Properties of Acids

- taste sour
- not slippery
- solution conducts electricity
- causes blue litmus paper to turn red
- will react with some metals to produce H_2 gas
- pH < 7

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Properties of Bases

- taste bitter
- slippery, like soap
- will not react like acids
- causes red litmus paper to turn blue
- pH > 7
- solution conducts electricity

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Acid/Base Solutions

- **aqueous solutions** (*solutions with H_2O*) all contain H^+ (*hydrogen ions*) and OH^- (*hydroxide ions*)

- **acidic solutions**: contain more H^+ ions
- **basic solutions**: contain more OH^- ions
- **neutral solutions**: contain equal amounts of H^+ and OH^- (water, pH = 7)

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The Proton: H^+

- an H^+ is just a proton
- cannot exist in solution by itself
- will join with a water molecule to become H_3O^+
- H_3O^+ is called the hydronium ion
- H^+ and H_3O^+ can be used interchangeably in chemical reactions

$H_2O + H^+ \rightarrow H_3O^+$

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Arrhenius Acids/Bases

- Arrhenius Acid: contains hydrogen, ionizes to form a hydrogen ion in solution
  - > ex: $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$
- Arrhenius Base: contains hydroxide, ionizes to form a hydroxide ion in solution
  - > ex: $NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$
- Works for some acids and bases, but not all the time

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Bronsted-Lowry Acids/Bases

- *more inclusive model*
- **Bronsted - Lowry Acid**: hydrogen ion (proton) donor
- **Bronsted - Lowry Base**: hydrogen ion (proton) acceptor
- Using HX as a general formula for an acid
  - > $HX(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + X^-(aq)$
  - > *Bronsted-Lowry Acid:* HX
  - > *Bronsted Lowry Base:* H_2O

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Conjugate Acids/Bases

$HX(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + X^-(aq)$

- *Both the forward and the reverse reactions are acid-base reactions*
- **Conjugate Acid**: substance produced when a base accepts a proton (H_3O^+)
- **Conjugate Base**: substance produced when an acid donate a hydrogen ion (X^-)

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Conjugate Pairs

Before After

$HX(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + X^-(aq)$

bronst. acid (donates H^+) bronst. base (accepts H^+) conj. acid conj. base

Conjugate acid-base pairs: substances related to each other by donating and accepting a single hydrogen ion

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Conjugate Pairs

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

bronst. base (accept.) bronst. acid (donate) conj. acid conj. base

What are the conjugate acid-base pairs?

Does NH_3 fit the Arrhenius model of a base?

Arrh. – ^-OH

Is water an acid or a base? both

Amphoteric (Amphoprotic): substances that can act as both an acid and a base. *example: water*

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Practice:

Identify the acid-base pairs in the following reactions

1. $HBr(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + Br^-(aq)$

acid (donates) base (accept.) conj. acid conj. base

2. $CO_3^{2-}(aq) + H_2O(l) \leftrightarrow HCO_3^-(aq) + OH^-(aq)$

base (accept.) acid (donate) conj. acid conj. base

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Monoprotic and Polyprotic Acids:

H^+

For a hydrogen ion to be donated, it must be bonded to a highly electronegative element. (F, Cl, Br, I, O, N, S)

Monoprotic Acids: a substance that can only donate 1 hydrogen ion per molecule

ex: HBr, HCl, HI, CH_3COOH (acetate)

Polyprotic Acids: a substance can donate more than 1 hydrogen ion per molecule

ex: H_3PO_4 and H_2SO_4

-- will ionize in steps, not all at once

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