Section 4.C Concentration Applications

- Defining Acids and Bases
- pH and pOH
- Titration Curves
- Molarity, Molality and Mole Fraction
- Colligative Properties

Properties of Acids and Bases

- Taste - acids have a sour or tart taste, while bases taste bitter
- Touch- acids will give a sharp sting on an open sore, while bases will feel slippery.
- Reactivity - metals react vigorously with acids, bases are unaffected

Properties of Acids and Bases

- Conductors - acids and bases are both good conductors of electricity.
- Indicators - an indicator is a substance that has a different color in an acid than in a base.
- Neutralization - when acids and bases are mixed, they retain none of the properties of either an acid or base.

Arrhenius Definition

Arrhenius (1884) said that acids and bases release specific ions in water:

Acids - dissociate to produce H^+ ions in water

Bases - dissociate to produce OH^- ions in water

Bronsted-Lowery Definition

- Bronsted and Lowery independently (1923) said that acids and bases can be thought of H^+ donors and acceptors:
  - Acids donate H^+ ions
  - Bases accept H^+ ions

Water can either accept or donate a H^+ ions. When water accepts a H^+ ion (H_3O^+), it is called hydronium.

Reversible Reactions

Any neutralization reaction can be reversed. When the reaction is reversed, the substances can still act like Bronsted-Lowery acids and bases.

Because of this reversibility, we call the substances in the reverse reaction conjugate acids and conjugate bases.

Naming Monatomic Acids

1) Prefix “Hydro-”, followed by
2) Root “-anion name-”, followed by
3) Suffix “-ic”, all in one word
4) Followed by the word “acid”

Ex. HF

Answer : Hydroflouric Acid

Naming Polyatomic Acids

1) Root “Anion name-”, followed by
2a) Suffix “-ic” for ions with -ate or -ide ending,

or

2b) Suffix “-ous” for ions with -ite ending
3) Followed by the word “acid”

(no hydro prefix on polyatomic acids)

Ex. HNO_3

Answer : Nitric acid

Ex. $HClO_2$

Answer : Chlorous acid

Concentrations

Chemists often need to specify precisely how concentrated or dilute a solution is. The concentration is the amount of solute in a given amount of solvent.

Ways to show concentration:

1) Molarity - the number of moles of solute dissolved in each liter of solution.

$$\text{Molarity (M)} = \frac{\text{moles solute}}{\text{liters solution}}$$

Concentrations

2) Molality - the number of moles of solute dissolved in each kilogram of solvent.

$$\text{Molality (m)} = \frac{\text{moles solute}}{\text{kilograms solvent}}$$

Molarity is more common, but molality is not temperature dependent.

3) Mole Fraction - the number of moles of one component divided by the total number of moles in solution.

$$\text{Mole Fraction (X)} = \frac{\text{moles of component}}{\text{total moles in solution}}$$

Self-ionization of Water

Water can self ionize, which means that if conditions are right, two molecules of water can produce a hydronium ion and a hydroxide ion:

$$2\ H_2O_{(l)} \Longleftrightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$$

When this happens, we can write a special mathematical relationship, which is given a special symbol: K_w

Pure water has a $K_w = 1.0 \times 10^{-14}$

pH

The pH scale, designed by Sorensen, was a proposal that expresses acidity and basicity in a more compact form.

Since the molar concentration of hydronium is different in different substances, we use a scale to show this concentration.

Formula for pH:

$$pH = -\log [H_3O^+]$$

A pH of 0 is very acidic. A pH of 14 is very basic. A pH of 7 is neutral.

pOH

Similar to pH, except pOH is a scale to show the concentration of OH^- ions in solution.

Formula for pOH:

$$pOH = -\log [OH^-]$$

Would a substance with a pOH of 6 be an acid or base? How about a pOH of 10?

Titration

Titration is a way to identify unknown concentrations of acids or bases.

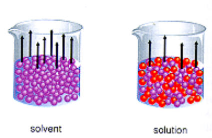
In titration reactions, you neutralize an unknown acid with a known concentration of base. By knowing the amount of moles of base added, you can determine the moles and molarity of acid.

Equation: $M_aV_a = M_bV_b$

Vapor Pressure Reduction

Vapor pressure is due to molecules at the surface of a liquid which break their intermolecular forces and become a gas.

By adding a nonvolatile substance to a liquid, the vapor pressure is reduced due to the solute taking up more room at the surface, so less solvent can vaporize.



Boiling Point Elevation

When a solvent boils, the vapor pressure needs to be at the same pressure as the atmospheric pressure.

By adding solute, the solution's vapor pressure is reduced, therefore needing a higher temperature to boil off the liquid.

ΔT_b , the difference between the normal boiling point and the new boiling point depends on the molality of the solution:

$\Delta T_b = K_b m$, where K_b depends on the solvent.

Freezing Point Depression

Same as BPE, except this colligative property requires a lower temperature to overcome the molecules of solute getting in the way of intermolecular forces.

Difference between the solvent freezing point and the solution freezing point is ΔT_f :

$\Delta T_f = K_f m$, where K_f depends on the solvent