Summary of Basic Chemistry

<table>
<thead>
<tr>
<th>Significant Figures</th>
<th>Tell you about the precision of a measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy = correct</td>
<td>Precision = consistent</td>
</tr>
<tr>
<td></td>
<td>All nonzero #s and zeros between non-zero #s are significant. 708 has 3 sig figs</td>
</tr>
<tr>
<td></td>
<td>If a # is less than one, count all the #s after the first non-zero #. Ex: 0.0009870 has 4 sig figs.</td>
</tr>
<tr>
<td></td>
<td>If a # is greater than 1 and no decimal point is written, count only the non-zero #s and zeros in-between non-zero #s. Ex: 408000 has 3 sig figs.</td>
</tr>
<tr>
<td></td>
<td>If a # is greater than one and a decimal point is written, count all #s. Ex: 9487.000 has 7 sig figs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adding and Subtracting</th>
<th>(round the answer to the LEAST number of decimals from the givens)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Line up the decimal point. Add or subtract the numbers. Round your answer to the place of the least decimal places given (the one farthest to the left)</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>15.00 cm + 5100 cm = 5255 cm</td>
</tr>
<tr>
<td></td>
<td>4,352 cm + 4.3 cm = 4356 cm</td>
</tr>
<tr>
<td></td>
<td>19.352 cm = 19.35 cm</td>
</tr>
<tr>
<td></td>
<td>5104.3 cm = 5100 cm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Multiplying and Dividing</th>
<th>(Round the answer to the LEAST # of significant figures of all of your givens)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Multiply or divide the numbers. Count the total number of significant figures in each number. Your final answer should have no more significant figures than the lowest number of significant figures you started with</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>6.7 moles * 1.101 g/mol = 7.3767 g</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prefixes</th>
<th>kilo (1 km = 1000m), deci (10dm = 1m), centi (100cm = 1m), milli (1000mm = 1m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>these prefixes work for any unit (ex: 1kPa = 1000Pa, 1kL = 1000L etc…)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metric values</th>
<th>Volumes: 1L = 1 dm³ 1mL = 1cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperatures: 0°C = 273K (all gas laws need to be in Kelvin!)</td>
</tr>
<tr>
<td></td>
<td>Pressures: 1atm = 760 mmHg = 101.3kPa</td>
</tr>
<tr>
<td></td>
<td>1 Mole of anything = multiplying factor</td>
</tr>
<tr>
<td></td>
<td>UNREDUCED ratio of atoms)</td>
</tr>
<tr>
<td></td>
<td>LOWEST ratio of atoms)</td>
</tr>
</tbody>
</table>
|               | These prefixes work for any unit (ex: 1kPa = 1000Pa, 1kL = 1000L etc…)
|               | The average atomic mass is: 12*0.989 + 13*0.0119 = 12.02 amu |
|               | (do not round the final answer, units are AMU = atomic mass units) |

