociation (x) of a 0.100 M solution of the weak acid HA with $K_a = 1.00 \times 10^{-5}$.

\[ \text{pH} = \phantom{0}3.003 \]

\[ x = 0.00095 \]

Solving quadratic equation: $x = 9.95 \times 10^{-4} \text{ M}$.

4. \[ \text{HA} \rightleftharpoons H^+ + A^- \]

$0.100 - x \quad x \quad x$

$K_a = \frac{x^2}{(0.100 - x)}$

Solving quadratic equation: $x = 9.95 \times 10^{-4} \text{ M}$.

12. Calculate how many milliliters of 0.689 M KOH should be added to 5.00 g of MOBS (Table 9.2) to give a pH of 7.40.

\[ \text{pH} = 7.40 \]

\[ 15.9 \text{ mL} \]

13. Consider the dimeric acid HA with $K_a = 1.00 \times 10^{-4}$ and $K_{a2} = 1.00 \times 10^{-7}$. Find the pH and concentrations of HA, H$^+$, and A$^-$ in the following solutions:

\[ \begin{array}{c|c|c}
\text{Solution} & \text{pH} & \text{Concentration} \\
\hline
\text{1.00 M} & 1.00 \text{ M} & \text{HA} \\
\text{0.100 M NaA} & 2.10 \text{ M} & \text{H}^+ \\
\text{0.0067 M NaA} & 0.099 \text{ M} & \text{H}^+ \\
\hline
\text{HA} & x \quad x \quad x \\
\text{H}^+ & \frac{x}{0.026 - x} \quad \text{HA} \\
\text{A}^- & \frac{0.026 - x}{0.026 - x} \quad \text{HA} \\
\end{array} \]
Consider the diprotic acid H\textsubscript{2}A with \( K_{a1} = 1.00 \times 10^{-4} \) and \( K_{a2} = 1.00 \times 10^{-9} \). Find the pH and concentrations of HA, \( A^{-} \), and \( A^{2-} \) in the following solutions:

(a) 0.100 M H\textsubscript{2}A

\[
\begin{align*}
\text{pH} & = -\log \left[ \frac{[HA]}{[H_{2}A]} \right] \\
& = 3.55
\end{align*}
\]

(b) 0.100 M HA

\[
\begin{align*}
\text{pH} & = -\log \left[ \frac{[A^{-}]}{[HA]} \right] \\
& = 5.50
\end{align*}
\]

(c) 0.0100 M H\textsubscript{2}A

\[
\begin{align*}
\text{pH} & = -\log \left( \frac{[HA]}{[H_{2}A]} \right) \\
& = 1.00 \times 10^{-3}
\end{align*}
\]

(d) 0.00100 M HA

\[
\begin{align*}
\text{pH} & = -\log \left( \frac{[A^{-}]}{[HA]} \right) \\
& = 1.00 \times 10^{-6}
\end{align*}
\]

\[
\begin{align*}
[A^{2-}] & = \frac{[H_{2}A]}{[HA]} = 0.00100 \text{ M}
\end{align*}
\]

\[
\begin{align*}
[A^{-}] & = \frac{[HA]}{[H_{2}A]} = 0.00100 \text{ M}
\end{align*}
\]

\[
\begin{align*}
[H^{+}] & = 0.00100 \text{ M}
\end{align*}
\]

\[
\begin{align*}
\text{pH} & = -\log [H^{+}] \\
& = 3.00
\end{align*}
\]

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How many grams of Na\textsubscript{2}C\textsubscript{2}O\textsubscript{4} (FM 105.99) should be mixed with 3.99 g of NaHCO\textsubscript{3} (FM 84.01) to produce a 100 mL of buffer with pH of 9.91? (The \( K_{a1} \) of carbonic acid are \( K_{a1} = 4.4 \times 10^{-7} \) and \( K_{a2} = 4.69 \times 10^{-11} \))

\[
\begin{align*}
1.992 \text{ g}
\end{align*}
\]

\[
\begin{align*}
P_{	ext{H}_{2}O} & = 0.1 M + \log \left[ \frac{[HA]}{[H_{2}A]} \right] \\
P_{\text{H}_{2}O} & = 0.1 \times 4.50 \times 10^{-7} + \log \left( \frac{0.1}{0.8} \right)
\end{align*}
\]

\[
\begin{align*}
[H^{+}] & = 10^{-8.27}
\end{align*}
\]

What is the pH at the equivalence point when 0.100 M hydroxyl acid is titrated with 0.0500 M KOH?

\[
\begin{align*}
\text{pH} & = \text{pK}_{a} \pm \log \left( \frac{[A^{-}]}{[HA]} \right) \\
& = 3.5 \pm \log \left( \frac{0.1}{0.05} \right)
\end{align*}
\]

\[
\begin{align*}
[H^{+}] & = 10^{-8.77}
\end{align*}
\]

\[
\begin{align*}
\text{pH} & = 8.77
\end{align*}
\]
Consider the titration of the weak acid HA with NaOH. At what fraction of $V_b$ does pH = $pK_a - 1$?

At what fraction of $V_b$ does pH = $pK_a + 1$?

\[ \text{HA} \rightleftharpoons H^+ + A^- \]

\[ pH = pK_a - \log \left( \frac{[H^+]}{[HA]} \right) \]

\[ pK_a = 4 \quad \rightarrow \quad p = 10 \]