Acids and bases. Ch 19.1 Acid base theory

Date: Notes!

	Acids	Bases
Properties	examples HCl & H_2SO_4 Sour tasting (lemon) Electrolytes -aqueous solutions of acids conduct electricity, some are strong electrolytes (like those in car batteries) some are weak electrolytes. (weak acids) -Will change the color of various indicators example litmus will change from blue to red in an acid -acids react with metals produce hydrogen gas $HCl_{(aq)} + Mg_{(s)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$ ← gas! (single replacement reaction) -neutralize bases, react with compounds containing hydroxide ions to produce salts (ionic compound) $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$ acid base salt water -can be corrosive	- bitter tasting - feels slippery. - Electrolytes aqueous solutions of bases conduct electricity -will change color of various indicators example: litmus will change from red to blue - will neutralize acids, reacts with compounds containing hydrogen ions to produce salt (ionic compound) -can be corrosive

Theory- Arrhenius

Swedish chemist Svante Arrhenius (1859-1927) proposed a way of explaining the behavior of acids and bases

Acids

- Hydrogen containing compounds that ionize to yield hydrogen ions in aqueous solution.
- The formula of an acid will be H____ or an organic acid ex. HCl
- Acids can be monoprotic HCl(aq), or polyprotic like the diprotic H_2SO_4(aq) or the triprotic H_3PO_4(aq)
- Example of a Arrhenius acid HCl or HNO_3 Ex $HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

Bases

- Compounds that ionize to yield hydroxide ions.
- The formula will be a ionic hydroxide that easily dissociates like sodium hydroxide
- Example LiOH

Arrhenius definition of an acid and base isn't a very comprehensive one. It does not include certain substances that have acidic and basic properties such as sodium carbonate (Na_2CO_3) and ammonia (NH_3).

Problems with Arrhenius theory

1. H^+ prob. not in solution. (attracted to polar water molecule to make H_3O^+)
2. Ionic salts should produce neutral solutions.
3. Water is imp. in acidic & basic properties.
4. NH_3 is a base! (Arrhenius definition could not explain this)

Bronsted-Lowry Acids and Bases

Danish chemist Johannes Bronsted (1879-1947) and English chemist Thomas Lowry proposed a new definition.

Acids: H^+ donors

Base: H^+ acceptor

$NH_{3(aq)}$ +	$H_2O(l)$ ↔	$NH_4^+(aq)$ +	$OH^-(aq)$
Ammonia Hydrogen ion acceptor (ACID)	Water Hydrogen ion donor (BASE)	Ammonium ion (ACID)	Hydroxide ion (BASE)

Conjugate Acids and Bases

conjugate acid is the particle formed when a base gains a hydrogen ion.

conjugate base is the particle that remains when an acid donates a hydrogen ion.

conjugate acid-base pair consist of substances related by the loss or gain of a single hydrogen ion.

Examples

conjugate acid base pair

$NH_3(aq)$ + $H_2O(l)$ ↔ $NH_4^+(aq)$ + $OH^-(aq)$

base acid acid base

$HCl(aq)$ + $H_2O(l)$ ↔ $H_3O^+(aq)$ + $Cl^-(aq)$

acid base acid base

conjugate acid base pair

Amphoteric/Amphiprotic – is a substance that behaves as an acid in some reactions and a base in others.

Examples

HSO_3^- + H_3O^+ ↔ H_2SO_3 + H_2O ← acting as a base

HSO_3^- + OH^- ↔ SO_3^{2-} + H_2O ← acting as an acid

HSO_3^- is amphiprotic, as are hydrogen carbonate and hydrogen sulfate. What do they have in common?

HCO_3^- HSO_4^- . both can give or take a H^+.

Another amphiprotic Example:

$HCl(aq)$ + H_2O ↔ H_3O^+ + $Cl^-(aq)$ ← acting as a base.

$NH_3(aq)$ + H_2O ↔ $NH_4^+(aq)$ + OH^- ← acting as an acid.

A water molecule that gains a hydrogen ion becomes a positively charged hydronium

In chemistry we might refer to **H^+ in solution but what we actually are referring to Hydronium Ion (H_3O^+)**

Questions

Identify the following acids as monoprotic, diprotic, or triprotic.

a. H_2CO_3 diprotic b. H_3PO_4 triprotic c. HCl monoprotic d. H_2SO_4 diprotic

Identify each reactant in the following equations as a hydrogen-ion donor(acid) or hydrogen ion acceptor(base). Label the conjugate acid-base pairs.

1. HNO_3 + H_2O → H_3O^+ + NO_3^-

A B A B

2. CH_3COOH + H_2O ↔ H_3O^+ + CH_3COO^-

A B A B

3. H_2O + CH_3COO^- ↔ CH_3COOH + OH^-

A B A B