Randolph Township Schools
Randolph High School

Chemistry Curriculum

"Every aspect of the world today – even politics and international relations – is affected by chemistry."

~ LINUS PAULING

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Randolph Township Schools
STEM Department
Chemistry

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Randolph Township Schools

Mission Statement

We commit to inspiring and empowering all students in Randolph schools to reach their full potential as unique, responsible and educated members of a global society.

Randolph Township Schools
Affirmative Action Statement

Equality and Equity in Curriculum

The Randolph Township School district ensures that the district's curriculum and instruction are aligned to the state's standards. The curriculum provides equity in instruction, educational programs and provides all students the opportunity to interact positively with others regardless of race, creed, color, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, religion, disability or socioeconomic status.

N.J.A.C. 6A:7-1.7(b): Section 504, Rehabilitation Act of 1973; N.J.S.A. 10:5; Title IX, Education Amendments of 1972

RANDOLPH TOWNSHIP BOARD OF EDUCATION
EDUCATIONAL GOALS
VALUES IN EDUCATION

The statements represent the beliefs and values regarding our educational system. Education is the key to self-actualization, which is realized through achievement and self-respect. We believe our entire system must not only represent these values, but also demonstrate them in all that we do as a school system.

We believe:

- The needs of the child come first
- Mutual respect and trust are the cornerstones of a learning community
- The learning community consists of students, educators, parents, administrators, educational support personnel, the community and Board of Education members
- A successful learning community communicates honestly and openly in a non-threatening environment
- Members of our learning community have different needs at different times. There is openness to the challenge of meeting those needs in professional and supportive ways
- Assessment of professionals (i.e., educators, administrators and educational support personnel) is a dynamic process that requires review and revision based on evolving research, practices and experiences
- Development of desired capabilities comes in stages and is achieved through hard work, reflection and ongoing growth

Randolph Township Schools
STEM Department
Chemistry

Introduction

Below is the Chemistry curriculum rewritten to model the newly adopted NJ state standards, Next Generation Science Standards, also known as NGSS. Within these standards there is a much higher placement of inquiry based learning which is the method where we as the educator supply the students with educational tools but allow them to build their own design. This method cultivates something that is core to mathematical and scientific thinking which is the application and analysis of data to observed phenomena. Through an analysis of the NGSS and an application of Randolph's high standard of excellence we have constructed a curriculum which will foster learning through rigorous course content, teach competency in chemistry and the sciences through inquiry based instruction, and allow the students to flourish in the science and technology age of the modern era with real world application.

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Curriculum Pacing Chart
Chemistry

SUGGESTED TIME ALLOTMENT	UNIT NUMBER	CONTENT - UNIT OF STUDY
3 weeks	I	Atomic Theory
3 weeks	II	The Electron
3weeks	III	Periodic Table/Trends
4 weeks	IV	Bonding
4 weeks	V	Chemical Reactions
4 weeks	VI	The Mole
5 weeks	VII	Stoichiometry
4 weeks	VIII	Solutions/Equilibrium
3 weeks	IX	Thermodynamics
3 weeks	X	States of matter

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Course: Chemistry
UNIT I: Atomic Theory

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="8">HS-PS1-3:
Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-8:
Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay

HS-PS2-6:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

HS-ETS1-3:
Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

.</td><td>Matter is made up of atoms, which contain smaller units defined by their charge</td><td>• How can an understanding of subatomic particles lead scientists to better explain the atom and its interactions?</td></tr>
<tr><td>Scientists can conduct experiments to gather information, even about things that cannot be seen.</td><td>• How can scientists gather data for things that are not visible to the naked eye?</td></tr>
<tr><td>Decay of atoms can be used to create large amounts of energy that could power our homes.</td><td>• How can understanding fission and fusion help with sustaining energy needs and sustainability?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:
Atoms consist of protons, neutrons and electrons and make up all matter.

The structure of an atom including mass, location and charges of subatomic particles.

Elements contain a single type of atom while compounds consist of two or more types of atoms that are chemically bound.</td><td>Students will be able to:
Determine atomic mass, mass number and amount of each subatomic particle of an element.

Map positions of various subatomic particles within an atom.

Change the proportions of subatomic particles within an atom to achieve specific elements, ions or isotopes.

Categorize atoms and/or groups of atoms as elements or compounds.</td></tr>
</table>

	Atomic mass is a weighted average of all of the isotopes and their relative abundance.	Calculate weighted average given mass number and relative abundance. Argue the importance of using a weighted average versus a simple average in determining the atomic mass.
	Elements can spontaneously decay to form other elements, radiation and large amounts of energy as well as new elements. Each isotope of an element decays at its own, relatively consistent rate.	Solve an equation for the missing radioactive Decay particle or the element formed or changed in a nuclear reaction. Compare amounts of initial substance to amount remaining after radioactive decay. Predict how much of a substance should be present after a certain amount of time and/or number of half-lives.
	Energy obtained from fission and fusion can be used to power our homes. **VOCABULARY:** atom, element, compound, proton, neutron, electron, isotope, ion, atomic mass unit, weighted average, atomic mass, atomic number, radioactive decay, alpha, beta, gamma, fission, fusion,	List products and reactants of nuclear reactions used to make. Argue the effectiveness of nuclear energy as a sustainable resource.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Identifying an element given only relative abundances of the various isotopes of said element, and identify ionic charge given subatomic particle data.
- Showing a decay series including each of the three types of radiation from a real world nuclear reaction

