**Acid-Base Theories**

- **Bronsted-Lowry**—applies to water solutions

Lewis theory
Gilbert N. Lewis
1875-1946

**Lewis Acids & Bases**

Lewis acid = electron pair acceptor (BF₃)

Lewis base = electron pair donor (NH₃)

A Lewis acid and base can interact by sharing an electron pair.

The combination of metal ions (Lewis acids) with Lewis bases such as H₂O and NH₃ — and are of the type [M(H₂O)ₓ]ⁿ⁺ where x = 4 and 6.

**Lewis Acids & Bases**

Formation of hydronium ion is also an excellent example.

Other good examples involve metal ions.
Add $\text{NH}_3$ to light blue $[\text{Cu(H}_2\text{O)}_4]^{2+}\rightarrow$ light blue $\text{Cu(OH)}_2$ and then deep blue $[\text{Cu(NH}_3)_4]^{2+}$

$[\text{Ni(H}_2\text{O)}_6]^{2+} + 6 \text{NH}_3 \rightarrow [\text{Ni(NH}_3)_6]^{2+}$

This interaction weakens this bond

Another $\text{H}_2\text{O}$ pulls this $\text{H}$ away as $\text{H}^+$

The $\text{Fe}^{2+}$ in heme can interact with $\text{O}_2$ or $\text{CO}$ in a Lewis acid-base reaction.

This explains why water solutions of $\text{Fe}^{3+}$, $\text{Al}^{3+}$, $\text{Cu}^{2+}$, $\text{Pb}^{2+}$, etc. are acidic.

Amphotericism of $\text{Al(OH)}_3$

See Kotz/Treichel, page 830
**Lewis Acids & Bases**

This explains **AMPHOTERIC** nature of some metal hydroxides.

\[ \text{Al(OH)}_3(s) + 3 \text{H}^+ \rightarrow \text{Al}^{3+} + 3 \text{H}_2\text{O} \]

*Here Al(OH)_3 is a Brønsted base.*

\[ \text{Al(OH)}_3(s) + \text{OH}^- \rightarrow \text{Al(OH)}_4^- \]

*Here Al(OH)_3 is a Lewis acid.*

---

**Neutral Lewis Acid**

Carbon dioxide is a neutral Lewis acid.

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \]

---

**Lewis Acids & Bases**

Many complex ions are very stable.

\[ \text{Cu}^{2+} + 4 \text{NH}_3 \rightarrow [\text{Cu(NH}_3)_4]^{2+} \]

\( K \) for the reaction is called \( K_{\text{formation}} \) or a “formation constant”

Here \( K = 6.8 \times 10^{12} \). Reaction is strongly product-favored.

---

**Lewis Acids & Bases**

Formation of complex ions explains why you can dissolve a ppt. by forming a complex ion.

\[ \text{AgCl}(s) + 2 \text{NH}_3 \rightarrow \text{Ag(NH}_3)_2^+ + \text{Cl}^- \]

\( K_{\text{sp}} = 1.8 \times 10^{-10} \)

\( K_{\text{form}} = 1.6 \times 10^7 \)

\( K_{\text{net}} = K_{\text{sp}} \cdot K_{\text{form}} = 2.9 \times 10^{-3} \)