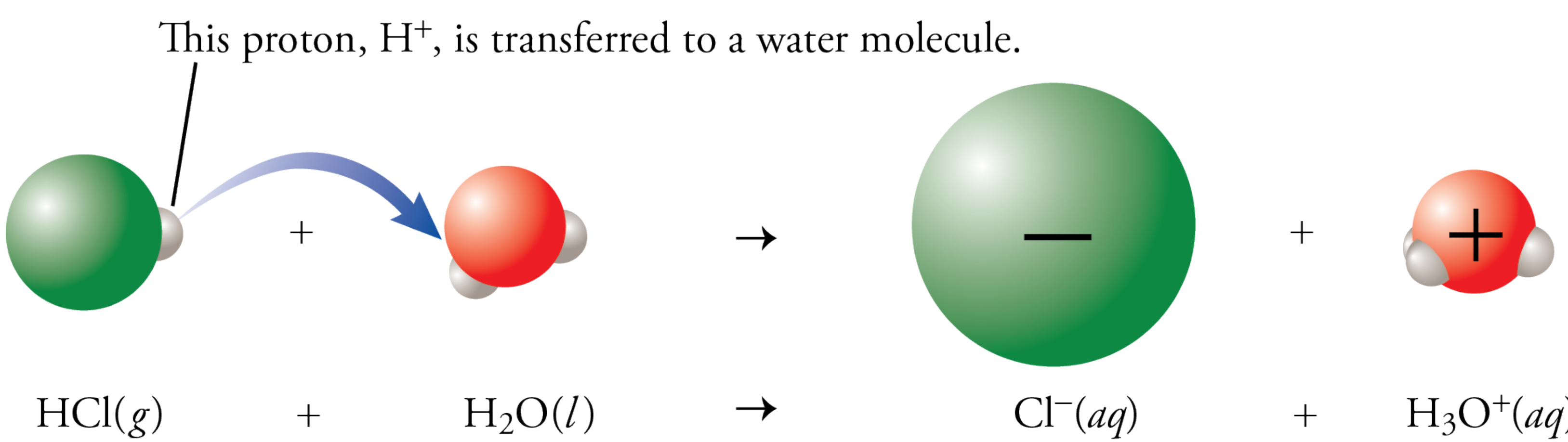
Arrhenius Acid Definition

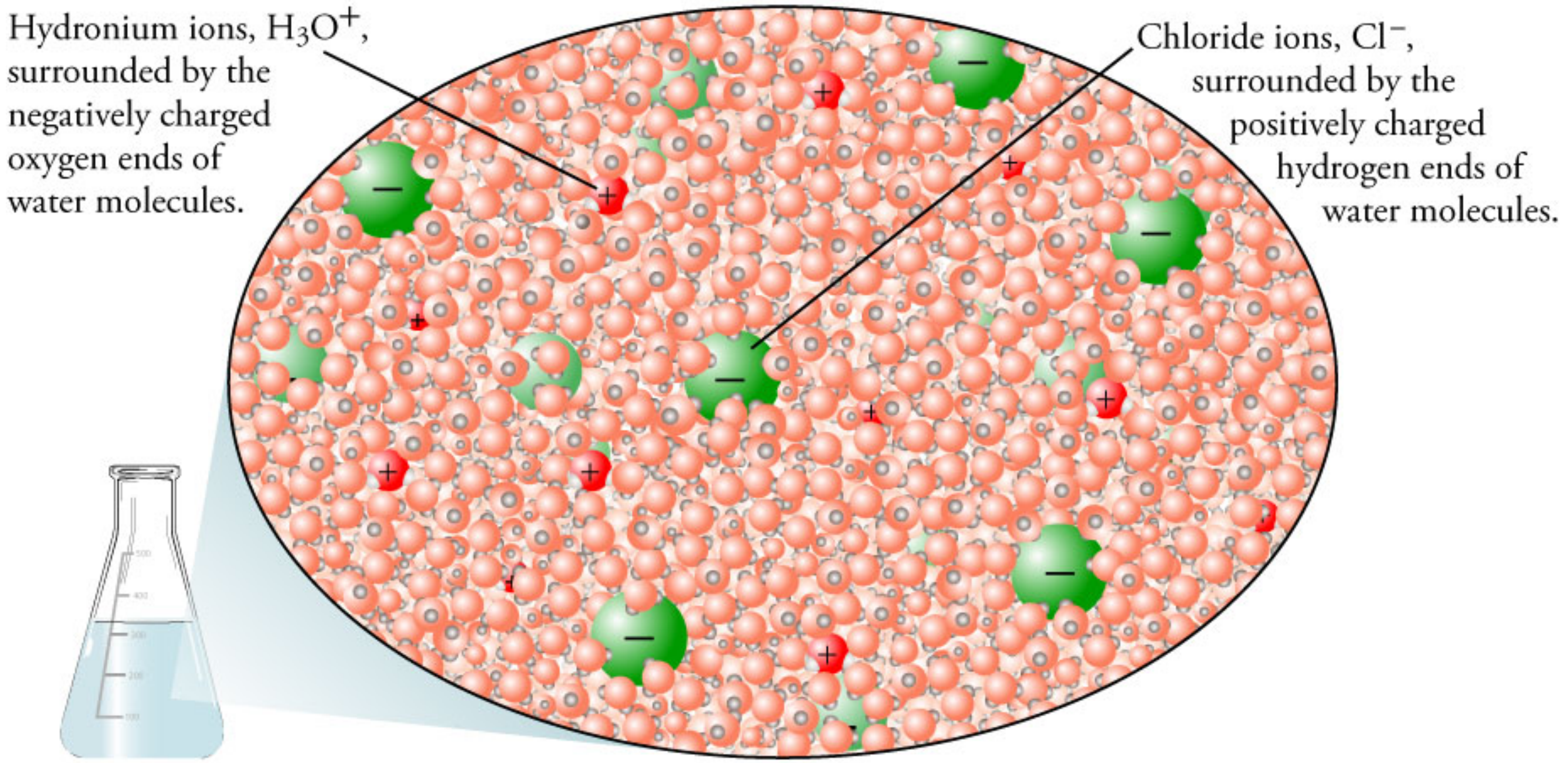
- An ***acid*** is a substance that generates hydronium ions, H_3O^+ (often described as H^+), when added to water.
- An ***acidic solution*** is a solution with a significant concentration of H_3O^+ ions.

Strong Acid and Water

When HCl dissolves in water, hydronium ions, H_3O^+, and chloride ions, Cl^-, ions form.