KEY LEARNING EVENTS AND INSTRUCTION:

- Use grading as an example for weighted average providing students with a set a data to perform calculations of both a weighted and a simple average and a discussion on which method gave a better representation of the student's grade
- Model decay series using cards representing various isotopes and radioactive particles such as those leading to the breakdown of Uranium to Lead

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit I: Atomic Theory

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
3 weeks	**Atomic Theory**	**Build an atom simulation- https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html** Crash Course Atomic Theory- https://www.youtube.com/watch?v=thnDxFdkzZs

Course: Chemistry
UNIT II: The Electron

STANDARDS / GOALS:	**ENDURING UNDERSTANDINGS**	**ESSENTIAL QUESTIONS**
HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.	Particles within an atom allow for unique properties that can help scientists to distinguish one element from another.	• Why is it helpful to scientists to be able to understand the way that specific atoms behave?
	The "Planetary" model is outdated and does not accurately reflect what is currently known about the atom.	• How has the atomic model changed over the course of history and why was it necessary?
	KNOWLEDGE	**SKILLS**
	Students will know: Electrons exist in quantized energy levels and can jump up or down to the next level depending on energy lost or gained. The amount of energy lost or gained from an electron changing levels is specific to an element and creates a unique emission spectrum. Emission spectra can be used to identify elements present within a compound. The amount of energy contained within a photon of light is inversely proportional to its wavelength.	**Students will be able to:** Explain What happens on a subatomic level when energy is absorbed or released by an atom. Calculate amount of energy gained or released from an atom by observing its emission spectrum. Write an explanation accounting for some elements emitting many different bands of light while others only release a few. Design an experiment to determine which type of gas is present in the tubes of a "neon" sign. Infer which bands form from energy released by inner orbitals and which form from energy released by outer orbitals.

	Electrons can exist alone or in pairs with opposite spin inside orbitals. There are different types of orbitals that electron fill in a set order. Atoms tend to prefer configurations that leave orbitals full or half full. **VOCABULARY:** electron, element, ion, wavelength, frequency, ground state, atomic emission spectra, photon, orbitals, quantum, Aufbau principle, Pauli exclusion principle, Hund's Rule, quantum mechanical model, s-orbital, p-orbital, d-orbital, f orbital, , Joule, Hertz, Energy Level, Spin, sub-level,	Draw an orbital diagram for a given element using up and down arrows to represent spin. Develop a model using the periodic table to assist in determining the order in which various orbitals are filled. Write an electron configuration for a given element. Predict how the electron configuration for an atom might change if it were to ionize. Investigate an exception to the rules for orbital filling and explain said phenomenon.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Design an experiment to determine the identify of the gas inside of a light and/or a mystery tube based on knowledge of the quantum mechanical model and emission spectra
- Use a previously created model of the periodic table to determine the electron configuration for a given element or group of elements
- Write an explanation accounting for some elements emitting many different bands of light while others only release a few.

- Investigate an exception to the rules for orbital filling and write an explanation for said phenomenon.

KEY LEARNING EVENTS AND INSTRUCTION:

- Develop a colored model of the period table that illustrates the trends in electron configurations across a period or down a group in order to assist in understanding of orbital filling rules
- Set up diffraction grate across from an emission tube while student observe, record and complete energy calculations using their data and can later compare this information to other emission tube to draw conclusions about
- Compare previously suggested models of the atom in order to critique and point out possible flaws based on what is now known about the atom

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit II: The Electron

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
3 weeks	**The Electron**	**Emission Spectrum Lab** Crash Course the electron- https://www.youtube.com/watch?v=rcKilE9CdaA

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Course: Chemistry
UNIT III: Periodic Table

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="6">HS-PS1-1:
Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-2:
Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS2-6:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

HS-ETS1-3:</td><td>Scientists can use the distinct properties of elements or compounds to solve real world problems.</td><td>• How can the periodic table help us to develop new useful materials and technologies?</td></tr>
<tr><td>Many trends can be observed across the periodic table due to differences atomic structure.</td><td>• How do differences in atomic structure result in an element’s distinct properties?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:
Atomic Structure determines the arrangement of elements in the periodic table.</td><td>Students will be able to:
Describe how the elements are organized in the periodic table.

Predict where new, undiscovered elements would fit into the periodic table.</td></tr>
<tr><td>The arrangement of the electrons of an atom determine the chemical behavior of an atom as well as its physical properties.</td><td>Anticipate the likelihood of two elements reacting with one another based on their chemical properties.

Predict the properties of an element based on its position on the periodic table</td></tr>
<tr><td>Trends in atomic radius, ionic radius, electronegativity, ionization energy and reactivity can be observed across the periodic table.</td><td>Compare two or more elements using any of the periodic trends.</td></tr>
</table>

Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.	Trends are mostly due to the distance of valence shells from the nuclei, the size of the nucleus and how full a valence shell is. Scientists have used, and continue to use, the periodic table to determine which materials might be useful in helping to solve real world problems. **VOCABULARY:** periodicity, ionization energy, atomic radius, reactivity, electronegativity, metal, non-metal, metalloid, alkali metal, alkaline earth metal, halogen, noble gas, trend	Modify an element of known characteristics and explain how the change would affect those characteristics. Organize a list of un-named elements based on properties, atomic structure and periodic trends. Anticipate ways that the periodic table can be used in the future to determine which materials could be used to solve problems.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Use the periodic table as a model to predict the properties of elements that have not yet been discovered.
- Write an explanation describing the difference in related periodic trends between two or more different elements or ions.

