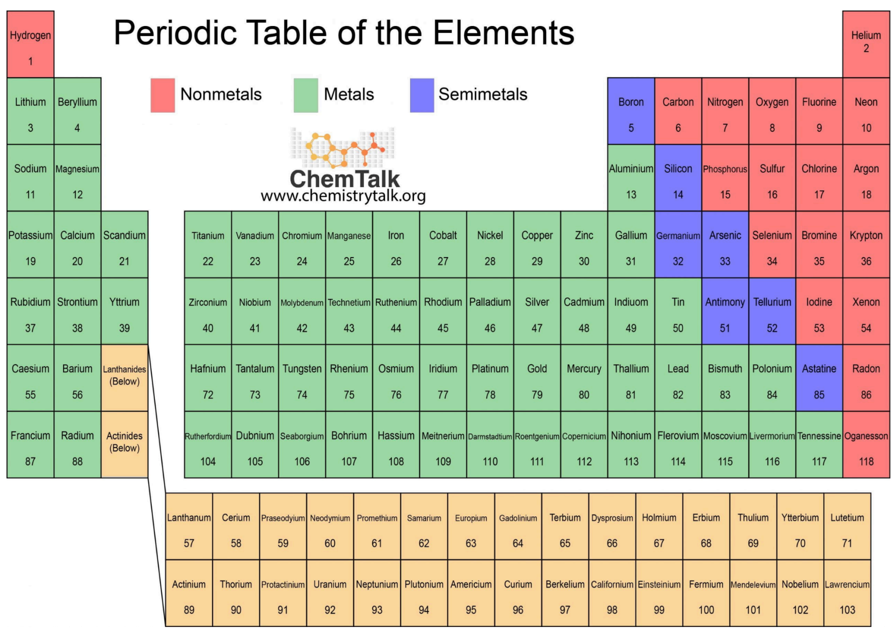
Chemistry Honors Unit 1 - Foundations of Chemistry

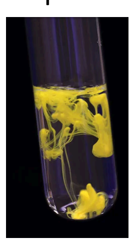
- Chemistry & Matter notes
  - Matter: Anything that has mass and takes up space
  - Types of Mixtures:
    - Pure substances
      - **Compound**: molecule or formula unit of 2 elems/more
        - E.g. H_2O
      - **Element**: atoms/molecules from only one element of p table
        - E.g. H_2, O_2, C, O_3, etc.
    - Mixtures
      - **Homogeneous mixture (solution)**: **<u>UNIFORM</u>** mixture
        - One or more substances dissolve completely in another
        - Spread out **<u>evenly</u>**
        - Solvent does the dissolving, solutes dissolve in solvent
        - Alloy: one or more solids dissolved in another solid
          - steel, bronze, brass
        - E.g. pool water
      - **Heterogeneous mixture: <u>Different parts = easy to see</u>**
        - Salad dressing, oil & water
        - Colloid: suspension of tiny particles
          - May appear homogeneous to naked eye but in reality is heterogeneous (microscopically)
          - E.g. milk, fog, smoke, paint, cream, mayo
      - What if a heterogeneous mixture can appear homogeneous for a long time? **<u>Shine a light through</u>**
        - Can see beam of light -> heterogeneous (nonuniform)
        - Cannot see beam of light -> homogeneous (uniform)
      - Homogeneous mixture: another name = solution
        - Can consist of solids/gasses

Solute	solvent	solution	example
gas	gas	gas	air
solid	solid	solid	Alloy
gas	liquid	liquid	Soda water
liquid	liquid	liquid	vinegar

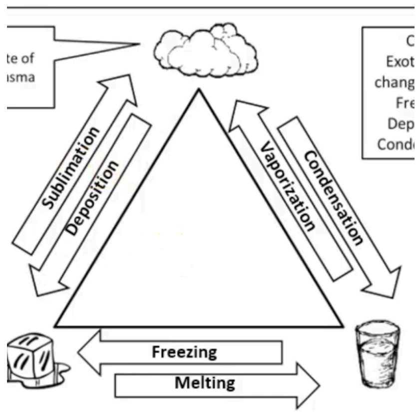
- How elements are classified
  - **Metals**
    - Lustrous (Shiny), good conductors of heat/electricity, high melting point, malleable (bendable), high density, ductile (stretchable)
    - Most metals are solid at room temp @ 25 deg C
      - EXCEPT for mercury and gallium that are liquid
  - **Nonmetals**
    - Dull (not shiny), poor conductors, good insulators, non-ductile (brittle)
    - can be solid, liquids, or gas
    - Lower density
  - **Semimetals**/Metalloids
    - Can be shiny or dull
    - All solid @ room temp
    - brittle/hard, somewhat reactive
    - Semiconductors: conduct not as good as metals
  - 