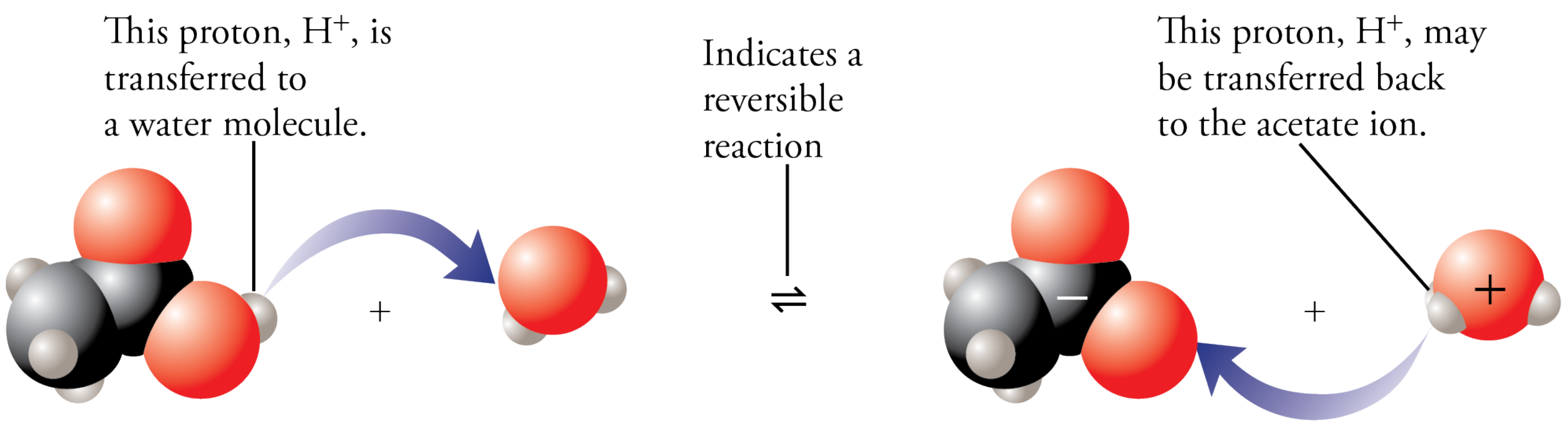


Solution of a Strong Acid



Weak Acid and Water

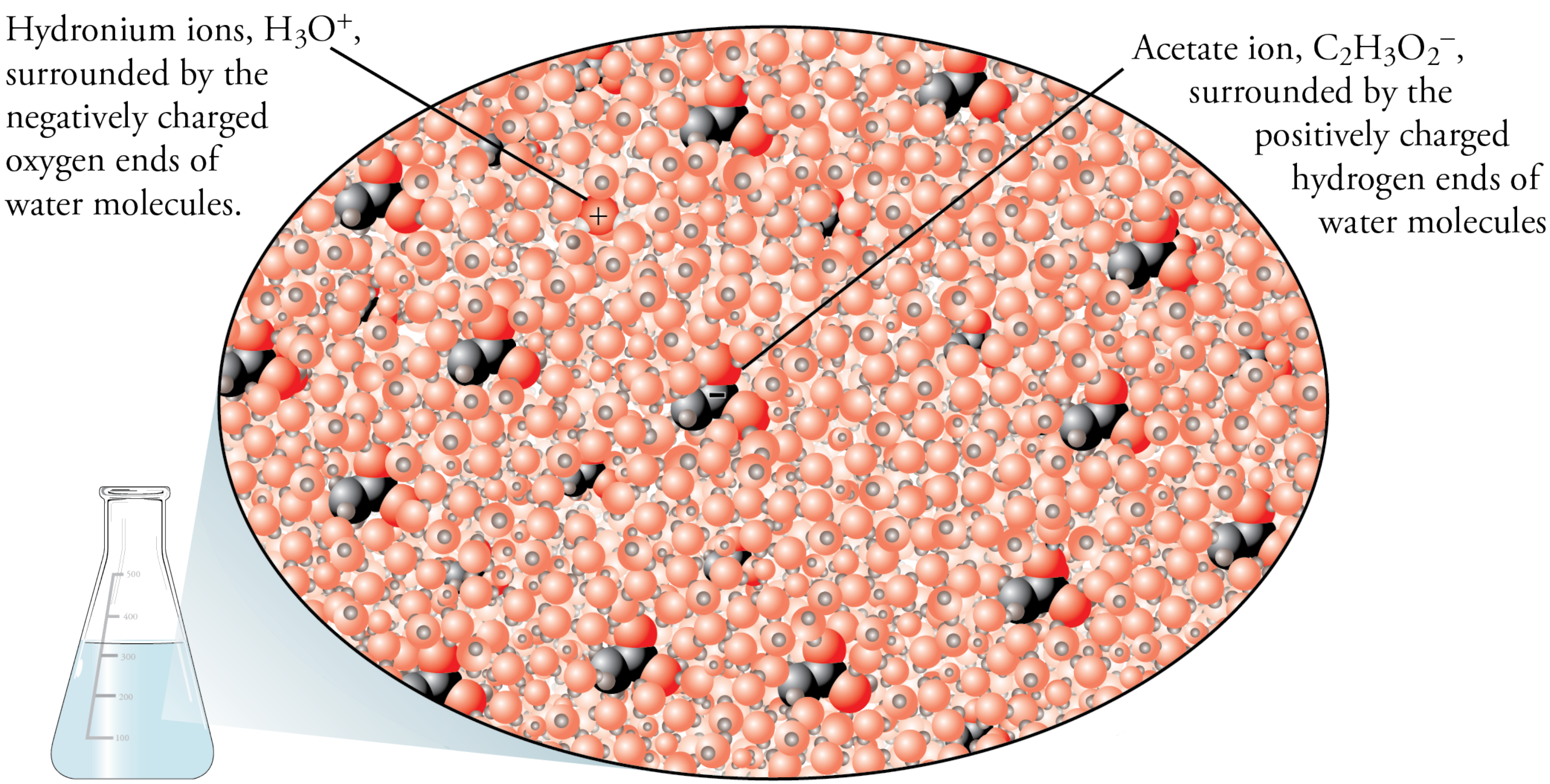
Acetic acid reacts with water in a reversible reaction, which forms hydronium and acetate ions.