KEY LEARNING EVENTS AND INSTRUCTION:

- Categorize and organize a list of given elements in order of increasing value of a particular periodic trend, followed by an explanation of why each element was arranged in that order
- Observe the effects of periodicity in a lab setting by combining substances from the same group but different periods with the same reactant

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit III: Periodic Table/ Trends

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
3 weeks	**Periodic Table**	**Periodicity Lab** **Alien Periodic Table** The periodic table crash course- https://www.youtube.com/watch?v=0RRVV4Diomg

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Course: Chemistry
UNIT IV: Bonding

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="5">HS-PS1-3:

Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-4:

Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS2-6:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.</td><td>Forces affect interactions between atoms just as they effect interactions between larger objects.</td><td>• How can a basic understanding of physics be used to predict shapes of particular molecules?</td></tr>
<tr><td>The shape that a particular molecule takes is very consistent, which is important to a variety of important chemical reactions.</td><td>• How might the world be affected if different molecular shapes formed each time the same elements combined in a particular order?</td></tr>
<tr><td>The nature of the bond(s) within a material will help determine its properties, which scientists can use to develop useful materials.</td><td>• How can knowledge of bonding help to develop new useful materials and technologies?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:
There is a set of rules for naming ionic and covalent compounds.

Polar compounds result from unequal sharing of electrons; therefore, due to the large difference in charge, ionic compounds are always polar and stronger, on average, than covalent bonds.</td><td>Students will be able to:
Identify a given compound based on its composition.

Evaluate the current system in place for naming ionic and molecular compounds.

Describe bonding interactions at the subatomic level.

Modify a compound in order to make more or less polar.</td></tr>
</table>

	The polarity of a particular bond depends on the difference in electronegativity between the two atoms involved, while overall molecule polarity is determined by shape and symmetry.	Calculate electronegativity difference for elements in a given compound and determine individual bond polarity. Compare polarity of one molecule to another. Create a model of a molecule and explain why it is polar or nonpolar based on the periodic trends.
	Bond strength plays in important role in determining a compound's properties.	List the properties that could be affected by bond strength. Explain why a particular property is affected by the strength of the bonds. Construct a molecule that will have specific, predetermined properties.
	Metals have very loosely attached valence electrons resulting in a sea of delocalized electrons, which account for many of the metallic properties.	Describe the subatomic characteristics that cause molecules to behave the way they do in a chemical bond. Relate subatomic characteristics within metals to real world examples of metallic properties and interactions.
	The VSEPR model accounts for repulsion forces of electron orbitals to determine the shape of a molecule.	Sketch the Lewis structure for a given molecule and describe its shape. Change the drawing for a molecule to reflect a different amount of lone pairs and/or attached atoms. Write an explanation for why changing the number of lone pairs and/or attached atoms would affect the structure of a compound.

	VOCABULARY: element, compound, chemical bond, ionic, covalent, orbital, double bond, triple bond, Lewis structure, octet, valence electron, chemical formula, formula unit, alloy, metallic bond, diatomic molecule, molecular formula, lone pair, polyatomic ion, resonance structure, structural formula, VSEPR theory, tetrahedral, linear, trigonal, planar, pyramidal, bipyramidal, polar bond, nonpolar bond, hydrogen bond,	

ASSESSMENT EVIDENCE: Students will show their learning by:

- Arguing the importance/relevance of an understanding of chemical reactions in a classroom activity, which could include but is not limited to, class discussion, debate, argumentative writing or presentation.
- Building a model of a particular compound or set of compounds using model kits.
- Analyzing and categorizing day-to-day phenomena as either a physical or chemical property/change.

KEY LEARNING EVENTS AND INSTRUCTION:

- Observe the physical characteristics of a variety of ionic compounds compared to a variety of molecular compounds using the naked eye as well as a magnifying glass by walking around the room and taking notes on what they see for each prepared sample compound present
- Construct molecules with proper bond angles using model kits in order to visualize shapes discussed during VSEPR lesson

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit IV: Bonding

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
4 weeks	**Bonding**	**Molecule building kits and lab** Ionic Bonding Introduction- https://www.youtube.com/watch?v=Qf07-8Jhhpc

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
UNIT V: Chemical Reactions

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="6">HS-PS1-2:
Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-3:
Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-4:
Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5:
Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the</td><td>We all observe and rely on a variety of chemical reactions to take place every day.</td><td>• To what degree should the average non-scientist understand the concept of chemical reactions? How might this understanding be useful in everyday life?</td></tr>
<tr><td>Chemical reactions can be described both qualitatively and quantitatively.</td><td>• How can qualitative data obtained from chemical reactions be used to gather useful information?</td></tr>
<tr><td>Certain recurring patterns can be observed in chemical reactions, which can help to predict.</td><td>• How might the way that a molecule distributes its electrons affect its various properties?</td></tr>
<tr><td></td><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td></td><td>Students will know:
There are different types of chemical reactions (such as: synthesis, decomposition, combustion, single replacement and double replacement.)

The Law of Conservation of Mass states that matter cannot be created or destroyed, therefore, matter is always conserved.</td><td>Students will be able to:
List real world examples of the different types of reactions that might be seen on a daily basis.