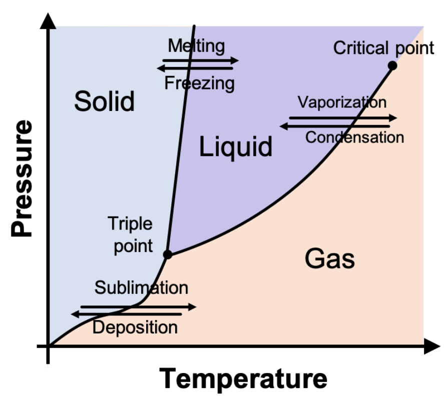
- Physical/Chemical Properties
  - **Physical Property**: can be observed/measured without changing composition
    - **Extensive**: depends on amount of matter
      - Mass, volume, length, shape
    - **Intensive**: doesn't depend on amount of matter

            - - color - melting point - boiling point - density - smell - temperature - state (solid, liquid gas) - texture/luster - hardness - malleability - concentration - conductivity
        - **Chemical property**: a characteristic that can only be determined by <u>changing chemical identity</u>, observed during a chem reaction or chem change.
            - - pH - flammability - rusting - burning - corrosion - solubility - toxicity - radioactivity - heat of combustion - enthalpy of formation - oxidation
            - SOLUBILITY AND RADIOACTIVITY ARE **<u>NOT</u>** PHYSICAL PROPERTIES
    - Physical/Chemical Changes
        - **Physical Change**
            - The space/arrangement between the building blocks of substance change, but the building blocks themselves **<u>DO NOT</u>** change
            - E.g. Phase changes (solid-liquid-gas) = ALWAYS physical
            - E.g. Tearing paper up
        - **Chemical Change**
            - Basic building blocks DO change. New substance with new properties are formed. This leads to changes in CHEMICAL PROPERTIES
                - Gas -> water
                    - E.g. $2H_2+O_2 \rightarrow 2\ H_2O$
                    - Hydrogen gas + oxygen gas -> form water
            - Signs of a Chemical change/reaction
                - formation of gasses in the form of bubbles (that do not come from being heated) or ODORS
                - precipitate formation; the creation of solids which can be suspended in a cloudy solution as a colloid

                  
                - An unexpected color change (not the same as color mixing due to diluting)
                - Changes in energy
                    - Temperature increase/decrease WITHOUT outside influence

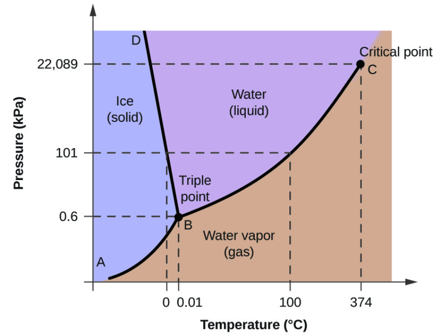
            - producing light/sound/electricity
- States of matter, phase change, phase diagram notes
    - States/Phases of Matter
        - Solids
            - Rigid, fixed shape
                - Particles vibrating, but have low KE, and high attractive energy
                - Locked close together
            - Fixed volume
            - Arranged in a lattice structure (grid/pattern)
            - Can’t be compressed easily/does not take shape of container
        - Liquids
            - Not rigid, no fixed shape
                - Takes shape of bottom of container
                - Particles not organized close together, but constantly slipping and sliding which leads to constant bonding/unbonding -> allows flow
            - Fixed volume
            - But NOT easily compressible
        - Gas
            - Not rigid
            - Easily compressible
            - No fixed shape
                - Takes shape of ENTIRE container
                - Particles = high speeds, moving relatively far away from each other
                - High KE in particles, but low attractive forces -> no bonds, but high speed particles
        - The different properties of ice, water, steam, determined by DIFFERENT ARRANGEMENTS of molecules
        - State of substance = @ room temp (20 deg C, 1 atm of pressure)
    - Phase Changes
        - All elements can exist in any of states of matter
        - State of a substance depends on TEMPERATURE AND PRESSURE
            - E.g.: liquid nitrogen EVAPORATES at room temp into gas
            - Dry ice SUBLIMES at room temp and atm pressure into gas

