General/Honors Chemistry 2015-16 School Year

Semester 1

Unit	Driving Experiences
Alchemy 1: Particulate Nature of Matter, Gases, Measurement	Gas law labs + board meetings
Alchemy 2-3: Atomic Theory	
Alchemy 4-5: Ionic Compounds and Properties of Particles based on Bond Type	Mystery Powders Project - ID Ionic and covalent compound (presentation for panelists)
Smells 1: Molecular Structure and Properties	
Semester 1 Final Exam	Reflection

Semester 2

Unit	Driving Experiences
Smells 2-3:Molecular Structure and Properties (continued)	• Ester Synthesis • Connections between molecular properties and smells
Toxins 1: The Mole	Empirical Formula Lab
Toxins 2: Chemical Reactions	Animation Project
Toxins 3-4: Solutions, Acids, and Bases	
Toxins 5: Stoichiometry	Baayer Challenge - Make 2.00 g of an aqueous nutrient (presentation for panelists)

*Note 1: While I don't have the NGSS alignment here, I do have mapped that out but it felt not terrifically helpful- much of that alignment comes from not only the content, but how the students engage in the content. [Note: As of early June 2016, I no longer have access to my alignment as I have shifted contexts.]

**Note 2: While it is in NGSS, I do not teach nuclear chemistry anymore because it is no longer in the AP Chemistry standards.

***Note 3: This level 2 business is what I force all honors students to do. I'm not perfect, but I try to structure my classes such that students in general chemistry who are ready for level 2 work have access to it and are assessed on it.

Alchemy 1: The Particulate Nature of Matter

Essential Questions:

- What evidence is there of the particulate nature of the world around us?
- How can density be represented on a particle level? What is the meaning of ratio?
- Why should someone believe the quantitative data you collect?

Objectives:

1. General Lab Safety
    a. Identify safety rules and describe their importance.
    b. Identify and use safety equipment.
    c. Find, identify and explain use of commonly used lab equipment.
2. Experimental design
    a. ID independent, dependent variables
    b. ID variable(s) to keep constant
    c. Design a control experiment and explain purpose of control experiment
3. Kinetic Molecular Theory: The gaseous state can be effectively modeled with a mathematical equation relating various macroscopic properties. A gas has neither a definite volume nor a definite shape; because the effects of attractive forces are minimal, we usually assume that the particles move independently.
    a. Ideal gases exhibit specific mathematical relationships among the number of particles present, the temperature, the pressure, and the volume.
    b. Graphical/Calculation representations of the relationships between P, V, and T are useful to describe gas behavior.
    c. Translate between graphical and particulate diagrams of gases as their conditions change.
    d. Interpret “mountain-valley-hill” curves to describe how atoms attract and repel each other due to electrons and protons attracting and repelling.
4. Mass, Volume, and Density
    a. Calculate the volume of an object using water displacement.
    b. Describe density as the relationship between mass and volume of an object.
    c. Calculate density, mass and volume using the density formula.
    d. Identify intensive vs. extensive properties.
    e. Explain why some things float and other things sink (density) using mathematical and/or particulate diagrams.
2. Perform Measurement and Calculations so they are Reproducible
    a. Identify the number of significant figures in a number or measurement.
    b. Round calculated answers and measurements to the correct number of significant figures.
    c. Read measuring equipment (i.e., ruler, graduated cylinder) with the correct number of significant figures.

Alchemy 2 and 3 Objectives: The Atom and Periodic Trends

Alchemy 2 Essential Questions:

- How can matter be classified? What are differences between mixtures and pure substances?
- How do scientists distinguish between different types of matter?
- What do they learn from the comparison?
- How are atoms similar and different from one another?
- How is matter conserved?
- What trends are found in the periodic table?