Categorize chemical reactions as one of the known types.

Balance a chemical equation.

Develop an argument for a claim that less mass of product was produced in a test tube than the total mass of the reactant, pointing out possible experimental flaws and designing an experiment to test the claim.</td></tr>
</table>

reacting particles on the rate at which a reaction occurs. HS-PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	The release or absorption of energy depends on the total changes in bond energy. Reaction products can be predicted based on valence electron states, periodic trends and chemical properties. **VOCABULARY:** law of conservation of mass, chemical equation, coefficient, subscript, chemical change, combustion, synthesis, decomposition, single replacement, double replacement.	Calculate the net change in total bond energy for a particular reaction. Predict whether a reaction will occur based on periodic trends. Predict the products for a particular reaction (Ex. $Na + Cl_2 \rightarrow$ _____).

ASSESSMENT EVIDENCE: Students will show their learning by:

- Arguing the importance/relevance of an understanding of chemical reactions in a classroom activity, which could include but is not limited to, class discussion, debate, argumentative writing or presentation
- Determining if a particular will take place when Given relative electronegativity for all necessary atoms,
- Combining reactants in a lab setting and observing the reaction, then predicting the products based on the reactants added together and classifying the type of reaction

KEY LEARNING EVENTS AND INSTRUCTION:

- Calculate the change in total bond energy for a particular reaction observed in class when given bond energy data for each bond in the reaction
- Observe various types of chemical reactions in a lab setting

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit V: Chemical Reactions

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
4 weeks	**Chemical Reactions**	Classification of reactions- https://www.youtube.com/watch?v=a7PZDEeqjcU

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
UNIT VI: The Mole

<table>
<tr><td rowspan="4">STANDARDS / GOALS:

HS-PS1-7:
Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

.</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td>The size of an atom is extremely small and cannot be accurately measured in “common” amounts (tens, hundreds, thousands, etc.) so therefore must be determined in moles.</td><td>• Why is the unit of the Mole so crucial for chemistry and chemical calculations?</td></tr>
<tr><td>Mass of a substance does not explicitly give enough information to determine the amount present.</td><td>• How can we determine the relative amount of a substance present?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:
The Unit of the mole is used to compare relative amounts of different substances.

Mole, particle, and mass conversion calculations are all done via dimensional analysis.

Percent by mass calculations are figured out using the atomic mass of each element within the molecule and the total molecular mass.

Empirical formulas are determined based off of the molar ratio of each element within a compound.</td><td>Students will be able to:
Determine the molar mass of an element.

Apply dimensional analysis to chemistry; to be able to convert between number of particles, Moles, and Grams of a substance.

Calculate the molar mass of a compound.

Find percent by mass by doing mass of an element within a compound divided by the mass of the whole compound.

Explain the difference between an empirical and molecular formula.</td></tr>
</table>

	Molecular formulas are determined from the relative mass of the molecule compared to its empirical formula. When determining the amount of water molecules compared to a salt, the molar ratio must first be established. VOCABULARY: conservation of mass, mole, molar mass, Avogadro's number, percent by mass, particle, molecule, dimensional analysis, empirical formula, molecular formula, hydrate, mole ratio	Create an empirical and/or molecular formula for a compound given percent by mass data. Solve for percent element by mass of any compound or hydrate.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Calculating the number of particles from a given mass of a molecule.
- Solving a percent by mass problem in a lab setting, such as dehydration of copper (II) sulfate.
- Determining molecular and empirical formulas given a data set.

KEY LEARNING EVENTS AND INSTRUCTION:

- Visualizing the size of a mole laboratory experiment
- Mapping out techniques to solve for different types of qualitative relationships, have the students show the dimensional analysis techniques that they will use to convert between units
- Compare masses of a mole of everyday objects (such as a mole of marbles) to that of a mole of an element, this will highlight the enormity of Avagadro's number and how small atoms are

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit VI: The Mole

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
4 weeks	**The Mole**	**Emperical / Molecular Formula Lab** **Visualizing a Mole**

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
UNIT VII: Stoichiometry

<table>
<tr><td rowspan="6">STANDARDS / GOALS:

HS-PS1-7:
Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

.</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td>Chemical reactions can be quantitatively analyzed which allows the observer to make informed predictions.</td><td>• How, and in what different ways can reactions be quantitatively analyzed?</td></tr>
<tr><td>Most natural phenomena are not 100% efficient.</td><td>• How do processes differ for quantitative chemical reaction analysis?</td></tr>
<tr><td>Stoichiometry can help to minimize the amount of excess reagent wasted at the end of a reaction, which can be important when working with expensive materials.</td><td>• How is conservation of mass an important concept for both chemistry and real world concepts?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:
Stoichiometry is the math behind reactions and can be used to predict both the amount of products you will produce and the amount of reagents you will need to achieve a desired result.

Percent yield calculations are used to compare how much products are made in reality vs. how much products could have been theoretically made with a known amount of reactants.</td><td>Students will be able to:
Determine the molar ratio between products and reactants.

Determine the mass of a product produced given the mass of an initial reactant.