$$HC_2H_3O_2(aq) \quad + \quad H_2O(l) \quad \rightleftharpoons \quad C_2H_3O_2^-(aq) \quad + \quad H_3O^+(aq)$$

Solution of Weak Acid

In a typical acetic acid solution, there are about 250 times as many uncharged acetic acid molecules, $HC_2H_3O_2$, as acetate ions, $C_2H_3O_2^-$.



Strong and Weak Acids

- ***Weak Acid*** = due to a reversible reaction with water, generates significantly less than one H_3O^+ for each molecule of acid added to water.
- ***Strong Acid*** = due to a completion reaction with water, generates close to one H_3O^+ for each acid molecule added to water.

Strong and Weak Acids

For every 250 molecules of the weak acid acetic acid, $HC_2H_3O_2$, added to water, there are about

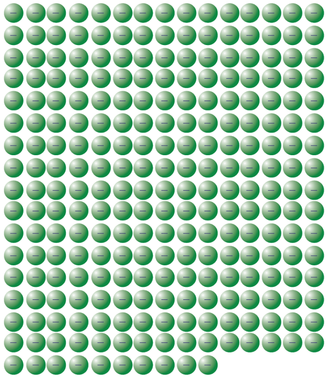
$$HC_2H_3O_2(aq) + H_2O(l) \rightleftharpoons C_2H_3O_2^-(aq) + H_3O^+(aq)$$

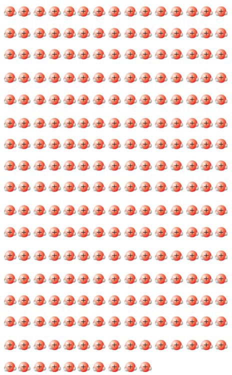
249 uncharged acetic acid molecules — One acetate ion — One hydronium ion

For every 250 molecules of the strong acid hydrochloric acid, HCl, added to water, there are about

$$HCl(g) + H_2O(l) \rightarrow Cl^-(aq) + H_3O^+(aq)$$

Zero uncharged HCl molecules — 250 chloride ions — 250 hydronium ions





Acid Animation and Tutorial

- There is an animation on the textbook's website that will give you a better understanding of weak and strong acids.

https://preparatorychemistry.com/acids_Canvas.html

Sulfuric Acid

$$H_2SO_4(aq) + H_2O(l) \rightarrow H_3O^+(aq) + HSO_4^-(aq)$$

$$HSO_4^-(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + SO_4^{2-}(aq)$$

Acid Summary

	Strong	Weak
Binary acid	hydrochloric acid, HCl(aq)	Hydrofluoric acid, HF(aq)
Oxyacid	nitric acid, HNO_3 sulfuric acid, H_2SO_4	other acids with $H_aX_bO_c$
Organic acid	none	acetic acid, $HC_2H_3O_2$

Arrhenius Base Definitions

- A ***base*** is a substance that generates OH^- when added to water.
- A ***basic*** solution is a solution with a significant concentration of OH^- ions.

Characteristics of Bases

- Bases have a bitter taste.
- Bases feel slippery on your fingers.
- Bases turn litmus from red to blue.
- Bases react with acids.

Strong Bases

- ***Strong Base*** = due to a completion reaction with water, generates close to one (or more) OH^- for each formula unit of base added to water.
  - – Metal hydroxides are strong bases.