Alchemy 2 - Deciphering the Code: You will learn

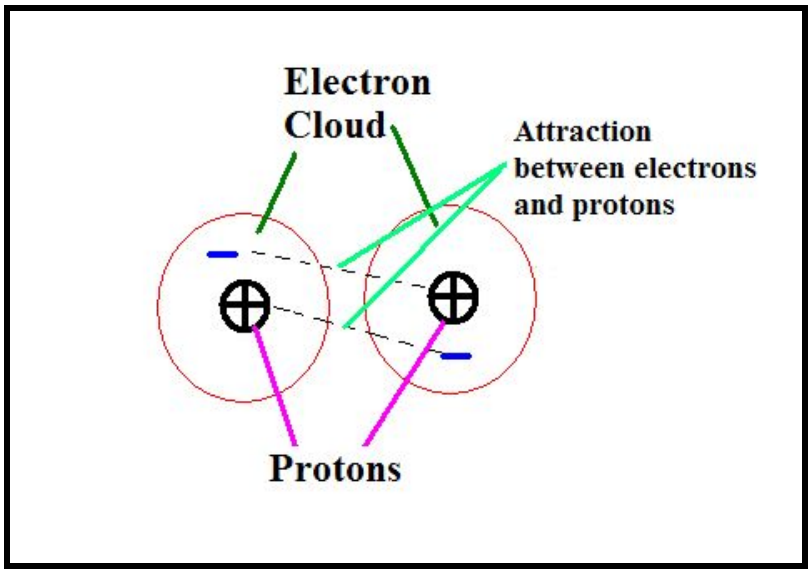
1. Classification of Matter
    a. Determine if an object is matter by identifying if it has mass and takes up space.
    b. Distinguish between mixtures (homogeneous and heterogeneous) and a pure substance (compounds and elements).
2. how to decipher basic chemical names and symbols
3. how to follow a lab procedure
4. to make and record accurate observations
5. how to describe a basic chemical reaction
6. Explain what a precipitation reaction is.
7. that matter can not be created or destroyed
8. how the periodic table of elements is organized
9. to recognize patterns related to elemental properties
10. list observations that suggest a chemical change has occurred
11. explain how the Law of Conservation of Mass applies to changes of matter

Alchemy 3 Essential Questions:

- Has human history gotten smarter over the course of history?
- How can we justify the structure of the atom when we can't see it?
- What information can be gleaned from the periodic table surrounding an element?
- What variables will affect the force of attraction between charged objects?
- Level 2: How does the quantum model of the atom differ from other models? What are pros and cons of each model?

Alchemy 3- Models of the Atom: You will learn

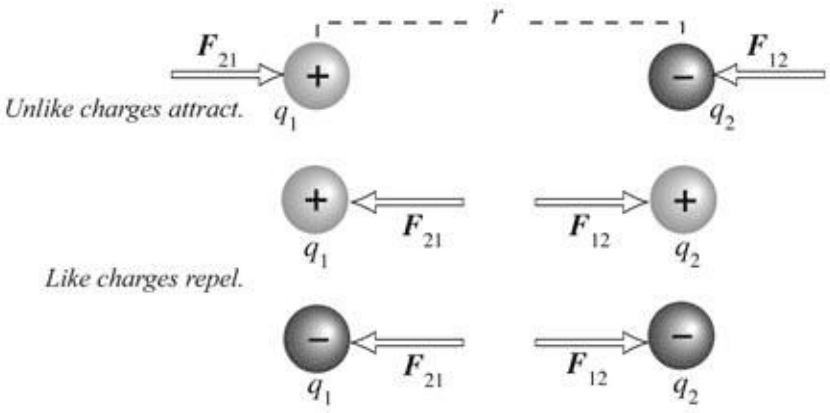
Level 1	Level 2 - dig deeper
1. the historical development of the atomic model 2. basic atomic structure - draw simple Bohr/shell models 3. to use the periodic table to extract information about atomic structure (protons, electrons, neutrons of an element) 4. calculate average atomic mass from empirical data 5. coulombic attractions ○ rank sets of charged particles in order of increasing force of attraction by analyzing distances between particles and total charges involved ○ predict changes to the attractive force on the outermost electron in an atom as you move down or across the periodic table	Construct electron configurations, orbital diagrams, and noble gas configurations. Compare and contrast the quantum model of the atom to other models. **Possibly more periodic trends as well/relate them to coulomb's law!