Compare experimental results with the theoretical results of a reaction, apply the comparison to determine different properties of the reaction such as percent yield, and limiting reagent.</td></tr>
</table>

	The limiting reagent of a reaction is the reagent that will be depleted first therefore ending the reaction. VOCABULARY/Key Terms: stoichiometry, molar mass, mole ratio, limiting reagent, percent yield.	Apply knowledge of yield to determine potential commercial and real world applications of conservation of mass. Calculate the limiting reagent by comparing the number of moles of each reagent to the balanced reaction.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Demonstrating the conservation of mass via laboratory experiment and calculation.
- Predicting how much product will be produced given a known amount of reactants.
- Applying quantitative calculations of reactions.
- Mapping out techniques to solve for different types of qualitative relationships.
-

KEY LEARNING EVENTS AND INSTRUCTION:

- Stoichiometric calculation laboratory experiment, such as a titration lab, or the rocket lab
- Use a model, such as the stoich train, to help simplify stoichiometric calculations
- Limiting reagent modeling and demonstrations, students will predict what reactant will run out first in a given reaction

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit VII: Stoichiometry

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
5 weeks	**Stoichiometry**	**Crash Course Stoichiometry- https://www.youtube.com/watch?v=UL1jmJaUkaQ**

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
UNIT VIII: Solutions and Equilibrium

STANDARDS / GOALS:	**ENDURING UNDERSTANDINGS**	**ESSENTIAL QUESTIONS**
HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. HS-PS1-7: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. .	Equilibrium is a state where no net change is taking place, within an equilibrium both the forward and reverse reactions are taking place, just at an equal rate.	• Why does equilibrium occur?
	Conditions of equilibria can be changed to alter results, how the results change is reaction specific.	• What conditions of a reaction determine the rate?
	Equilibrium reactions occur in aqueous solutions while pure solids do not have concentrations.	• What is significant about the unit of molarity and how does concentration effect reaction?
	Stoichiometric calculations can apply to reactions with aqueous solutions.	• What is the proper procedure for dilution and what is the significance of concentrations?
	Aqueous solution is a different concept than liquid, one is a mixture and one is a state of matter.	• Why is molarity a crucial topic when discussing solutions and how they are handled and used in a laboratory setting?
	KNOWLEDGE	**SKILLS**
	Students will know: Lechatlier's Principle describes how the ratio of products to reactants changes as conditions change.	**Students will be able to:** Use models to predict how changes in temperature, and concentrations will effect a reaction when it is at equilibrium.

	The equilibrium constant is used to calculate product and reactant concentrations of a reaction when said reaction has achieved equilibrium. The unit of molarity is the amount of moles of a chemical that is dissolved in a solvent (usually water) and can also be used in stoichiometric calculations. Dilution of stock solutions into desired molarity must first be done mathematically before doing so in a laboratory setting. **VOCABULARY:** equilibrium, equilibrium constant, Lechatlier's principle, solutions, molarity, concentration, dilution	Apply an equilibrium constant to a set of conditions and determine if the reaction is at equilibrium or not. Map a solution pathway to stoichiometric calculations with solutions. Properly, safely, and accurately dilute stock solutions.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Successfully diluting a stock solution
- Performing stoichiometric calculations using solutions and the unit of molarity
- Predicting relative concentration of a product or reactant when the concentrations of the other products or reactants is altered
- Applying equilibrium constant to calculate concentrations of products and reactants at equilibrium

KEY LEARNING EVENTS AND INSTRUCTION:

- Dilution and concentration reactions in a laboratory setting
- A visually reversible reaction, students will observe and make observations and predictions on the reaction chamber
- Lechatlier's Principle demonstration, such as a temperature dependent equilibrium reaction

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit VIII: Solutions and Equilibrium

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
4 weeks	**Solutions and Equilibrium**	**Determining solubility of a compound using a Solubility chart** Equilibrium crash course- https://www.youtube.com/watch?v=g5wNg_dKsYY

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
UNIT IX: Thermodynamics

<table>
<tr><th>STANDARDS / GOALS:</th><th>ENDURING UNDERSTANDINGS</th><th>ESSENTIAL QUESTIONS</th></tr>
<tr><td rowspan="6">HS-PS1-4.:
Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5.
Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-6
Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

HS-PS3-4.
Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among</td><td>All chemical reactions will induce a change in energy, enthalpy, and entropy.</td><td>• What do enthalpy, entropy and free energy tell you about a reaction’s viability?</td></tr>
<tr><td>If a reaction is spontaneous is very dependent on the conditions and the enthalpy and entropy of the molecules involved.</td><td>• Where does energy come from and go when a reaction is exothermic or endothermic?</td></tr>
<tr><td>Different substances have different affinities for containing their internal energy.</td><td>• How does specific heat assist in calculating the resilience of a material to change energy?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:
Enthalpy is the heat of a reaction and the change of enthalpy determines if the reaction is endothermic or exothermic.

Entropy is a measurement of disorder and the change of entropy determines if the products are more or less ordered than the reactants within a reaction.

Gibbs free energy is the amount of energy contained within a reaction and the change of Gibbs free energy</td><td>Students will be able to:
Describe the flow of energy as heat through a reaction.

Analyze the change in Enthalpy and determine if a reaction is endothermic or exothermic.

Analyze the change in Entropy of a reaction and determine if the products are more or less disordered.

Determine a reaction’s change in enthalpy, entropy, and free energy.</td></tr>
</table>

the components in the system (second law of thermodynamics). .	determines whether a reaction is spontaneous or not in a certain set of conditions. Specific heat calculations tell you the energy transfer of a specific material given a temperature change. VOCABULARY/Key Terms: Kelvin, specific heat, enthalpy, entropy, Gibbs free energy, spontaneous, non spontaneous, endothermic, exothermic	Analyze the change in free energy and determine spontaneity of a reaction. Predict potential commercial applications of exothermic and endothermic reactions. Calculate the energy given off by a metal when cooled.

