Lecture Notes O: Strong acids and bases (cont)

1) Practice problems

A solution of HCl has a pH of 3. What is the concentration of the solution?

$$\rho H = -\log_{10}([H^+]) \quad \text{or} \quad [H^+] = 10^{-\rho H}$$

$$\rho H = 3 \quad \Rightarrow \quad [H^+] = 10^{-3} = 10^{-3} \text{ M HCl}$$

A solution of NaOH has a pH of 12. What is the concentration of the solution?

$$\rho \text{ON} = 14-\rho H \quad \Rightarrow \quad [\text{OH}^-] = 10^{-2} \quad 10^{-2} \text{ M NaOH} \quad \text{(dominant species)}$$

100ml of 1.0M NaOH is mixed with 100ml of 1.0M H₂SO₄. What is the pH of the resulting solution?

$$\text{NaOH} + 2\text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$$

$$\text{After dilution} \quad \text{Na}_2\text{SO}_4 \quad 1.0 \text{ M} \times \frac{100}{200} = 0.50 \text{ M}$$

$$[\text{OH}^-] = 0.50 \text{ M} \quad \text{(dominant species)} \quad [\text{H}^+] = 1.0 \text{ M}$$

$$\rho \text{H} = -\log_{10}(0.5) = 0.30 \quad \rho \text{ON} = 14-0.30 = 13.7$$

300ml of 1.0M NaOH is mixed with 100ml of 1.0M H₂SO₄. What is the pH of the resulting solution?

$$\text{Dilution} \Rightarrow \text{0.75M OH}^- \quad \text{0.25M H}_2\text{SO}_4$$

$$\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$$

$$\text{I} \quad 0.50 \quad 0.75$$

$$0.50 - 0.75$$

$$0 - 0.75$$

$$0.75$$

$$\text{OH}^- \quad \text{OH}^- \quad \text{OH}^-$$

$$\text{0.25} \quad \text{0.50} \quad \text{0.75}$$

$$\text{0.75} \quad \text{0.50} \quad \text{0.25}$$

$$\Sigma [\text{OH}^-] = 0.25 \text{ M}$$

$$\rho \text{ON} = -\log_{10}(0.25) = 0.60 \quad \rho \text{H} = 14 - 0.60 = 13.40$$
The following are mixed together: 100ml 1.0M NaOH, 50ml 1.0M HCl, 25ml 0.50M H\textsubscript{2}SO\textsubscript{4}. What is the pH of the resulting solution?

\[
\begin{align*}
\text{NaOH} & \quad 1.00 \times \frac{100}{175} = 0.57 \\
\text{HCl} & \quad 1.00 \times \frac{50}{175} = 0.29 \\
\text{H}_2\text{SO}_4 & \quad 0.50 \times \frac{25}{175} = 0.071 \\
\end{align*}
\]

\[
\begin{align*}
\text{H}^+ + \text{OH}^- & \rightarrow \text{H}_2\text{O} \\
0.43 & \quad \text{pOH} = -\log(0.14) \\
-0.43 & \rightarrow \text{pOH} = 0.85 \\
0.14 & \quad \text{pH} = 14 - 0.85 = 13.15 \\
\end{align*}
\]

2) **Interpreting acid-base titration curves**

100ml of an unknown strong acid is titrated with 0.100M NaOH. The following titration curve is obtained.

What is the concentration of the unknown acid solution?

![Titration Curve Diagram]

\[
\text{Moles Acid} = \text{Moles Base} = (0.100\text{M})(0.140) = 0.0140 \text{ Moles}
\]

\[
\text{[Acid]} = \frac{0.0140 \text{Moles}}{0.100 \text{L}} = 0.14 \text{ M}
\]