<table>
<thead>
<tr>
<th>% Error</th>
<th>Measure of accuracy (how correct your data is)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Error =</td>
</tr>
<tr>
<td></td>
<td>actual</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Molar mass</th>
<th>Synonyms:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Formula mass</td>
</tr>
<tr>
<td></td>
<td>Formula weight</td>
</tr>
<tr>
<td></td>
<td>molecular mass</td>
</tr>
<tr>
<td></td>
<td>molecular weight</td>
</tr>
<tr>
<td></td>
<td>Add up the atomic masses of each atom. Pay attention to subscripts and parenthesis.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>Cu(C₂H₃O₂)₂ = Cu + 4C + 6H + 4O</td>
</tr>
<tr>
<td></td>
<td>63.546 + (4 * 12.011) + (6 * 1.0079) + (4 * 15.999) = 181.633 g/mol</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Empirical Formula</th>
<th>(empirical formulas are the LOWEST ratio of atoms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1:</td>
<td>Calc. moles of each atom</td>
</tr>
<tr>
<td>Step 2:</td>
<td>Divide by smallest # moles to find a mole ratio</td>
</tr>
<tr>
<td>EX:</td>
<td>79.8% C, 20.2% H</td>
</tr>
<tr>
<td>Step 1 for C:</td>
<td>79.8 g (1 mol/12.011 g) = 6.64 mol C</td>
</tr>
<tr>
<td>Step 2 for H:</td>
<td>20.2 g (1 mol/ 1.008 g) = 20.0 mol H (no diatomics!)</td>
</tr>
<tr>
<td>Step 2 for C:</td>
<td>6.64 mol C /6.64 mol = 1 C</td>
</tr>
<tr>
<td>Step 2 for H:</td>
<td>20.0 mol H /6.64 mol = 3 H</td>
</tr>
<tr>
<td>So the empirical formula is</td>
<td>CH₃</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Molecular Formula</th>
<th>(molecular formulas are the UNREDUCED ratio of atoms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1:</td>
<td>Molar mass = multiplying factor</td>
</tr>
<tr>
<td>Step 2:</td>
<td>Multiply the empirical formula by the multiplying factor</td>
</tr>
<tr>
<td>The molecular mass of a compound with an empirical formula of CH₃S 45 g.</td>
<td></td>
</tr>
<tr>
<td>What is the molecular formula?</td>
<td></td>
</tr>
<tr>
<td>Molar mass = 45</td>
<td></td>
</tr>
<tr>
<td>Empirical mass is C + 3H = (12.011 + 3*1.008) = 15</td>
<td></td>
</tr>
<tr>
<td>Step 1: 45 / 15 = 3</td>
<td></td>
</tr>
<tr>
<td>Step 2: 3 (CH₃) = C₃H₉</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% Composition</th>
<th>Mass of part X 100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%Na = 3(22.98) X 100 = 69.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Polyatomic ions</th>
<th>Ammonium (NH₄⁺)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfate (SO₄²⁻)</td>
<td>Carbonate (CO₃⁻²)</td>
</tr>
<tr>
<td>Nitrate (NO₃⁻)</td>
<td>Chlorate (ClO₅⁻³)</td>
</tr>
<tr>
<td>Hydroxide (OH⁻)</td>
<td><em>ate always has 1 more oxygen than ite</em></td>
</tr>
</tbody>
</table>

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Notes:
- **Addition and Subtraction:** Align the decimal points and add or subtract the numbers. Round your answer to the least decimal places given.
- **Multiplication and Division:** Multiply or divide the numbers. Count the total number of significant figures in each number. Your final answer should have no more significant figures than the lowest number of significant figures you started with.
- **Accuracy:** Correct your data is.
- **Precision:** Consistent measurement.
- **Significant Figures:** All nonzero #s and zeros between non-zero #s are significant. 708 has 3 sig figs.
- **Accuracy:** Correct your data is.
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### Mole Conversions

Use the compound's Molar Mass (from the periodic table)

**Example:**
1 mole of Ca$_3$(PO$_4$)$_2$ = 3(40) + 2(31) + 8(16) = 310 grams/mol

How much would 0.8 moles weigh?

$$0.8 \text{ moles} \times \frac{310 \text{ g}}{1 \text{ mole}} = 248 \text{ grams}$$

### Particles $\leftrightarrow$ moles

(atoms, molecules, or formula units)

Use Avogadro's Number:

**Example:**
1 mole = 6.022 x $10^{23}$ molecules, atoms, or formula units for ANY substance

How many moles of Fe would you have if you had $2.8 \times 10^{23}$ atoms

$2.8 \times 10^{23} \text{ atoms} \times \frac{1 \text{ mole}}{6.022 \times 10^{23} \text{ atoms}} = 0.46 \text{ moles}$

### Liters $\leftrightarrow$ Moles

GASES ONLY, Use 1 mole = 22.4 L for any gas at STP (STP = 0°C and 1 atm)

**Example:**
How much space would 2.5 moles of diatomic chlorine (Cl$_2$) occupy?

$2.5 \text{ moles} \times \frac{22.4 \text{ L}}{1 \text{ mole}} = 56 \text{ L}$

### Multi-step Examples:

Convert 10g H$_2$O to molecules:

$$10 \text{ g H}_2\text{O} \times \frac{1 \text{ molH}_2\text{O}}{18.015 \text{ g H}_2\text{O}} \times \frac{6.022 \times 10^{23} \text{ molec H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 3.34 \times 10^{23} \text{ molecules H}_2\text{O}$$

Convert 2.5 L H$_2$O to molecules:

$$2.5 \text{ L H}_2\text{O} \times \frac{1 \text{ molH}_2\text{O}}{22.4 \text{ L H}_2\text{O}} \times \frac{6.022 \times 10^{23} \text{ molec H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 6.7 \times 10^{22} \text{ molecules of H}_2\text{O}$$

Remember moles and molecules are NOT the same thing!