ASSESSMENT EVIDENCE: Students will show their learning by:

- Calculating how much energy is contained within a solid by measuring the temperature change it causes water to undergo
- Predicting whether a reaction will be exothermic or endothermic
- Predicting the spontaneity of a reaction under set conditions
- Evaluating how a change in conditions would affect reaction spontaneity, be able to alter conditions to change spontaneity

KEY LEARNING EVENTS AND INSTRUCTION:

- An Exothermic/Endothermic reaction laboratory
- A laboratory with specific heat, such as a bomb calorimetry type laboratory.
- A demonstration highlighting that enthalpy, and entropy change of a reaction are independent of one another, however, both affect the total free energy

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit IX: Thermodynamics

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
3 weeks	**Thermodynamics**	**Calorimetry lab**

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
UNIT X: States of matter

<table>
<tr><td rowspan="8">STANDARDS / GOALS:

HS-PS1-3:
Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-5:
Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

.</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td>States of matter are determined by energy of the molecule.</td><td>• How do different states of matter behave?</td></tr>
<tr><td>Everything in nature goes towards the most stable energy state.</td><td>• What are the relative energies for different states of matter?</td></tr>
<tr><td rowspan="2">Behavior and properties of matter are defined by the structure of the molecule and the material’s current state of matter.</td><td>• What does vapor pressure tell us about how a liquid behaves?</td></tr>
<tr><td>• How do gasses behave, when pressure, temperature, and volume are altered?</td></tr>
<tr><td>There are different forces between molecules depending on the makeup and size of a molecule.</td><td>• What are the different intermolecular forces and how do we determine which ones are present and their relative strengths when compared to one another?</td></tr>
<tr><td>KNOWLEDGE</td><td>SKILLS</td></tr>
<tr><td>Students will know:
Solids, liquids, and gasses all behave differently, gasses are the most fluid, followed by liquids, and solids are the most rigid.</td><td>Students will be able to:
Create a general model describing molecules of a gas, liquid, or solid interacting.</td></tr>
</table>

	London dispersion forces are present in all molecules, dipole-dipole interactions occur with all polar molecules, and hydrogen bonding occurs with only specific types of polar molecules.	Determine the type of intermolecular forces a molecule experiences based off of its structure.
	The stronger the intermolecular force, the high the boiling point of a material. The relative strength of intermolecular forces is hydrogen bonding at the strongest, dipole dipole interactions in the middle, and London dispersion forces generally being the weakest.	Organize relative boiling points of different molecules based off of the molecular properties.
	Phase change diagrams show the conditions in which materials change phases from solid to liquid to gas.	Analyze and apply a phase change diagram to a real world material.
	The ideal Gas law and the Ideal Gas law derivatives (Boyle's, Charles', and Combined) are sets of equations that can be used to determine the volume, pressure, temperature, and number of moles of gas are present in a system.	Calculate different properties of gasses using the ideal gas law and the ideal gas law derivatives.
	VOCABULARY: Intermolecular forces, dipole-dipole interaction, hydrogen bonding, London dispersion forces, Van Der Waals forces, solid, liquid, gas, boiling, freezing, melting, condensation, sublimation, deposition, phase change, kelvin, gas constant, ideal gas law, Boyle's law, Charles's law, combined gas Law, Avogadro's law, standard temperature and pressure (STP).	

ASSESSMENT EVIDENCE: Students will show their learning by:

- Applying a phase diagram to a real world scenario to explain natural phenomena. For example, why Earth is the only planet that has surface liquid water.
- Demonstrating how condition changes will affect the behavior of gasses, and explaining the behavior with the applicable gas law.
- Predict how temperature change will affect a substance and what occurs in regards to energetics and phases.

KEY LEARNING EVENTS AND INSTRUCTION:

- An analysis of phase change and phase change diagrams.
- A laboratory experiment on boiling points and intermolecular forces analysis.
- Boil water with a pressure change not a temperature change, students will explain using fundamentals of vapor pressure.

RANDOLPH TOWNSHIP SCHOOL DISTRICT
Chemistry
Unit X: States of matter

SUGGESTED TIME ALLOTMENT	CONTENT-UNIT OF STUDY	SUPPLEMENTAL UNIT RESOURCES
3 weeks	**States of matter**	**Changing states of matter- https://www.youtube.com/watch?v=uYYEX5v5a9A**

Appendix A- Observing Chemical Changes Lab Quiz

Observing a Chemical Change

1. State two objectives for performing this experiment :

   a._____

   b._____

2. What are the four main ways listed that a chemistry student can determine when a chemical change has occurred?

   A. _____

   B. _____

   C. _____

   D. _____

Use the information below to answer question # 3:

Reagent 1	Reagent 2	Water temperature	Solution temperature
Ammonium nitrate	Water	25ºC	19ºC
Calcium chloride	Water	20ºC	26ºC

3. Which experiment was exothermic (hot) and which one was endothermic(Cold). How did you know?

   _____

   _____

Use the information below to answer question #4-5:

	Reagent 1	**Reagent 2**	**Observations**
A	Sodium bicarbonate	Acetic Acid	Fizzing and bubbling
B	Sodium hydroxide	Phenolphthalein	Clear → magenta pink
C	Barium chloride	Sodium sulfate	Milky white and opaque

4. According to the data provided, which chemical change indicator(s) does each experiment show.

   A. _____

   B. _____

   C. _____

5. Using the data above, draw a conclusion of which two chemicals combined were the likely ones to produce the “wine” in the wine, milk & beer demonstration? _____

6. Identify the following lab equipment used in the lab.

a. 

b. 