Electrostatic Force - Coulomb's Law

$$F = k\frac{q_1 q_2}{r^2}$$

F = electrostatic force
q = electric charge
r = distance between charge centers
k = Coulomb constant
$9.0 \times 10^9\ N \cdot m^2/C^2$



Alchemy 4-5: Ionic Compounds and Properties of Bond Types

Essential Questions:

- How can it be that sodium will explode in water but the element right behind it doesn't?
- Why is it that sodium will explode in water but table salt doesn't?
- How do atoms combine to make the variety of things we see?
- What role do electrons play in different types of chemical bonds? Can we manipulate those properties?
- What is a formula unit and how is that different from a single atom?
- How does electron arrangement in bonds determine properties we can see and measure?
- How can carbon containing compounds be so different from one another (calcium carbonate, diamonds, paint thinner)?
- How can atoms influence the properties we can easily observe?

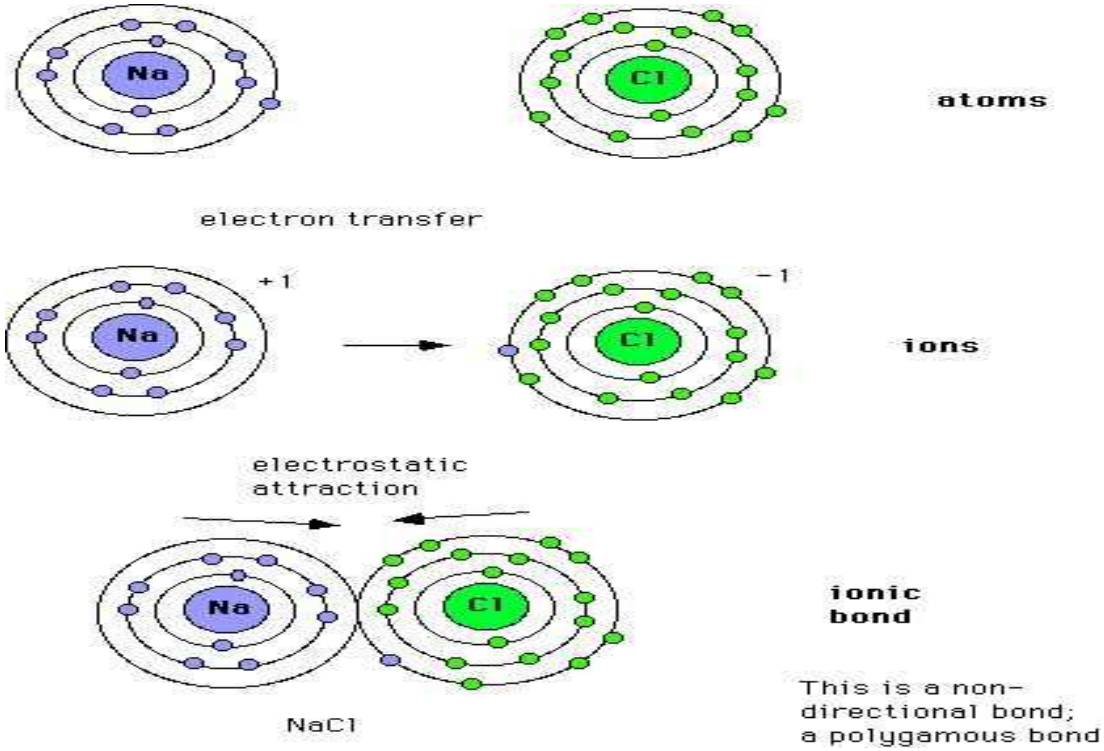
Alchemy 4 Objectives:

1. conduct a flame test and use the results to determine the identity of a compound
    a. interpret evidence of the presence of certain atoms within compounds
2. create a shell model diagram of an atom, placing the correct number of electrons in the correct shells
    a. explain the difference between a valence electron and a core electron
    b. describe the patterns in the periodic table associated with electron arrangements
3. explain that an ion is formed when an atom loses or gains electrons and state the difference between a cation and an anion
    a. determine the charge on an ion based on an atom's placement in the periodic table
    b. explain the relationship between ion charge and valence electrons
4. predict the chemical formula of compounds that will form between metal and nonmetal atoms
    a. explain how an ionic compound forms and determine whether it follows the rule of zero charge
5. use valence electrons to predict ionic compounds
    a. develop proficiency at naming binary ionic compounds and writing their chemical formulas
    b. name ionic compounds with transition metals
6. recognize and name polyatomic ions
    a. write names and chemical formula of compounds with polyatomic ions

Alchemy 5 Objectives:

1. classify substances into four categories based on solubility and conductivity
    a. explain the difference between the terms "soluble" and "insoluble"
    b. begin to describe the atomic makeup of substances based on whether they are soluble and/or conduct electricity
    c. explain how ionic compounds dissolve in water (exposure) (limit in this unit: ignoring water's polarity)
2. define a chemical bond and describe the four basic types of chemical bonds
    a. use chemical formulas to sort substances into bonding categories - covalent (molecular and network; identify if a compound is an acid), ionic (identify if a compound is a base - metal hydroxide)
    b. develop proficiency at naming simple covalent compounds
    c. predict the properties of a substance based on its chemical formula and bonding type
3. recognize acids by chemical formula and write names from formulas and vice versa
4. recognize bases by chemical formula

FORMATION of Ionic Electrostatic Attractions



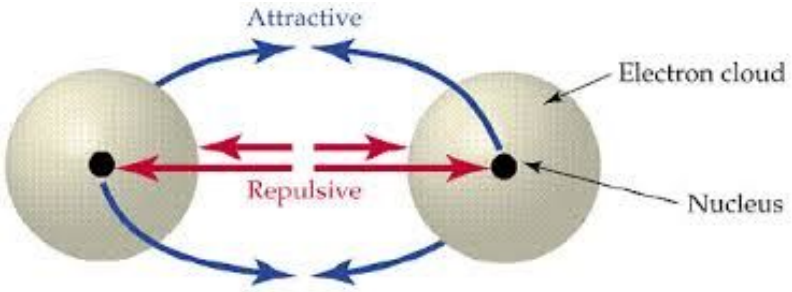
The actual “ionic bond” (electrostatic attraction) - lots of ions come together to make a crystal lattice.

Smells: Molecular Structure, Shape, and Polarity

Essential Questions:

- How do atoms combine to make the variety of things we see?
- What role do electrons play in different types of chemical bonds?
- How can carbon containing compounds be so different from one another (calcium carbonate ($CaCO_3$), diamonds (C), paint thinner (C_7H_8))?
- How can atoms influence the properties we can easily observe? Can we manipulate those properties?
- What is a molecule and how is that different from a single atom?
- How are atoms connected in molecular covalent compounds?
- How do structure, shape, and polarity affect properties we can observe?

"Bonding" really has to do with coulombic attractions



Objectives:

Smells - Section 1

1. identify if a compound is an acid), ionic (identify if a compound is a base - metal hydroxide)
1. develop proficiency at naming simple covalent compounds
2. recognize acids by chemical formula and write names from formulas and vice versa
3. recognize bases by chemical formula
1. detect patterns in chemical formulas and relate these patterns to a molecular property
2. create a hypothesis based on analysis of data
3. describe the difference between structural formulas and molecular formulas
4. recognize isomers
5. create accurate structural formulas from molecular formulas
6. identify and differentiate between isomers and molecules oriented differently in space
7. explain and utilize the HONC 1234 rule
8. create accurate structural formulas using Lewis dot symbols
9. describe the type of bonding found in molecular substances
10. explain the chemistry behind the HONC 1234 rule
11. apply the octet rule to predict bonding in molecules
12. draw Lewis dot structures and structural formulas for molecules that contain double and triple bonds
13. L2/L3 - exceptions to the octet rule (hypo/hypervalent) and draw line structures
14. identify and name basic functional groups within molecules
15. relate certain functional groups to certain smell categories