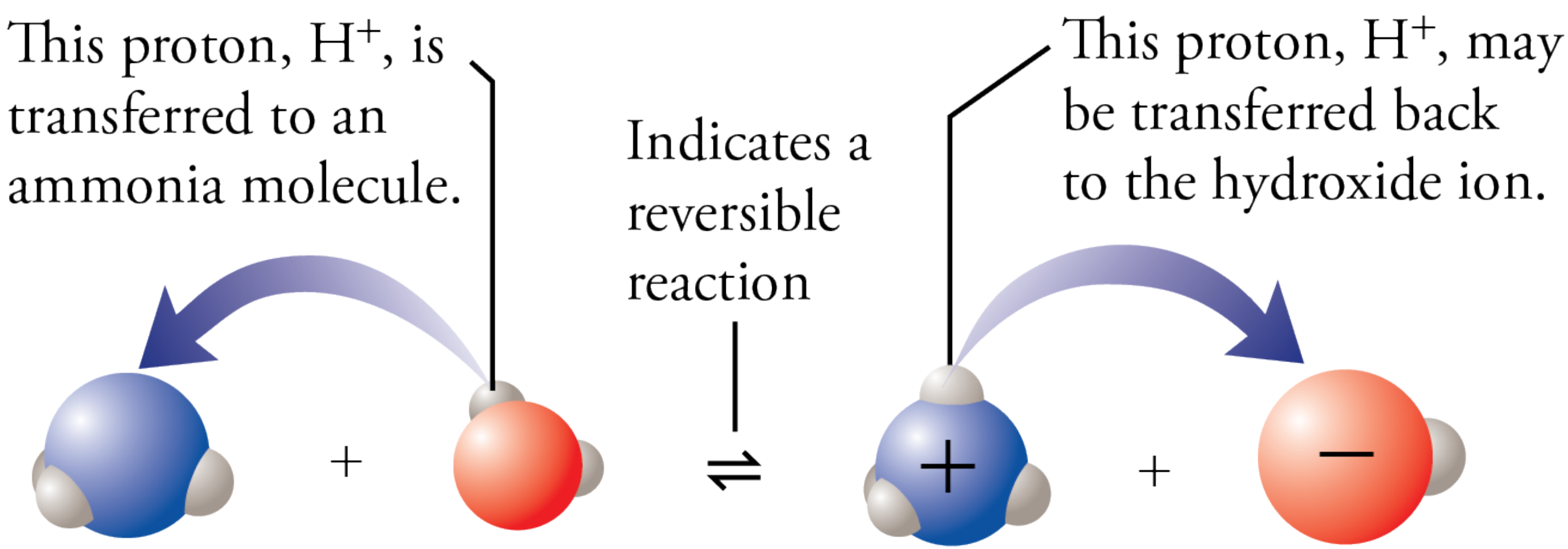
$$NaOH(s) \rightarrow Na^+(aq) + OH^-(aq)$$

