The Chemistry of Acids and Bases

Chapter 17

Strong and Weak Acids/Bases

• Generally divide acids and bases into STRONG or WEAK ones.

STRONG ACID: \( \text{HNO}_3(aq) + \text{H}_2\text{O}(\text{liq}) \rightarrow \text{H}_3\text{O}^+(aq) + \text{NO}_3^-(aq) \)

\( \text{HNO}_3 \) is about 100% dissociated in water.

Strong and Weak Acids/Bases

Hydronium ion

• Weak acids are much less than 100% ionized in water.

One of the best known is acetic acid = \( \text{CH}_3\text{CO}_2\text{H} = \text{HOAc} \)

\( \text{HOAc}(aq) + \text{H}_2\text{O}(\text{liq}) \rightarrow \text{H}_3\text{O}^+(aq) + \text{OAc}^-(aq) \)

\( \text{OAc}^- = \text{CH}_3\text{CO}_2^- \) = acetate ion

Strong and Weak Acids/Bases

Strong Base: 100% dissociated in water.

\( \text{NaOH}(aq) \rightarrow \text{Na}^+(aq) + \text{OH}^-(aq) \)

Other common strong bases include \( \text{KOH} \) and \( \text{Ca(OH)}_2 \).

\( \text{CaO (lime)} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 \) (slaked lime)

Strong and Weak Acids/Bases

• Weak base: less than 100% ionized in water

One of the best known weak bases is ammonia

\( \text{NH}_3(aq) + \text{H}_2\text{O}(\text{liq}) \rightarrow \text{NH}_4^+(aq) + \text{OH}^-(aq) \)
ACID-BASE THEORIES

- The most general theory for common aqueous acids and bases is the BRØNSTED - LOWRY theory
- ACIDS DONATE H⁺ IONS
- BASES ACCEPT H⁺ IONS

ACID-BASE THEORIES

- The Brønsted definition means NH₃ is a BASE in water — and water is itself an ACID

\[ \text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^- \]

Every acid has a conjugate base - and vice-versa.

ACID-BASE THEORIES

A strong acid is 100% dissociated. Therefore, a STRONG ACID—a good H⁺ donor—must have a WEAK CONJUGATE BASE—a poor H⁺ acceptor.

\[ \text{HNO}_3(aq) + \text{H}_2\text{O(liq)} \rightarrow \text{H}_3\text{O}^+(aq) + \text{NO}_2^-(aq) \]

STRONG A base acid weak B

Notice that every A-B reaction has two acids and two bases!

ACID-BASE THEORIES

Acetic acid is only 0.42% ionized when [HOAc] = 1.0 M. It is a WEAK ACID

\[ \text{HOAc} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{O}^+ + \text{OAc}^- \]

Because [H₂O⁺] is small, this must mean

1. H₂O⁺ is a stronger acid than HOAc
2. H₂O is a stronger base than OAc⁻
Acid-Base Reactions

- Now we can describe reactions of acids with bases and the direction of such reaction.
- Consider the acid HF reacting with the base NH₃.
- HF + NH₃ → NH₄⁺ + F⁻.

Predicting the Direction of Acid-Base Reactions

Based on experiment, we can put acids and bases on a chart — Table 17.3 (page 794)

Use chart to predict the direction of reactions between any A-B pair.
Reactions always go from the stronger A-B pair to the weaker A-B pair.

ACID-BASE THEORIES

Predicting the direction of an acid-base reaction.
Reactions always go from the stronger A-B pair to the weaker A-B pair.

Use Table 17.3