16. describe the naming patterns found among molecules associated with specific functional groups
17. deduce the probable smell of a compound from its name or structural formula
18. successfully complete a laboratory procedure to produce sweet-smelling esters
19. explain what happened at a molecular level during the ester synthesis lab
20. predict the product of a reaction between an alcohol and a carboxylic acid
21. generally define a chemical reaction
22. define what a catalyst is

Smells - Section 2

1. visually interpret three-dimensional ball-and-stick molecular representations
2. translate between molecular models, molecular formulas, and structural formulas
3. describe connections between molecular properties and molecular structure
4. determine the shapes of small molecules
5. explain how lone pairs of electrons influence molecular shape
6. describe electron domain theory and how it relates to molecular shape
    a. differentiate between electronic and molecular geometry
    b. assign predicted bond angles and describe trends in changes in bond angles based on geometry
7. predict and explain molecular shape, including in molecules with multiple bonds
8. build a space-filling molecular model given the structural formula
9. begin to relate the overall shapes of molecules to their smell categories
10. summarize the various connections explored so far between molecular structure and smell
11. predict smells of a wide variety of compounds by examining molecular formulas, chemical names, molecular structures, and molecular shapes
12. come up with a plausible model to explain how smell works in the nose, based on the evidence thus far
13. describe the receptor site model
14. HONORS ONLY:
    a. assign predicted bond angles and describe trends in changes in bond angles based on geometry

Smells - Section 3

1. describe the behavior of polar molecules
2. explain the general difference between a polar and a nonpolar molecule
3. describe basic intermolecular attractions
4. define a partial charge
5. explain what causes polarity and polar molecules
6. describe the different types of bonding that correspond to different combinations of electronegative atoms
7. predict the general direction and strength of a dipole for any two atoms, using the periodic table
8. use the electronegativity scale to compare atoms and to compare (calculate) the polarity of different bonds
9. use the electronegativity scale to predict bond dipoles and bond type

10. describe the continuum of nonpolar, polar, and ionic bonding in terms of electronegativity
11. assess a molecule for symmetry and determine whether it is likely to be polar
12. use electronegativity values to locate the partial negative and partial positive portions of a molecule
13. explain the connection between polarity and smell
14. explain the connections between smell and polarity, molecular size, phase, and type of bonding
15. predict whether a molecule will have a smell based on its structure, composition, and phase
16. model dissolving ionic vs. covalent compounds (exposure)

Smells 3 - HONORS ONLY

1. determine if a small molecule is chiral or achiral (mirror image isomers of one another)
2. determine if molecules are enantiomers of one another or if they are the same molecule
3. describe how chiral molecules can rotate plane polarized light
4. understand that if one enantiomer rotates light in one direction, its enantiomer will rotate light in the exact opposite direction

Toxins 1: The mole, empirical and molecular formulas

Essential Questions:

- What does it mean for a reaction to be toxic?
- How might one determine the identity of an unknown compound?
- What is the mole?
- How does the mole help us study things we can't directly see?

Toxins 1: Define and make conversions using moles.
Complete simple unit conversions given conversion factors (i.e., kg to lb) and explain the role of dosage in toxicity.
Explain how large numbers of small objects are determined.
Calculate the percent error of a calculation.
Translate numbers into scientific notation, and vice versa.
Explain the mole concept and Avogadro's number in terms of number of particles, mass and gaseous volume.
Define the molar mass of an element or compound.
Calculate the molar mass of an element or compound.
Convert between moles, number of particles, volume, or mass of an element or compound using dimensional analysis.
Toxins 1: Distinguish between and find empirical and molecular formulas.
Find the percent composition of an element or ion in a given compound.
Explain the concept of empirical formulas and provide examples.
Explain the concept of molecular formulas and provide examples.
Distinguish between empirical and molecular formulas.
Calculate empirical formulas of compounds given mass or percent composition for each element.
Level 2: Calculate molecular formulas of compounds using their empirical formulas and molar masses.
Level 2: Calculate the empirical formula of a hydrocarbon using combustion analysis data.