### Electron Config.

**Rules & Laws:**

- **Aufbau Principle:** electrons are added one at a time in order of lowest energy 1$^{st}$

- **Pauli Exclusion Principle:** orbitals have a maximum of 2 e$^-$ (must be opposite spin $\uparrow\downarrow$)

- **Hund’s Rule:** (pairing rule) electrons fill sublevels p, d and f, they must fill each sublevel with one $\uparrow$ e$^-$ before any gets a paired electron $\uparrow\downarrow$

Read electron configurations from the Periodic table

N = 7 e$^-$ = 1s$^2$2s$^2$2p$^3$ (note that the super scripts = e$^-$)

### Formula Writing

**Ionic formulas**

(also called salts)

- Made of positive cations and negative anions

> Ionic Compounds have no charge, so add **subscripts** so that the total + & - charges are equal.

TRICK: Switch the charges for subscripts (leave off charge and make sure the subscripts are not divisible by anything but 1)

**Example**: Tin (IV) oxide = Sn$^{4+}$ O$_2^-$, so you have Sn$_2$O$_4$

Since these subscripts are divisible by 2… simplify! SnO$_2$

### Molecular formulas

(covalent)

- Made of two nonmetals

Use prefixes (mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca) to determine subscripts. **Note:** mono is not used for the 1st element

**Examples:**
Carbon tetrachloride = CF$_4$

Tri sulfur hexoxide = S$_3$O$_6$ (DO NOT REDUCE covalent!)

### Polyatomic ions

- Ammonium (NH$_4$$^{+}$)
- Sulfate (SO$_4$$^{2-}$)
- Carbonate (CO$_3$$^{2-}$)
- Chlorate (ClO$_3$$^{-}$)

- Hydroxide (OH$^{-}$)
- Nitrate (NO$_3$$^{-}$)
- Phosphate (PO$_4$$^{3-}$)

**Note:** *ate* always has 1 more oxygen than *ite*
### Naming Compounds

**Ionic Compounds**
- (contains a metal and/or a polyatomic ion)
- Name the cation. Name the anion (change ending to –ide if an element… if a polyatomic ion do not change the ending –ite or –ate)
- (If the cation can have more than 1 charge, determine charge and include as a roman numeral)

**Examples:**
- $Ca_3N_2 = calcium$ nitride  
  $Ca(NO_3)_2 = $ calcium nitrate  
  $Fe_2O_3 = Iron$ (III) Oxide

**Molecular Compounds**
- (two nonmetals)
- Use prefixes to denote subscripts (mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca) (do not start the 1st word with mono-)

**Examples:**
- $CO = carbon$ monoxide  
  $N_2O_8 = $ tetranitrogen octoxide

### Naming Acids

- (H$^+$ with and anion)
- Anion ending: –ide = hydro(stem)ic acid  
  -ite = (stem)ous acid  
  -ate = (stem)ic acid

**Examples:**
- $HCl = hydrochloric$ acid  
  $HNO_2 = nitrous$ acid  
  $H_3PO_4 = phosphoric$ acid

### Balancing Equations

- You can’t change the compounds at all you can only Add coefficients to get the same number of atoms of each element on each side of the equation.

