Acids and Bases

What are acids and bases?

•Arrhenius model: Acids produce H^+ ions and bases produce OH^- ions

Example: $HCl \rightarrow H^+ + Cl^-$ and $NaOH \rightarrow Na^+ + OH^-$

•Brønsted-Lowry model: Acids are proton (H^+) donors and bases are proton acceptors. This allows for bases that don't have a hydroxide ion.

Conjugate acid: particle formed when a base has accepted a H^+ ion

Conjugate base: particle formed when an acid has donated a H^+ ion

Example: $HA_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + A^-_{(aq)}$

Acid base conj. Acid Conj. base

Note: water can be an acid or a base (amphoteric)

Acids and Bases

"Strength of an Acid or Base"

•Strong acids and strong bases completely dissociate -- such as HCl or NaOH

•Weak acids and weak bases are mostly undissociated in water -- such as CH_3COOH (acetic acid) or NH_3 (ammonia)

•Animation at
http://www.chembio.uoguelph.ca/educmat/chm19104/chemtoons/chemtoons9.htm

•How do you measure strength of an acid and a base?

•K_a and K_b -- they work just like K_{eq}

•Bigger = stronger

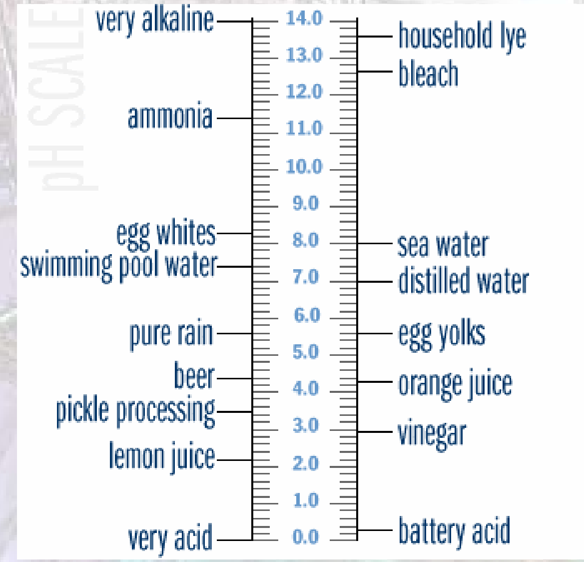
pH

- pH = -log $[H_3O^+]$
(also written as pH = -log$[H^+]$, both mean the same thing)
- pOH = -log $[OH^-]$
- $[H_3O^+]$ $[OH^-]$ = 10^{-14} = K_w(true at all pHs at 25°C, called the ion-product constant or water dissociation constant)
- Thus, pH + pOH = 14

Pure Water?

- So what about pure water? It's neither an acid nor a base. This means pH=7 (neutral). Or in other words, not acid and not base
- If pH = 7, then $[H^+] = 10^{-7}$ and $[OH^-] = 10^{-7}$
- So in pure water $[H^+] = [OH^-]$

pH Scale



Equivalence Point

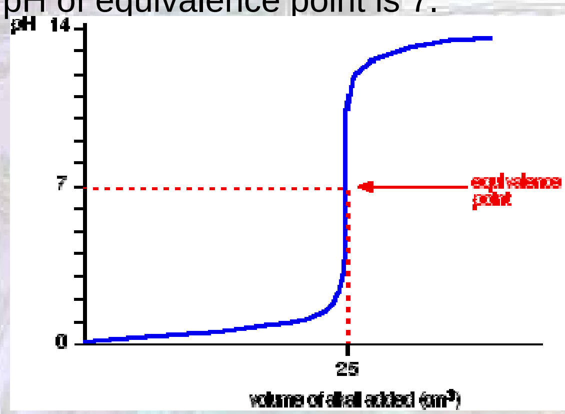
- When acids and bases react with each other it is called a <u>neutralization reaction.</u>
- Example:
- $HCl + NaOH \rightarrow H_2O + NaCl$ or
- Acid + base → water + salt
- Note: if base is a carbonate, CO_2 will also be produced
- $HCl + CaCO_3 \rightarrow H_2O + CaCl_2 + CO_2$

Equivalence Point

- Equivalence point is defined as when the number of moles of H^+ equals the number of moles of OH^-
- Equivalence points are determined via a lab technique called titration
- In a titration you add acid to base (or vice versa). The concentration of one is known, and you are determining the concentration of the other.
- You may find equivalence points (also known as an endpoint) using a graph or with an indicator
- To calculate the moles of the unknown, we will use stoichiometry (examples to come later)

Equivalence Point

- Using a pH meter, you can graph how pH changes as you add acid or base. Picture below shows strong base being added to strong acid.
  Note pH of equivalence point is 7.