Toxins 2: Chemical reactions!

Essential Questions:

- What does it mean for a reaction to be toxic?
- What patterns of chemical reactions exist?
- What predictions can be made using solubility rules?
- How do atoms combine to make a variety of things we see?
- How can you predict products of a chemical reaction?
- How is a mixture different from an atom or molecule?
- Why do solutions act differently from compounds and molecules?
- Level 2: How might you know when a reaction is done? What does it mean for a reaction to be in dynamic equilibrium? How can that equilibrium be manipulated?

Identify parts of an equation, classify types of reactions and predict the products.
Identify the reactants and products of an equation.
Classify chemical reactions by type (synthesis, decomposition, single replacement/redox, double replacement, acid/base, and combustion).
Write chemical equations from words.
Interpret notations in chemical equations (states of matter, catalysts, heat, etc).
Predict the products of chemical reactions.
Use solubility rules to make predictions whether or not a compound will be soluble or insoluble (group 1 elements soluble, nitrates are soluble, acetates are soluble; otherwise, use a table)
Balance chemical reactions.
Identify the number of atoms in a given formula.
Explain how a balanced equation relates to the Law of Conservation of Mass.
Balance chemical equations.
Model and make connections between a different representations of chemical reactions.
There are four conceptual levels involved in most chemistry concepts: 1) The macroscopic level (what you experience) 2) The nanoscopic (particle) level 3) The symbolic level Example: $2H_2 + O_2 \rightarrow 2H_2O$ (+ energy) 4) The mathematic or quantitative level Example: 4 grams of hydrogen react with 32 grams of oxygen to produce 36 grams of water. $4\ g\ H_2 + 32\ g\ O_2 \rightarrow 36\ g\ H_2O$

Translate between the four conceptual levels for new reactions. Connect what is happening at the particle level with what your experience of the reaction is, and so you will describe what occurs at the macro level during these rearrangements.
Show similarities and differences among how ionic compounds, acids, and covalent compounds dissolve in water.
Describe ways the formula, macroscopic observations, or nanoscopic representations of a compound indicates if the bonding is ionic or covalent.
Level 2: Define and solve problems involving chemical equilibria.
Redox reactions- define what's being oxidized and reduced in a reaction.
Define chemical equilibrium as a process in which two opposite reactions proceed at the same rate.
Level 2: Connect equilibrium to energetics of a reaction (qualitative)
Define reaction coordinate, activation energy
Make predictions about whether or not reactants or products are favored at equilibrium

Toxins 3 and 4: Solutions, Acids, and Bases

Essential Questions:

- How is a mixture different from an atom or molecule?
- Why do solutions act differently from compounds and molecules?
- How can we quantitatively make solutions?
- Why does an acid taste sour while bases taste bitter?
- How are the compositions of acids and bases different on the atomic scale?
- Are acids and bases always dangerous?
- What does it mean to be a strong or weak acid? How is that different from a concentrated or dilute acid?