            - 

    - Phase Diagrams
        - These diagrams plot pressure versus temperature
        - Every substance has it own unique phase diagram
        - Normally:
            - A solid is on the left
            - A liquid is the section in the middle
            - A gas is the section on the bottom right
        - 

        - The lines and curves on phase diagrams represent specific temperatures and pressures where two states of a substance will exist simultaneously at equilibrium
        - Curves: represents the transition between two states
            - E.g. fusion curve represents transition between melting/freezing
        - Triple point: the point (temp, pressure) where 3 states of matter coexist at equilibrium
        - The point at which a substance is indistinguishable between liquid and gaseous state, at which is called a SUPERCRITICAL fluid
        - In water
            - In water, the Fusion (melting / freezing) curve is tilted toward the left, meaning that its solid form is less dense than its liquid form

        - Solids expand, less dense than liquid water



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- Gasses & Gas Variables Notes
    - Properties of gasses
        - Highly compressible, can flow or diffuse, have low densities, COMPLETELY fill a container, have no Definite shape or volume
        - They exert PRESSURE on a container
        - Can model gasses using particle diagrams, where arrows = speed/KE
    - Kinetic Molecular Theory Assumptions
        - Different ideal gasses behave in the same way under the same conditions
        - Gas molecules in CONTINUOUS, RANDOM motion
        - They COLLIDE with each other and container
        - Volume of all molecules = negligible compared to volume of container
            - Very far apart on average, and the SPACE between changes
        - Attractive and repulsive forces = NEGLIGIBLE. Gasses STAY gasses
        - Collisions of gas particles = PERFECTLY ELASTIC (energy conserved)
    - Gas Variables
        - Gas affected by Temperature, Pressure, and Volume
        - Temp = avg speed/KE of particles
        - In KELVIN!!!! K = C + 273
        - **<u>Volume: 1 mL = 1 cm^3</u>**
        - Pressure: force exerted per unit area by one substance on another
            - Number & speed of collisions that particles have with sides of the container
            - atmospheres (atm), mmHg (millimeters of mercury), kPA (kilopascals), psi (pounds per square inch)
        - atm pressure: weight of air molecules pushing down on surface of Earth
            - Higher altitude - less air molecules on top => lower atm pressure
    - Pressure Differential
        - Occurs when difference in two opposing pressures
        - Pressure inside wants to be the same as outside pressure

        - When forces are balanced - pressure from the gas inside is equal to the pressure from the air outside -> balloon has a constant volume
    - Standard pressure/temperature - 1 atm and 0 deg C / 273 K
    - PV = nRT
- Situations of Pressure/Temp/Vol changes
    - NONFLEXIBLE container
        - Add more gas
            - increases the number of molecules inside the fixed volume
            - Thus, more frequent collisions with the container walls, resulting in a higher pressure because the volume remains constant and cannot adjust to accommodate the additional gas
        - Heat the gas
            - increases the speed and energy of the gas molecules, which leads to more frequent and forceful collisions with the walls of the container. Since the volume cannot change, this results in an increase in pressure inside the container.
        - Decrease outside pressure
            - Nothing will change except the pressure differential will be nonzero now. For a high enough difference between inside and outside pressure the can will explode.
    - FLEXIBLE container
        - Add more gas
            - Frequency of collisions INCREASES but later the container expands to accommodate increased amount of gas -> a larger volume
            - pressure inside remains constant/balanced with external pressure
        - Heat the gas
            - Increases KE of gas molecules -> more frequent collisions
            - because the container is flexible, it will **expand** to relieve the pressure increase -> higher volume
        - Reducing external pressure of gas
            - Less force pushing inward on container, but same force pushing OUTWARD on the container, so volume of container INCREASES until pressure decreases until it MATCHES that of outside.
    - Temperature inside a balloon decreases as you go higher, but the outside pressure decreases even more (trumps the temperature decrease), so to accommodate for that pressure differential the gas still expands according to PV=nRT. P decreases to match that of the outside pressure, T also decreases, but not as much as P does. Thus V still becomes bigger.

