Acids and Bases

Definitions

- Arrhenius-
  - Acids give off Hydrogen ions (protons)
  - Bases give off hydroxide ions
- This definition did not include enough acids but does explain many.
- Brønsted-Lowry
  - Acids are proton donors
  - Bases are proton acceptors

Conjugate pairs

- Acid and base dissociation (dissolving) reaches an equilibrium so a reverse reaction is possible.
- If a compound acts like an acid for the forward reaction, it will act like a base for the reverse reaction.
- Ex: $NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$
- The NH_3 acts like a base for the forward reaction, and the NH_4 acts like an acid for the reverse reaction.

Conjugate pairs continued

- $NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$
- The water acts like an acid for the forward reaction, and the hydroxide acts like a base in the reverse reaction.
- That makes NH_3 and NH_4^+ one conjugate acid-base pair.
- That also means that H_2O and OH^- make the second conjugate pair.
- There are k values to describe these equilibriums.

Dissociation of Water

- $H_2O_{(l)} + H_2O_{(l)} \leftrightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$
- One water molecule acts as a base, and one acts as an acid for the forward reaction.
- This means water is amphoteric meaning it can act as both an acid and a base.
- H_3O^+ is called a hydronium ion and is what is formed when a positive charged hydrogen ion interacts with polar water.
- So H_3O^+ and H^+ are the same thing, so don't let that confuse you!

Equilibrium of Water

- Since the dissociation of water establishes an equilibrium, it has a constant value associated with it.
- The $k_w = 1x10^{-14}$
- So writing out the equilibrium expression gives:
  - $1x10^{-14} = [H_3O^+][OH^-]$
- Remember that concentration is measured in molarity.

pH scale

- The pH scale is a mathematical way to represent the strength of the acid or base solution without writing out the concentrations all the time.
- It is based on a logarithmic scale which means that the number for the pH represents what power of ten the concentration is equal to.
- $pH = -\log[H_3O^+]$
- So a concentration of $1x10^{-4}$ would give a pH of 4.

Meaning of the pH scale

- The pH scale mostly focuses on the values between 0 and 14.
- The lower the pH, the higher the concentration of hydronium ions, so the more acidic the solution is.
- A pH of 7 would be a solution where the concentration of acid and also the base would be $1x10^{-7}$M and is a neutral solution.
- Any value around means the solution is weak, and far away from 7 means the solution is strong.

Strength of solutions

- Anything below 7 is an acid, and anything above 7 is a base.
- A pH of 5 is a weak acid while a pH of 2 is a strong acid.
- Since the pH scale is logarithmic, it means that the pH of 2 is 1000 times stronger than the solution with a pH of 5.
- A pH of 8 is a weak base, while a pH of 12 is a strong base.