**Examples:**
- $Sn(ClO_3)_4 \rightarrow SnCl_4 + O_2$  
  $Sn(ClO_3)_4 \rightarrow SnCl_4 + 6O_2$

### Types of Equations

- **Synthesis (combination)**: $A + B \rightarrow AB$  
  **EX:** $H_2 + O_2 \rightarrow H_2O$
- **Decomposition**: $AB \rightarrow A + B$  
  **EX:** $CaO \rightarrow Ca + O_2$
- **Single Replacement**: $A + BC \rightarrow B + AC$  
  **EX:** $Li + CaSO_4 \rightarrow Ca + Li_2SO_4$
- **Double Replacement**: $AB + CD \rightarrow CB + AD$  
  **EX:** $CaCl_2 + NH_4NO_3 \rightarrow Ca(NO_3)_2 + NH_4Cl$
- **Combustion**: Carbon compound $(C_xH_y) + O_2 \rightarrow CO_2 + H_2O$
- **Neutralization**: Acid $+ base \rightarrow salt + water$ (type of double replacement)  
  $H_2SO_4 + NaOH \rightarrow Na_2SO_4 + HOH$

### Molarity

- $M = \frac{mole}{L}$ (dilution)
- Molarity = Moles of solute  
  Liters of solution

**Don’t forget to change grams to moles before using the formula for molarity**

### Gas Laws

- **Kinetic Molecular Theory**
  - Gases can be compressed or expanded
  - Gases fill up the volume of the container
  - Move faster with higher temperature
  - Constantly moving (straight paths until they bounce off – elastic collision)
  - NO attractive forces
  - Less dense than solids and liquids

- **Combined Gas Law**
  - $P_1V_1/T_1 = P_2V_2/T_2$

- **Charles’ Law**
  - $V_1/T_1 = V_2/T_2$ (direct proportion) $V \uparrow \uparrow$

- **Boyle’s Law**
  - $P_1V_1 = P_2V_2$ (indirect proportion) $P \downarrow \downarrow$

- **Avogadro’s Law**
  - $V_1/n_1 = V_2/n_2$ (direct proportion) $V \uparrow \uparrow$

- **Gay-Lussac’s Law**
  - $P_1/T_1 = P_2/T_2$ (direct proportion) $P \uparrow \uparrow$

- **Dalton’s Law**
  - $P_1 + P_2 + P_3 + P_4 + \ldots = P_{total}$ (add up the partial pressure of each gas in the mixture)
  - ONLY USED when there is more than one gas in the container

### Stoichiometry

- **Start with # given**
- **l mole**
- **mole ratio**
- **definition of mole**
- **mole ratio**
- **l mole**

- **definition of mole**
- **mole ratio**

- **Define units must cancel in diagonally in order to end up with the units needed in the end**

- **Limiting Reactant / Reagent** the reactant that you run out of
- **Excess Reactant / Reagent** the reactant that you have extra
**pH & pOH**

- pH = - log[H⁺]
- pOH = - log[OH⁻]
- pH + pOH = 14

if [H⁺] = 10⁻⁵ the pH is 5
if the pH is 9 the [H⁺] = 10⁻⁹
if the pH is 3 the pOH is 14 - 3 = 11
if [OH⁻] = 0.0001 or 10⁻⁴ the pOH is 4
if the pOH is 2 the [OH⁻] = 10⁻² or 0.01

Acids are pH 1-6
Bases are pH 8-14
Closer to 7 is more neutral

**Acids and Bases**

**Arrhenius:**
Acids have H⁺; Bases have OH⁻

**Bronsted-Lowry:**
Acids are proton donors;
Bases are proton receivers

**Equilibrium**

Equilibrium means

- Arrhenius:
  \[ \text{pOH} = - \log[\text{OH}⁻] \]
- Bronsted-Lowry:
  \[ \text{pH} = - \log[\text{H}⁺] \]

**Equilibrium means**

- Both → and ← RATES are the same
- (in a closed system)
- \[ \ce{N_2(g) + O_2(g) \leftrightarrow 2NO(g)} \]

**Le Chatelier’s Principle**

Equilibrium will shift to counter the stress applied to it

- An increase in concentration or heat ↑ will cause a shift AWAY from what was ↑
- A decrease in concentration or heat ↓ will cause a shift TOWARDS it
- An increase in volume will shift towards the side with LESS moles of gas
- An increase in volume will shift towards the side with MORE moles of gas