- Sig Figs and Sci Notation Notes
    - Sig Figs
        - Same # of same figs in calculated value
        - <u>**Only if you use a visual to measure length/width/etc. You have to use s.f. Like rulers/thermometers**</u>
        - scales/balances - do NOT use s.f.
    - Rules for Sig Figs
        - All NONZERO digits are significant
            - E.g. 3.141 - 4 s.f.
        - Sandwiched zeros = always significant
            - 10.01 - 4 s.f.
        - Leading zeroes = NEVER significant
            - 0.0009 - 1 s.f.
        - If AFTER decimal point: trailing zeroes = significant, if it's to the RIGHT of the last nonzero digit
            - E.g.: 12.4500: 6 s.f.
            - 0.001920: 4.s.f
        - If no decimal: trailing zero's are NOT significant
            - E.g. 280: 2 s.f.
    - Scientific notation
        - All digits in coefficient are SIGNIFICANT
        - Use sci notation if no other option to produce accurate # of sig figs
        - E.g. 6.022 * 10^23
            - Coefficient always geq 1, but less than 10
        - 2300: 2 s.f., but when written as 2.30*10^3 -> 3 s.f.
    - <u>**Sigfig Rules for Add/subtract**</u>
        - Same # of sig figs to RIGHT of decimal point as your LEAST precise measurement
        - 8.90 + 7.8991 cm = 16.7991 cm -> 16.80 cm (became 8.90 has only 2 s.f. To right of decimal point)
    - <u>**Sigfig rules for multiplication/division**</u>
        - Same # of sig figs as measurement with LEAST total # of sig figs
        - 6.7 * 7.091 = 47.5097 -> 48 (because 6.7 only has 2 s.f. total)
    - Do whole calculator then round <u>**last**</u> UNLESS there is a part in the problem where you have already rounded once
    - If multiplication AND addition (e.g. 0.04*1.000+0.05*1.200 = round final ans to 2 sig figs because 0.04 has the least # of sig figs (2)).

- Metric & Measurement Notes

quantity	Metric base unit	SI unit
length	meter (m)	Meter (m)
mass	Gram (g)	Kilogram (g)
volume	Liter (L)	Cubic meter (m^3)
time	Seconds (s)	Second (s)
temp	Degree celsius (deg C)	Kelvin (K)
Amount of substance	Mole (mol)	Mole (mol)

  - Converting prefixes of metric system
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King	Henry	Died	by	Drinking	Choc	Milk
Kilo	Hecto	Deka	Base	Deci	Centi	Milli
1000	100	10	1	0.1	0.01	0.001

    - Converting to a smaller unit: move decimal digit to the RIGHT
    - Converting to larger unit: move decimal digit to the LEFT
    - # of jumps = # of moves that decimal place goes
  - How to correctly measure
    - Measure to one place value BEYOND finest marking:
      - E.g. if marked between 3 and 4 (up by 1s) and ruler is at ~ 3.24, you would record 3.2
      - If PERFECTLY at the mark according to you (like PERFECTLY at 94 mL), then you would say 94.0
    - Uncertainty
      - We ESTIMATE one and ONLY ONE further digit
      - Measure the BOTTOM of the liquid marking
  - Two main sources of error that lead to uncertainty
    - random/**reproducibility**: precision of measurement tool
      - More precise, less random error
    - **Systematic** error: miscalibrated scale/instrument error
  - Accuracy vs precision
    - **Accuracy** = how close/correct to the true answer that results were
    - **Precision**: how repeatable the results are

        - Same spots every time
        - Finer markings = more PRECISE
    - Eliminate systematic error: weigh by difference
        - (Mass of beaker + solution + error) - (mass of beaker + error) = (mass of solution)
- Dimensional Analysis Notes
    - Converting between systems of measurement
        - Unit equality: how much of one unit = another
            - E.g. 60 min / 1 hr or 1 hr / 60 min
    - How to set up DA problem
        - 7.3 m * 100 cm / 1 m = 730 cm (the m cancels)
    - How to use Sig figs
        - Unlimited sig figs because no uncertainty
            - When converting between same system of measurement
            - Metric -> metric (m->cm)
            - english -> english (ft->in)
            - Counting numbers (1 apple, 200 servings)
            - Exact numbers
        - Measurements (uncertainty)
            - Between diff systems of measurement (g->lb)
            - EXCEPTION: in->cm
                - 1 inch is EXACTLY 2.54 cm, NO uncertainty
    - Percent and Density as conversion factors
        - E.g. (30.5 g of food) * (18 g of fat) / (100 g of food) = (5.5 g of fat)
    - If it’s something like 0.39 in/ 1 cm, the 1 in the 1 cm has INFINITE SIG FIGS!!!!