_____ _____

7. ___ How do you dispose of chemicals?
   a. All unused chemicals are returned to their original container
   b. Stored in you lab drawers for future use.
   c. Leave for the lab assistant to clean up
   d. Solids are wrapped and trashed; liquids go down the sink with water.

8. ___ An exothermic reaction is a chemical reaction that:
   a. Releases heat energy
   b. Absorbs heat energy
   c. Breaks apart compounds
   d. Absorbs water moisture

Appendix B- Observing Chemical Change Lab

Observations of a Chemical System

Al + blue-green chemical

Introduction:

Observation is the foundation of all science. By combining observations, theories are formulated. In the laboratory, it is necessary to be constantly aware of changes, which occur. In chemistry, we study two types of changes – physical and chemical. A **physical change** is one in which there is a change in appearance but nothing new is formed. A **chemical change** is one in which a new substance with new properties is formed. A dramatic change in color is one indication of a chemical change. Occasionally, the changes will be manifested in a more subtle way. An example of this type of change would be gradual oxidizing of iron to form rust. Some changes will be recognized by using the senses of sight, touch and smell, while others require specialized equipment such as a thermometer, a balance, pH paper, and a buret.

The five indicators of chemical change are:

1. Dramatic change in color
2. Evolution of a gas
3. Formation of a precipitate
4. Change in temperature without heating or cooling.
5. Formation of a new substance

After this experience you know that there is more to making complete observations then you have previously realized. Skill and experience are needed to become a very good observer. You will also be able to distinguish between an observation and a conclusion, a chemical and physical change, and between a qualitative and quantitative observation.

This experiment provides another opportunity for careful observation. Think about the variables that will affect the results of different lab groups. Your data should be a record of both qualitative and quantitative observations and be as complete as possible. You may wish to use a thermometer.

Reagents: aluminum foil, Al
Blue chemical, copper (II) chloride ($CuCl_2$)

Procedure:

1. Have a sheet of paper out ready to record your initial and final observations, as well as observations made during the change. Later you will transfer your observations to the data table, placing them in the appropriate section.

Initial Observations:

2. Weigh a small heaping of the blue chemical on weighing paper with an electric balance. Record this value. _____g_
3. Fill a 250-mL beaker halfway with tap water. Add the weighed blue chemical into the 250-mL beaker. Observe for a few minutes. Holding a piece of paper behind the beaker, observe through the side of the beaker as well as from the top. Record any and all observations.
4. After a few minutes stir with a stirring rod until no solid remains. Record any observations.

Observations **during the change:**

5. Place a piece of loosely crumpled Al foil in the solution. Observe and record what happens. It may be necessary to hold the foil down with your stirring rod.
6. After the reaction shows no additional change, pour off (**decant**) the liquid phase into a 400-mL beaker, leaving the solid behind.

Final Observations (after the change):

7. Wash the solid by covering it with tap water, gently swirling the beaker, and allowing the solid to settle. Decant the rinse water, and scrape the solid on a folded paper towel.
8. Set the towel on your watch glass and lock the watch glass with product in your drawer to dry overnight.
9. Clean-up your lab station, including all used glassware. Have teacher check lab station and obtain stamped data table.

2nd Day Procedure:

10. After the solid has dried overnight, re-weigh the solid produced on weighing paper. Record this value. _____g_
11. Observe your product and then compare it to that of other lab groups.

Analyzing the Data:

Arrange the observations and values recorded in the appropriate boxes in the data table provided by the teacher.

Questions

Answer the following questions:

1. Define the following terms:
    a. Physical Change –
    b. Chemical Change –
    c. Qualitative Data –
    d. Quantitative Data –
2. If double the water was used, how would this affect the result?
3. If double the blue-chemical was used, how would this affect the result?
4. Why does the same product made from different lab groups *look so different*? Be specific.

Conclusions

Write two to three closing statements describing possible conclusions as to what happened during the experiment.

Data Table

Physical Properties/Changes	***Chemical Properties/Changes***

Appendix C- Alien Periodic Table of elements

Alien Periodic Table of Xion

In this activity you will place unknown elements into a blank periodic table. You will be given physical and chemical properties to help you place these elements into the table.

Materials (per pair)
Blank periodic table, modified for this activity. Observations on the unknown elements. Your notes. Pencil.

Background Information:

Earth's scientists have announced that they have made radio contact with intelligent life on a distant plant called Xion. One of this alien planet's languages has been translated, and scientific information has started to e exchanged. The planet is composed of the same elements as Earth. However, the inhabitants of the planet have different names and symbols for them. Since the alien scientists do not now the names of our elements, they have radioed the following data on the known properties of elements. Strangely, but luckily, there are no transition or inner elements on the alien planet. This means that their periodic table consists only for the "A" group or representative elements. Scientists want to answer the various questions regarding the alien elements. But first you will need to refresh you memory about:

Pre-Questions:

1. What is Magnesium's outer most energy level? _____
2. If you gain 3 electrons, in which family would you be? _____
3. Which element's location suggests that it is a metalloid, but is actually a metal? _____
4. Which element's location suggest that it is an alkali metal, but is not? _____
5. If an element is lighter than another element in its family, where would it be located in that family's column?