**Heat**

**Calories or Joules**

- Specific heat of H₂O = 1 cal/g°C
- or 4.18 J = 1 cal

Specific heat defined as amount of energy needed to change 1 gram by 1°C

- \[ \Delta T = \Delta T_{\text{final}} - \Delta T_{\text{initial}} \]
- Within a phase
- Heat (q) = (mass) x (specific heat) x (ΔT) = mCₚΔT

Changing phase

- Heat (q) = mHساء
- Heat (q) = mHاء

**Oxidation & Reduction**

**REDOX reactions**

- Loss of Electrons is Oxidation
- Gain of Electrons is Reduction

Oxidized = lost e⁻ and increase in oxidation number (gaining oxygen)
Reduction = gain e⁻ and decrease in oxidation number (loss of oxygen)

**AGENTS are opposite...**

- The reactant that was oxidized becomes the reducing agent
- The reactant that was reduced becomes the oxidizing agent

**MUST look at oxidation numbers!**

**EX:** \( \text{Al} + \text{NaNO}_3 \rightarrow \text{Al(NO}_3)_3 + \text{Na} \)
- Al is oxidized (red agent)
- Na is reduced (ox agent)

\[ \begin{array}{ccc}
0 & +1 & +5 & -2 \\
+1 & +5 & +2 & 0 \\
\end{array} \]

½ Reactions

- Ox \( \frac{1}{2} = \text{Al}^{3+} \rightarrow \text{Al}^{3+} + 3\text{e}^- \)
- electrons on the right of the arrow \( \rightarrow \text{e}^- \)

- Red \( \frac{1}{2} = \text{Na}^{+} + 1\text{e}^- \rightarrow \text{Na}^{0} \)
- electrons on the left of the arrow \( \rightarrow \text{e}^- \)

**Scientists**

**Models:**
- Idea of indivisible atom (Democritus)
- Billiard ball (Dalton)
- Plum pudding (Thomson)
- Nuclear (Rutherford)
- Planetary (Bohr and Plank)
- Quantum (Schrödinger, Heisenberg – Uncertainty Principle, deBroglie – Wave theory)

**Discoveries & Experiments:**
- Thomson = cathode ray tube experiment = electron charge
- Millikan = oil drop experiment = mass to charge ratio of electron
- Rutherford = Gold foil experiment = atom’s dense nucleus

**Periodic Tables:**
- Mendeleev = 1st PT = based on increasing atomic mass
- Mosely = modern = based on increasing atomic number

**Radioactivity & Half Life**

**3 types of radiation:**
- Alpha \( \alpha \) = weakest = He nucleus (2 p⁺ + 2n⁻) = Shielded by paper
- Beta \( \beta \) = moderate = electrons = Shielded by aluminum
- Gamma \( \gamma \) = strongest = EMR rays = Shielded by lead

**HALF LIFE** = the amount of time needed to decay a radioactive substance to half the mass.
If 4000 g of substance has a half life of 3 hours. How much remains after 12 hours?
- 12/3 = 4 half lives (→) take place in 12 hours
- 4000 → 2000 → 1000 → 500 grams

**Factors Affecting Reaction Rates**

An increase in any of the following will increase the rate
- Temperature, Concentration, Surface area

**Catalysts** – chemical that lowers the activation energy and speeds up the reaction
**Periodic Table (Basics)**

**How to read it**

| Atomic mass | Si | 28.0955 |
| Symbol | Si |  
| Atomic number | 14 |  
| Electron configuration | (Ne)3s2p2 |  
| Name | Silicon |  

*The key above is given on the SOL periodic table*

**Isotopes**

<table>
<thead>
<tr>
<th>Isotope Symbols</th>
<th>Isotopes have same proton number, but different neutron number and this changes the mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kr</td>
<td>94 - 36 = 58</td>
</tr>
</tbody>
</table>

**Another way for writing this isotope of Krypton is** Kr – 94

**Periodic Table (Groups)**

<table>
<thead>
<tr>
<th>Alkali Metals</th>
<th>Alkaline Earth</th>
<th>Transition Metals</th>
<th>Halogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li</td>
<td>Be</td>
<td>Mg</td>
<td>Ca</td>
</tr>
</tbody>
</table>

**Alkali Metals:** ns

(+1 oxidation; 1 valence electron)