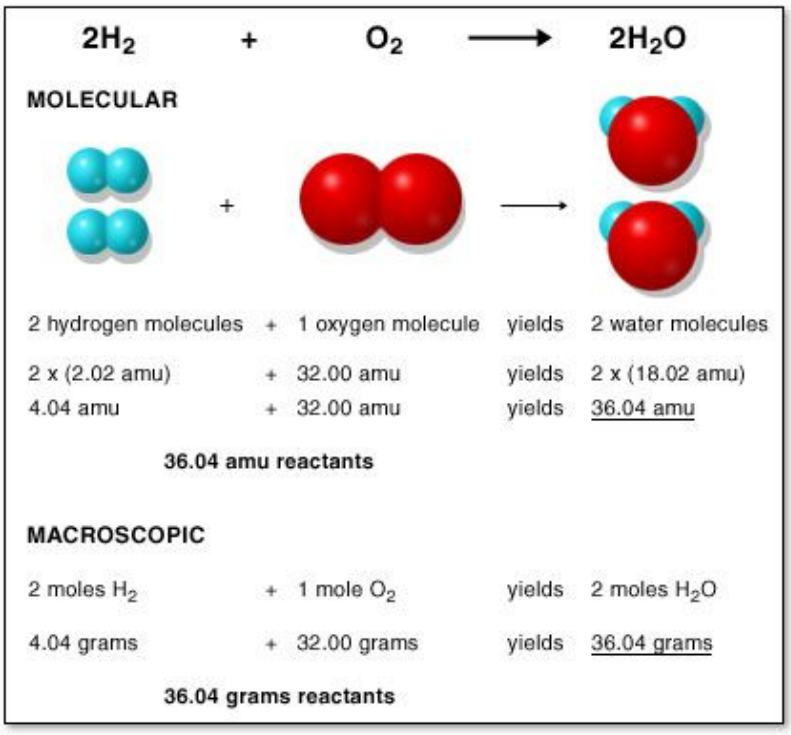
Toxins 3 - Solutions

1. Define the terms *solution, saturated solution, solute, and solvent.*
2. Differentiate between particles in ionic and molecular solutions.
3. Explain what the concentrations and molarity of a solution represent.
4. Complete calculations involving molarity.
5. Describe solution concentration on a particulate level.
6. Calculate the number of moles of particles from the molarity and the volume of a solution.
7. Calculate the amounts necessary to create a solution with a desired volume and molarity.
8. Determine the number of grams of solute in a sample with a specific volume and molarity.
9. Explain what a dilution is on a nanoscopic level and calculate the new molarity of a diluted solution.
10. Use $m_1v_1=m_2v_2$ to dilute a concentrated solution to a less concentrated solution with a math and nanoscopic understanding.
11. Level 2 (if time): Explain the relationship between the mass of a solution sample and the molar mass of the solute.

Toxins 4 - Acids, Bases, and Titrations

1. Identify acids and bases based on general observable properties.
2. Explain how an indicator is used to determine whether a solution is acidic, basic, or neutral.
3. Define Arrhenius and Bronsted-Lowry acids and bases.
4. Explain the behavior of acids and bases on a particulate level.
5. Explain the difference between strong and weak acids and bases, and concentrated and dilute acids and bases.
6. Explain the mathematical relationship between H^{+1} and OH^{-1}.
7. Define pH and explain the relationship between concentrations of hydrogen ions and pH
8. Determine $[H^{+1}]$ concentration of a solution given $[OH^{-1}]$ and vice versa.
9. Complete a serial dilution of a solution.
10. Explain the effect of dilution on the acidity or basicity of a solution.
11. Write a chemical equation for an acid-base neutralization reaction, and describe what happens on a particulate (nanoscopic) level.
12. Describe how pH changes when acids and bases are mixed.
13. Explain and complete a titration procedure.
14. Use titration data to determine the molarity of a solution whose concentration is unknown.
15. Level 2: Is the pH at the equivalence point always neutral? (If time).

Toxins 5: Stoichiometry, Limiting Reactants, and % Yield



Essential Questions:

- How can we use stoichiometry to understand reactions?
- What is the meaning of mole ratio?
- What are the meanings of limiting reactant and excess reactant?
- How can we use stoichiometry to understand how "good" or "useful" a reaction is with percent yield and percent error?

Toxins 5 Objectives:

1. Define a mole ratio.
2. Complete stoichiometric calculations for a variety of chemical reactions using Before, Change, After tables, such as:
    a. Explain how to combine reactants in order to make the most product from a reaction.
    b. Identify a limiting reactant.
    c. Complete stoichiometric calculations involving limiting reactant.
3. Calculate percent yield when the actual yield is known.
4. Level 2: AP style problems I throw at you.