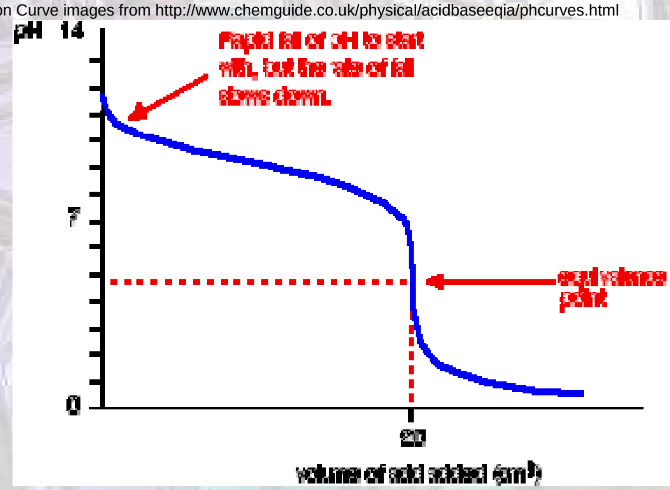


- Titration Curve images from http://www.chemguide.co.uk/physical/acidbaseeqia/phcurves.html

Equivalence Point

- Picture below shows strong acid being added to weak base. Note pH at endpoint is ~4.

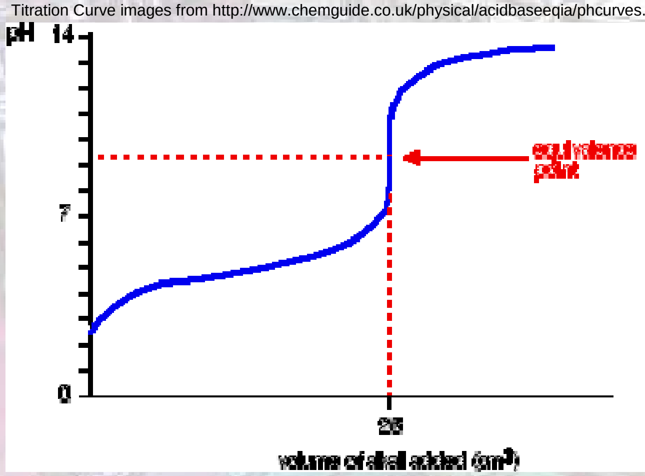
Titration Curve images from http://www.chemguide.co.uk/physical/acidbaseeqia/phcurves.html



Equivalence Point

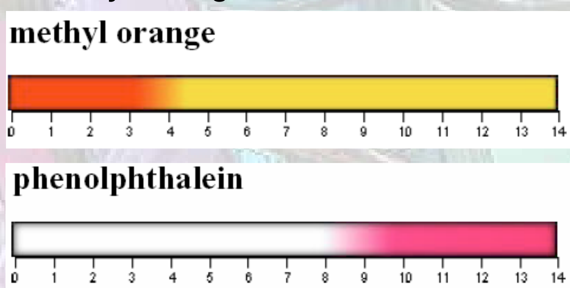
- Picture below shows a strong base being added to weak acid. Note pH at endpoint is ~9.

Titration Curve images from http://www.chemguide.co.uk/physical/acidbaseeqia/phcurves.html



Equivalence Point

- Indicators: You can also find equivalence point by properly selecting an acid base indicator (a substance that changes colors at different pH).
- You will be using methyl orange and phenolphthalein as indicators. Note the pH at which they change colors. When would you use them?



Images from http://antoine.frostburg.edu/chem/senese/101/acidbase/indicators.shtml

Normality

- Forgot what normality is?
- Normality is really just a molarity – think of it this way:
  Normality = Molarity of H^+ or OH^-
- Or in other words: N = (M)•(# of H^+ or OH^-)
- Or M = (N)/(# of H^+ or OH^-)

pH Meters

How Does A pH Electrode Work?

- Cell potential (voltage) depends on concentration. As concentrations vary, so will the voltage (59.2 mV per pH unit at 25°C)
- A pH electrode is made of an outer glass membrane, glass stem (filled with dilute HCl), and a silver/silver chloride wire.
- The glass is a special type of glass made with alkali metals. The glass membrane allows the metal ions (+) to pass through, but not H3O+ ions. As the number of H3O+ ions in the solution being tested varies, so does the voltage. This voltage is then converted into a pH.
- pH meters must be calibrated and stored in a special solution due to their unique structure

pH Meters