Most reactive of the metals; very soft; explodes in water to make H₂;
oxidizes very easily

**Alkaline Earth Metals:** ns²

(+2 oxidation; 2 valence electrons)

Moderately reactive

**Transition Metals:** nd

Forms alloys easily; has varying oxidation states

**Halogens:** np⁵

(-1 oxidation; 7 valence electrons)

Most reactive of the nonmetals; deadly gases, diatomic

**Noble Gases:** np⁶

(NO oxidation; 8 valence electrons except He = 2)

“inert” = not reactive due to full outer shell (octet rule)

**Metals vs Nonmetals**

**Metals** *(LEFT of zig zag stair step line)*

Malleable (bend easily); Ductile (stretch easily)
Conductive (conduct electricity easily)
Lustrous (shiny)
Form + charged ions (cations) by losing electrons

**Nonmetals** *(RIGHT of zig zag stair step line)*

Brittle, break and shatter easily
NonConductive (do NOT conduct electricity easily)
Dull (not shiny)
Form – charged ions (anions) by gaining electrons

**Periodic Table (Trends)**

**Increasing ionization energy**

Decreasing atomic radius

Increasing nonmetallic character and electronegativity

Decreasing metallic character

**Ionization Energy:**

Energy needed to remove an electron (metals have lowest energy)

**Electronegativity:**

Ability to attract electrons when bonding
(Fluorine has the highest value)

**Atomic Radii:** Size of atom
(metals are larger than nonmetals)

**Reactivity:** How well it reacts
(Fr is the most reactive metal; F is the most reactive nonmetal)

**Shielding Effect:**

The effect of filled energy levels
(stonger shielding as you move down a group)

**Lewis Dot Diagrams**

<table>
<thead>
<tr>
<th>IVA</th>
<th>II A</th>
<th>III A</th>
<th>IVA</th>
<th>VA</th>
<th>VIA</th>
<th>VII A</th>
<th>VIIIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li²⁺</td>
<td>Be⁰</td>
<td>B⁺</td>
<td>C⁺</td>
<td>N⁻</td>
<td>O⁻</td>
<td>F⁻</td>
<td>Ne⁺</td>
</tr>
</tbody>
</table>

Lewis dot diagrams use # valence electrons

<table>
<thead>
<tr>
<th>Carbon dioxide</th>
<th>Water</th>
<th>H₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>⚫⚫</td>
<td>⚫⚫</td>
<td>⚫⚫⚫</td>
</tr>
</tbody>
</table>

carbon dioxide water H₂O
**Heating curve**

- Boiling Point
- Melting Point
- Freezing
- Vaporization
- Condensation

**Triple Point Curve**

- Solid
- Liquid
- Gas
- Triple Point

**Relationships**

- inverse
  - Boyles law (pressure and volume)
- direct
  - Charles (Volume and Temp)
  - GayLussacs (Pressure and Temp)

**Vapor Pressure Curve**

- Nonvolatile – high boiling point
- Volatile – low boiling point

**VSEPR – Geometric shapes**

- Linear
  - \( X_2Y \)
  - (X has no extra valence electrons)
  - \( H_2O \)
  - (X has no extra valence electrons)
  - Bent
  - \( X_2Y_2 \)
  - (X has extra valence electrons that cause the bent shape)

- Trigonal Planar
  - \( X_3Y \)
  - (X has no extra valence electrons)

- Tetrahedral
  - \( X_4Y_4 \)
  - (X has no extra valence electrons)

Look at Lewis Dot diagrams to help determine the shape.

**Solubility:**

- Solute dissolve in Solvents
  - “Like dissolves like”
- Supersaturated
  - ABOVE the line
- Saturated
  - ON the line
- Unsaturated
  - UNDER the line

- Solids increase with temp
- Gases decrease with temp

**Exothermic** = gives off heat

- \( A \rightarrow C + \text{Heat} \)

**Endothermic**

- \( A + \text{heat} \rightarrow C \)

**Safety FIRST:**

- Spilled chemical – rinse off
- Diluting acid - Add acid TO water
- MSDS – Material Safety Data Sheet
  - (read them carefully ALL the info is in them)