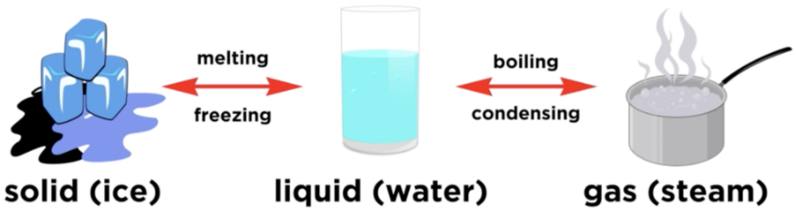
AP Chemistry Ultimate Review Packet
Unit 4: Chemical Reactions

Physical/Chemical Changes/Properties

Physical changes occur when matter changes forms but the identity of the substance does not change. Phase changes are a primary example (each molecule is unchanged)



Chemical changes occur when matter changes forms and the identity of the substance also changes. Any chemical reaction is a chemical change (bonds break and form)

Physical properties are those exhibited without necessitating a chemical change
- melting/boiling points, density, color, etc.
- can be used to separate components of a mixture using physical changes

Chemical properties are those exhibited during a chemical reaction
- flammability, toxicity, tendency to oxidize, etc.
- can be used to separate components of pure substances

Chemical Equations

Chemical reactions are depicted in **chemical equations:** A + B → C + D

- *reactants* on the left, *products* on the right, the arrow represents the reaction

The law of conservation of mass tells us the same number of each type of atom must be present on both sides of the equation, so the equation must be *balanced*:

$$aA + bB \rightarrow cC + dD$$

- coefficients a/b/c/d must be determined such that mass is conserved

Reactions of ionic solids in aqueous solution can be represented with **net ionic equations**

1. Balanced equation

$$CaCl_2(aq) + 2AgNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + 2AgCl(s)$$

2. Complete ionic equation (split up compounds into individual ions)

$$Ca^{2+}(aq) + 2Cl^-(aq) + 2Ag^+(aq) + 2NO_3^-(aq) \rightarrow Ca^{2+}(aq) + 2NO_3^-(aq) + 2AgCl(s)$$

3. Net ionic equation (cancel out spectator ions and reduce coefficients if possible)

$$Cl^-(aq) + Ag^+(aq) \rightarrow AgCl(s)$$

Stoichiometry

With a balanced equation we can perform **stoichiometric calculations**

(mass of A ⟵ ⟶ moles of A ⟵ ⟶ moles of B ⟵ ⟶ mass of B)

- we use molar masses and stoichiometric ratios to do conversions

When performing chemical reactions the reactants can't both react completely
- one compound is the *limiting reagent* (runs out first)
- the other compound is the *reagent in excess* (some left over)
- perform stoichiometric calculations to determine which is which
  - the limiting reagent is **NOT** automatically that which is present in the lesser amount (must consult stoichiometric ratios)

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We can quantify the efficiency of a chemical reaction:

- **theoretical yield:** maximum amount of product that is physically possible
- **actual yield:** amount of product that is actually obtained
- **percent yield:** (actual yield/theoretical yield) x 100

There are many types of chemical reactions, some important ones include:

1. **Acid-base reactions** – transfer of a hydrogen ion from acid to base
2. **Precipitation reaction** – formation of insoluble salt in solution
3. **Oxidation-reduction reaction** – transfer of electrons

Oxidation-Reduction Reactions (Redox Reactions)

We must be able to assign **oxidation numbers** to elements within a compound:

- pure elements = 0
- monoatomic ions = formal charge
- neutral compounds: oxidation numbers add up to zero
- polyatomic ions: oxidation numbers add up to overall charge on the ion
- H = +1 (except for hydrides)
- O = -2 (except for peroxides)
- halogens = -1 (almost always)
- the rest we discern by basic arithmetic

$$I_2O_5 + 5CO \rightarrow I_2 + 5CO_2$$

I_2O_5: O = -2, adds up to -10, so I must add up to +10, each I is +5
CO: O = -2 so C = +2
I_2: I = 0 (pure element)
CO_2: O = -2, adds up to -4, so C = +4

- the element that has its oxidation number increase has been oxidized
  (C went from +2 to +4 so C was *oxidized*, lost electrons)
- the element that has its oxidation number decrease has been reduced
  (I went from +5 to 0, so I was *reduced*, gained electrons)

- **OIL RIG** (oxidation is losing electrons, reduction is gaining electrons)