Acids and Bases

Chapter 17

A special solution

- Acids and bases are ALWAYS in a water solution.
- Your body has water in it so they are always dangerous to living things.
- Bases are just as dangerous as acids.
- In low *concentrations* they are not that dangerous and found all over your house.

Acids and Bases

•Although they can be dangerous, acids and base do not react with or "eat" everything.

•Neither has an effect on glass for example.

	Acid	Base
turn litmus paper	Red	Blue
have a pH	less than 7	more than 7
taste	sour	bitter and feel slippery
react with	metals and bases	oils and acids

Common places to find acids and bases

- Acids
  - Vinegar- acetic acid
  - citrus fruits- citric acid
  - carbonated drinks- carbonic acid
  - Your stomach- hydrochloric acid
- Bases
  - Antacid tablets (calcium hydroxide)
  - Windex- ammonia
  - Oven cleaner- sodium hydroxide
  - Draino – sodium hydroxide

Definitions

- Acid- a proton (H^+) donor [force feeder]
- Acids produce H_3O^+ (hydronium) in water
- Base- a proton (H^+) acceptor [thief]
- Bases produce OH^- (hydroxide) in water

Acid ionization equations

- Generically with the acid "HA"
- $HA \rightarrow H^+ + A^-$
- or
- $HA + H_2O \rightarrow H_3O^+ + A^-$
- Write the acid ionization equations for
- HF, HNO_3 and HCH_3COO

Base ionization equations

- Generically with the base "BOH"
- $BOH \rightarrow B^+ + OH^-$
- or
- $B + H_2O \rightarrow BH^+ + OH^-$
- Write the base ionization equations for
- NaOH, NH_3 and $Ca(OH)_2$

Heat of solution

- Normally dissolving a substance is an exothermic process.
- You are normally increasing the state of *entropy* (measure of disorder)
- The the result of this is normally a release of heat.
- There are exceptions, dissolving ammonium nitrate is an endothermic process

Always do what you oughta …

- Always add acid to water
- Dissolving the acid in water releases heat.
- This is especially true for concentrated hydrochloric acid and sulfuric acid.
- If you have a lot of acid and a little water on top, the water typically boils quickly causing the hot acid to spray out.
- A lot of water on the bottom typically doesn't boil if the acid is added slowly enough.

Self dissociation of water.

- Some water will dissociate itself
- $H_2O + H_2O \rightarrow H_3O^+ + OH^-$
- in "pure" water you will find
- H_3O^+ has concentration of 1×10^{-7} M
- OH^- has concentration of 1×10^{-7} M

pH

- The H_3O^+ and OH^- concentration is normally very small.
- pH- logarithmic method of representing the H_3O^+ concentration in a solution.
- **pH = -log [H_3O^+]**
- So the pH of water is…
- pH = - log 1×10^{-7}
- pH = 7

pH values

- pH of 7 is neutral- equal [H_3O^+] and [OH^-]
- below 7 is acidic, higher [H_3O^+] than [OH^-]
- above 7 is basic or alkaline, higher [OH^-] than [H_3O^+]

Neutralization of an acid or base.

Mixing acids and bases

- ~creates water
- $H_3O^+ + OH^- \rightarrow 2\ H_2O$
- this is called neutralizing the solution
- a neutralized solution is no longer dangerous.
- It is now safe to touch.

Salts

- ~the byproduct of an acid and a base.
- $NaOH + HCl \rightarrow H_2O + NaCl$
- (base) (acid) (water) (salt)
- there are several more than just table salt.
- $HNO_3 + KOH \rightarrow H_2O + KNO_3$
- Acid Base water salt

Gases can be created

- this depends on the reactants (not all will)
- sodium bicarbonate (baking soda) will always release the gas carbon dioxide when reacting with an acid.
- $NaHCO_3 + H_2SO_4 \rightarrow H_2O + NaHSO_4 + CO_2$

Salt Gas

Titration

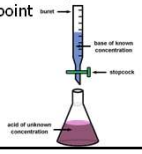
Titration is an experiment done commonly to determine the unknown concentration of an acid or a base.

During a titration a acid or base of unknown concentration called the analyte is placed under an apparatus, normally a burette or a buret, to add a acid or base of known concentration called the titrant.

The titrant is slowly added and the pH is monitored.

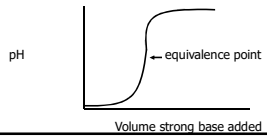
Titration

- The point where the moles of titrant is equal to the moles of analyte is called the equivalence point



Graph of titration

- A titration graph has a very distinct shape



Using math

- To neutralize a solution you will need to add an equal amount of H_3O^+ / OH^- to what was already present.
- so that
- mol H_3O^+ = mol OH^-
- This is used if and only if you are at the equivalence point (completely neutral solution)!

Problem

- If 94 mL of 4.0 M NaOH neutralizes 6.0 L of an unknown strong acid, what was the H_3O^+concentration of the unknown?
- 4 M NaOH x .094 L = .376 mol NaOH
- .376 mol H_3O^+/ 6.0 L = .063 M H_3O^+

Another problem

- If 127 mL of 2.0 M NaOH neutralizes 4.1 L of an unknown acid, what is the initial concentration of the acid?
- 2.0M(.127 L) = .254 mol NaOH
- $= .254 \text{ mol } OH^- = \frac{.254 \text{ mol } H_3O^+}{4.1 \text{ L}}$
- **=.062 M**

Strong acids and bases

- The strong acids and bases completely dissociate in water.
- Most acids or bases will only react to a certain extent
- Strong acids/bases make the most amount of hydronium or hydroxide that they possibly can.

Strong acids

Acid	formula	Acid	Formula
Hydrochloric acid	HCl	Sulfuric Acid	H_2SO_4
Hydrobromic acid	HBr	Nitric Acid	HNO_3
Hydriodic acid	HI	Perchloric Acid	$HClO_4$

Strong bases

- All of group 1 and group 2 metals (not H) make strong bases.
- However, most of them are not very soluble.
- For example, $Mg(OH)_2$ is a saturated solution at 1.6 $x10^{-4}$ M

Commonly Used Strong Bases

these make a lightning bolt on the periodic table!

Name	Formula	Name	Formula
Sodium Hydroxide	NaOH	Calcium Hydroxide	$Ca(OH)_2$
Potassium Hydroxide	KOH	Strontium Hydroxide	$Sr(OH)_2$
		Barium Hydroxide	$Ba(OH)_2$

Danger!!!

- Strong and Weak acids and bases do NOT necessarily tell you how dangerous they are.
- Concentration is the most important factor for determining danger.
- Ammonia is a weak base, if it is highly concentrated it can burn you.
- Dilute hydrochloric acid (less than 1 M) is not particularly dangerous

What is water

- Water is either an acid or base depending on the situation.
- Anything that is either an acid or a base is called *amphoteric*.
- Several things are amphoteric, like parts of you.

Donating Protons

- Hydrochloric acid (HCl) can donate 1 proton, so it is called a *monoprotic acid*.
- Sulfuric acid (H_2SO_4) can donate 2 protons, so it is called a *diprotic acid*.
- Phosphoric acid (H_3PO_4) can donate 3 protons, so it is called a *triprotic acid*.