   _____
6. If you were a more metallic metal, which side of the periodic table would you be? _____
7. If you are an unreactive gase, in which family would you be? _____

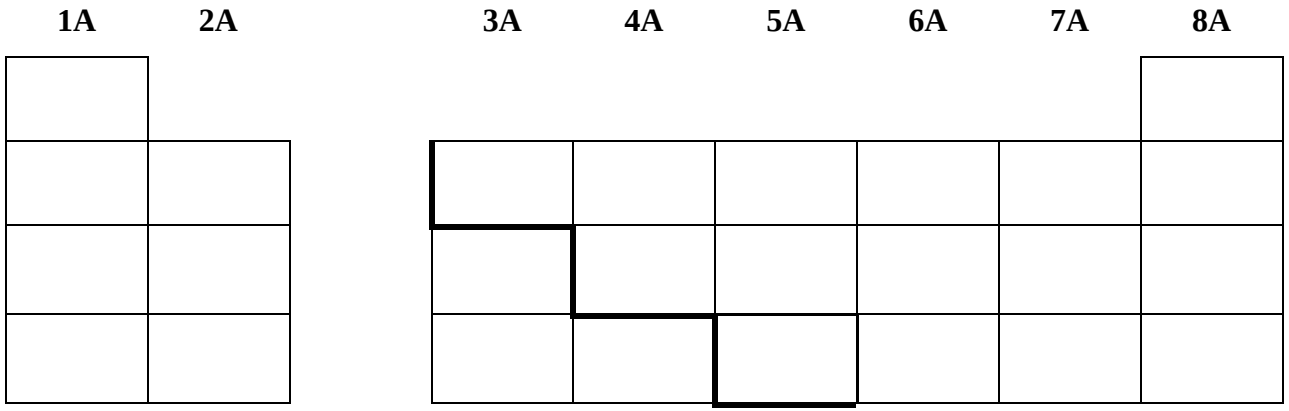
8. Which elements are diatomic? _____

DATA about the Alien Elements

1. The noble gases are Bombal (Bo), Wobble (Wo), Jeptum (J) and Logon (L). Bombal is a noble gas but does not have eight valence electrons. Wobble has the greatest atomic mass.
2. The alkali metals are Byyou (By), Chow (Ch), and Quackzil (Q). Of these alkali metals, Chow has the lowest atomic mass.
3. Apstron (A), Vlcania (V) and Kratt (Kt) are all in the same family that gains one electron when they become ions. Vulcania is in the same period as Quackzil (Q) and Wobble (Wo).
4. The metalloids are Ernst (E), Highho (Hi), Terriblum (T), and Sississ (Ss). Sississ is the metalloid with the highest atomic mass. Ernst is in the same period as Chow (Ch). Highho and Terriblum are in family 4A, but Terriblum has 8 more protons than Hi.
5. The element Yazzer (Yz) is a metalloid by location but has properties that suggest it is a light metal.
6. The lightest element on the planet is called Pfsst (Pf) and is in the same period as Bombal (Bo).
7. The element with the largest atomic size is Quackzil (Q) and is also very reactive.
8. The element called Doggone (D) has only four protons in its atom and is in the same period as Goldy (G).
9. Floxxit (Fx) is a black crystal that has four electrons in its outermost energy level.
10. Both Rhaatrap (R) and Doadeer (Do) also are atoms with four energy levels, but Rhapptrap is less metallic than Doadeer.
11. Magnificon (M), Goldy (G), and Sississ (Ss) are all members of Group 5A. Goldy has fewer total electrons than Magnificon.
12. Urrp (Up), Oz (Oz), and Nuutye (Nu) all gain two electrons. Nuutye has similar properties to a diatomic element on earth that also gains two electrons. Oz is in the same period as Yazzer (Yz).
13. Apstrom (A) is the most reactive nonmetal and is in the same period as Logon (L).

14. The element Zapper (Z) and Doggone (D) both lose two electrons.

Use This Table to Create Your Xionian Periodic Table



Questions:

1) Write an electron configuration for the element Yazzer. _____
2) Why is an atom of Byyou (By) smaller than an atom of Quakzil (Q)? _____
   _____
3) Which atom would have a:
   a. larger atomic radius Ernst or Nuutye? _____
   b. higher ionization energy Bobble or Wobble? _____
   c. higher electronegativity value Doggone, Kratt or Logon? _____
4) Chow is the largest atom in its period and Logon is the smallest. Predict the relative size of the atom of Doggone. _____
5) What factor explains the change in size as move from left to right across a period?

Reactions Test Review

Please use the book, notes, and prior knowledge to define the following terms and answer the following questions.

- Solid:
- Liquid:
- Gas:
- Aqueous:
- Precipitate:
- Coefficient:
- Subscript:

1) What is the difference between a liquid and an aqueous solution?

2) When balancing a chemical equation which number(s) must be changed to satisfy the law of conservation of mass, the coefficient or the subscript, and why?

Directions: **Please define the five types of reactions and write down two examples for each type.**

Single Replacement:

Double Replacement:

Synthesis:

Decomposition:

Combustion: