ECGERCIES



Properties of Acids and Bases



- When an acid dissolves in water, a proton is transferred from the acid to water:
 - $HA(aq) + H_2O(I) \leftarrow H_3O^+(aq) + A^-(aq)$
 - A new acid, H₃O⁺ (the conjugate acid), and a new base, A⁻ (the conjugate base), are formed.
 - The conjugate acid and base can react with one another, to re-form the parent acid and a water molecule.
 - This reaction can occur "in both directions."



- There is a competition for the H⁺ ion between H₂O (in the forward reaction) and A⁻ (in the reverse reaction).
- If H₂O "wins," then the solution will contain mostly H₃O⁺ and A⁻.
 - The H₂O molecule is a much stronger base than A⁻.
 - The forward reaction predominates.
 - The acid HA is <u>completely ionized</u> or <u>completely dissociated</u>.
 - This represents a strong acid.





- If A⁻ "wins," the A⁻ is a much stronger base than H₂O and the reverse reaction predominates:
 - $HA (aq) + H_2O (I) \leftarrow H_3O^+ (aq) + A^- (aq)$
 - A⁻ has a much larger attraction for H⁺ than does H₂O, and most of the HA molecules remain intact.
 - This represents a weak acid.





Strong Acids

- We can determine what is actually going on in a solution by measuring its ability to conduct an electric current.
 - A solution can conduct a current in proportion to the number of ions that are present.
 - When 1 mole of HCl is dissolved in 1L of water, the resulting solution is an excellent conductor.
 - HCI is a strong electrolyte.





– Each HCI molecule must produce H+ and CI- ions.

- The forward reaction predominates:

- $HCI(aq) + H_2O(l) \implies H_3O^+(aq) + CI^-(aq)$
 - In solution there are virtually no HCI molecules, only H+ and CI- ions.
 - This aqueous solution of HCI (*hydrochloric acid*) is a strong acid.
- A strong acid is one for which the forward reaction predominates.





 A strong acid contains a relatively weak conjugate base – one that has a low attraction for protons.

Relative

conjugate

base

strength

Relative

acid

strength

 An acid whose conjugate base is a much weaker base than water.





Weak Acids

- When acetic acid, HC₂H₃O₂, is dissolved in water, the resulting solution conducts an electric current only weakly.
 - Acetic acid is a weak electrolyte, which means that only a few ions are present.
 - The reverse reaction predominates:
- $HC_{2}H_{3}O_{2}(aq) + H_{2}O(l) \stackrel{\longrightarrow}{\checkmark} H_{3}O^{+}(aq) + C_{2}H_{3}O_{2}^{-}$ (aq)
 - Acetic acid is a weak acid.
 - It remains largely in the form of $HC_2H_3O_2$



- A weak acid is one for which the *reverse* reaction predominates.
- A weak acid dissociates (ionizes) only to a very small extent in aqueous solution.
- A weak acid contains a relatively strong conjugate base.







Table 16.1

Ways to Describe Acid Strength

Property	Strong Acid	Weak Acid
the acid ionization (dissociation) reaction	forward reaction predominates	reverse reaction predominates
strength of the conjugate base compared with that of water	A [–] is a much weaker base than H ₂ O	A [–] is a much stronger base than H ₂ O

Strong Acids The common strong acids are:

- Sulfuric acid, H₂SO₄ (aq)
- Hydrochloric acid, HCl (aq)
- Nitric acid, HNO₃ (aq)
- Perchloric acid, HClO₄ (aq)





- Sulfuric acid is actually a <u>diprotic acid</u>, an acid that can furnish two protons.
 - H₂SO₄ is a strong acid that is virtually 100% dissociated in water:

 $H_2SO_4(aq) \rightarrow H^+(aq) + HSO_4^-(aq)$

 The HSO₄⁻ ion is also an acid but it is a weak acid:

 $HSO_4^- (aq) \rightarrow H^+ (aq) + SO_4^{2-} (aq)$

 Most of the HSO₄⁻ ions remain undissociated.





Oxyacids

- Most acids are <u>oxyacids</u>, in which the acidic hydrogen is attached to an oxygen atom.
- Organic acids, those with a carbon-atom backbone, commonly contain the carboxyl group: -COOH
 - Acids of this type are usually weak.
 - For example, acetic acid:





Other Acids

- There are some important acids in which the acidic proton is attached to an atom other than oxygen.
- The most significant of these are the hydrohalic acids HX, where X represents a halogen atom.
 - Examples:
 - HCI a strong acid
 - HF a weak acid