$$LiOH(s) \rightarrow Li^+(aq) + OH^-(aq)$$

$$KOH(s) \rightarrow K^+(aq) + OH^-(aq)$$

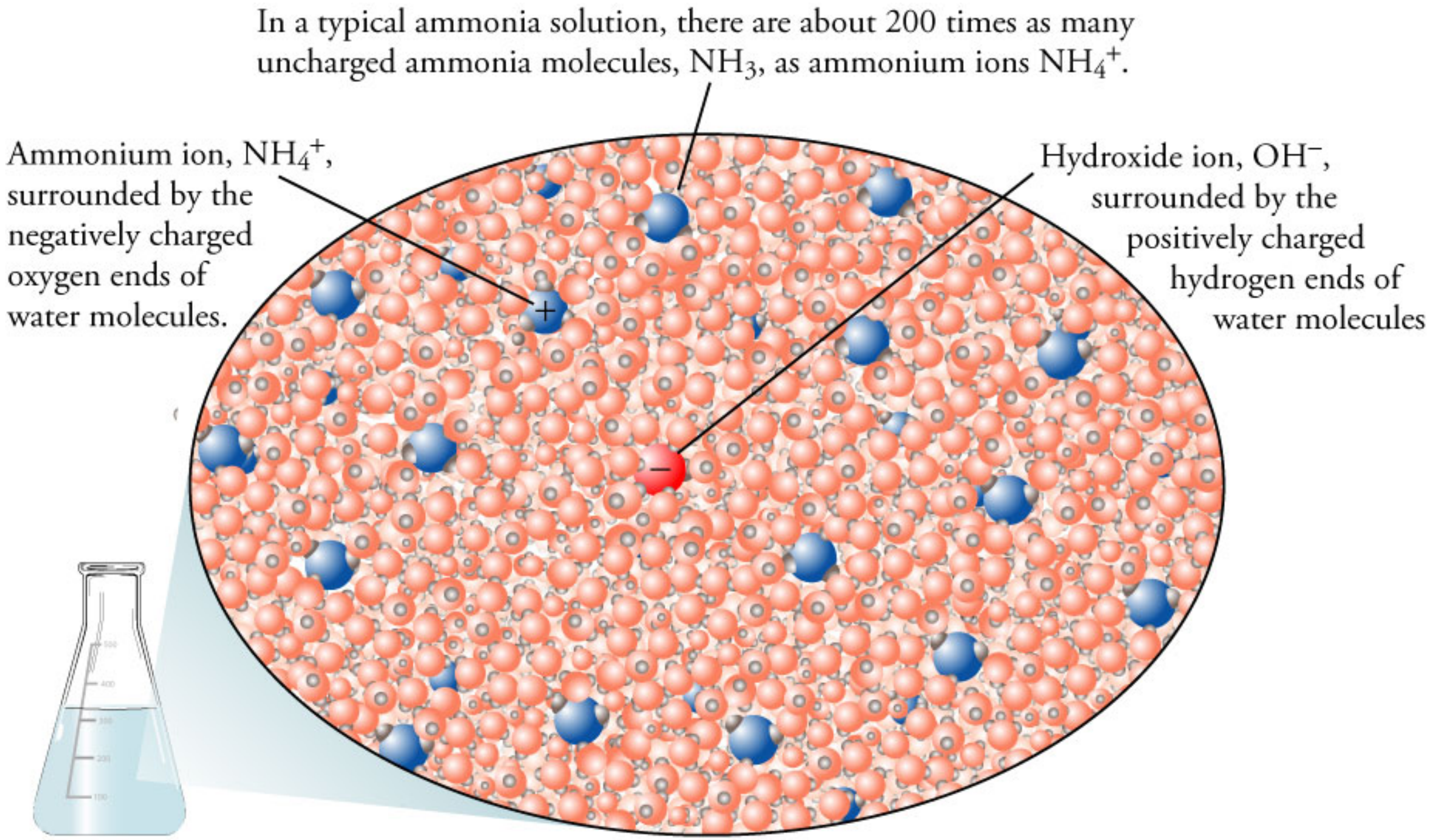
Ammonia and Water

Ammonia reacts with water in a reversible reaction, which forms ammonium and hydroxide ions.



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

Ammonia Solution



Weak Bases

- ***Weak Base*** = due to a reversible reaction with water, generates significantly less than one OH^- for each formula unit of base added to water.
  - Ammonia and ionic compounds that contain CO_3^{2-} or HCO_3^- are weak bases.

$$Na_2CO_3(s) \rightarrow 2Na^+(aq) + CO_3^{2-}(aq)$$
$$CO_3^{2-}(aq) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$$

$$NaHCO_3(s) \rightarrow Na^+(aq) + HCO_3^-(aq)$$
$$HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq) + OH^-(aq)$$

Arrhenius Bases

	Strong	Weak
Ionic Compounds	Metal hydroxides	Ionic compounds with CO_3^{2-} and HCO_3^-
Certain Uncharged molecules	None	NH_3

Practice

- There is a tool on the textbook’s website that will allow you to practice identifying whether substances are acids or bases, and if they are, whether they are strong or weak. A link to this tool is below.

https://preparatorychemistry.com/Bishop_acid_base_Canvas.html