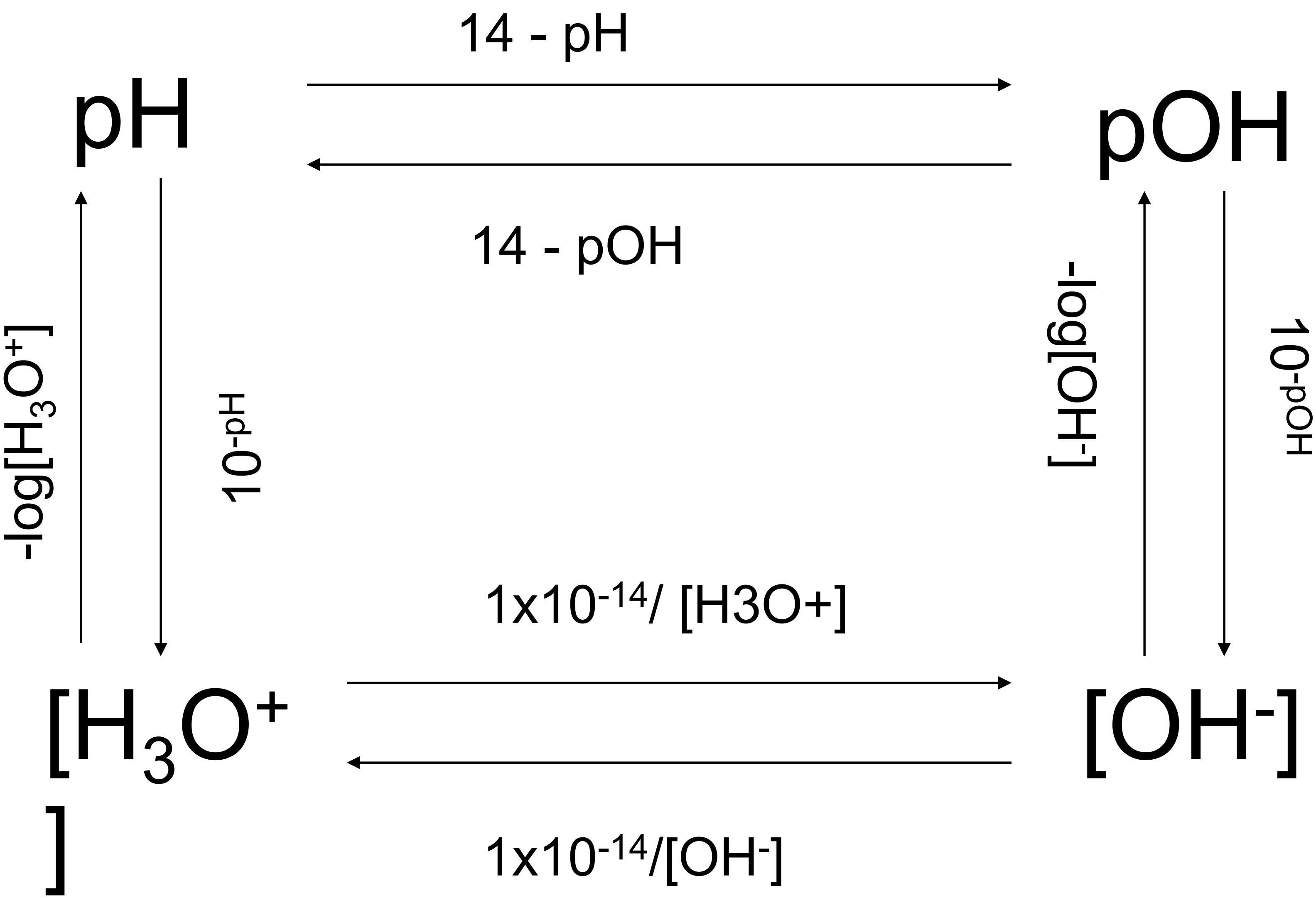
pOH

- Just like there is a pH scale focusing on hydronium ions, there is a pOH scale that looks at the hydroxide ions.
- pH + pOH = 14
- A pOH below 7 is basic while a pOH above 7 is acidic.
- The reverse of the log is the antilog.
- $10^{-pOH} = [OH^-]$

pH formulas to know

- $pH + pOH = 14$
- $pH = -\log[H_3O^+]$
- $10^{-pH} = [H_3O^+]$
- $pOH = -\log[OH^-]$
- $10^{-pOH} = [OH^-]$
- $1x10^{-14} = [H_3O^+][OH^-]$

pH conversions



Concentrations of acids and pH

- If the concentration of $[H_3O^+] = 1x10^{-5}M$ in a HCl solution, then $[HCl] = 1x10^{-5}M$.
- This is because each mole of HCl contains 1 mole of H^+ ions (remember H^+ and H_3O^+ are the same).
- If it is a sulfuric acid solution, H_2SO_4, then the concentration of the acid solution would be $5x10^{-6}M$, or half as much.
- This is because it takes 2 H^+'s to make each H_2SO_4.

Calculations with pH

- Remember that if you are given the pH, that only helps you get to the hydronium ions. (pOH only gets hydroxide)
- You always have to account for how many hydrogen ions and hydroxide ions are in your formula for your acid or base before you can determine their concentrations.
- The opposite is true as well, if you have the concentration of the acid or base, you must first figure out the concentration of the H^+ and OH^- before calculating pH or pOH.

Titrations

- Adding acids and bases together will neutralize the solution if equal amounts of ions are added.
- The products of this double replacement reaction is always a salt (ionic compound) and water.
- The process of adding a solution of known concentration to a solution of unknown concentration to determine that concentration is called a titration.

Titration process

- Add a known amount of the unknown to a beaker.
- Put two drops of an indicator (phenylphthalein is used in here) so that you know when the solution is neutralized.
- Add known opposite solution to burette above the beaker.
- Add solution from burette until one drop added causes a color change.
- Record volume of added solution.
- Do stoichiometry to calculate concentration of unknown solution.