TRG HS Pacing Guide Subject: Chemistry A & B		
Trimester A		
MONTH A1	**SCHOOL IMPROVEMENT STANDARDS**	**CLASSROOM INTERVENTION STANDARDS**
SCIENCE INQUIRY AND PROCESS (1 WK – AND ONGOING THROUGHOUT CHEMISTRY TRIMESTER A AND B) **C1.1A; C1.1B; C1.1C; C1.1D; C1.1E; C1.1F; C1.1G; C1.IH; C1.1I; C1.1J; C1.1K; C1.2A; C1.2B; C1.2D; C1.2E; C1.2F; C1.2G; C1.2H; C1.2I; C1.2J; C1.2K** **ATOMIC THEORY (2-3 WKS)** **C4.8; C4.8A; C4.8B; C4.8C; C4.8D; C4.10; C4.10A; C4.10B; C4.10x; C4.10C, C4.10D; C4.10E; C2.5X; C2.5A; C2.R5B;C 2.R5C; 2.R5D; C3.5X; C3.5A**		
MONTH A2	**SCHOOL IMPROVEMENT STANDARDS**	**CLASSROOM INTERVENTION STANDARDS**
PERIODIC TABLE (2 WKS) **C4.9; C4.9A; C4.9X; C4.9B; C4.9C;** **CHEMICAL BONDING (2-3 WKS)** **C4.8X; C4.8E; C4.8F; C4.8G; C4.8H; C4.8I; C5.5; C5.5A; C5.5B; C5.5X; C5.5C; C5.5D; C3.2; C3.2A;C3.2B; C5.8; C5.8A; C5.8B; C5.8C; C2.4; C2.4A; C2.4B; C2.4C; C2.4D; C4.1; C4.1A; C4.1B; 4.1C**		
MONTH A3	**SCHOOL IMPROVEMENT STANDARDS**	**CLASSROOM INTERVENTION STANDARDS**
NOMENCLATURE (1-2 WKS) **C4.2; C4.2A; C4.2B; C4.2C; C4.2D; C4.2E; C4.2X; C4.2C; C4.2D;**		

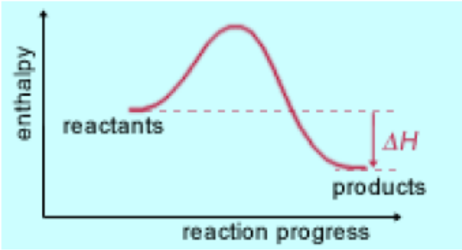
THE MOLE (1-2 WKS) **C4.6X; C4.6A; C4.6B;**		
Trimester B		
MONTH B1	**SCHOOL IMPROVEMENT STANDARDS**	**CLASSROOM INTERVENTION STANDARDS**
SOLIDS, LIQUIDS; GASES (2-3WKS) **C4.3; C4.3A; C4.3B; C4.3X; C4.3C; C4.3D; C4.3E; C4.3F; C4.3G; C4.3H; C4.3I; C4.4X; C4.4A; C4.4B; C4.7X; C4.7A; C4.7B; C5.4X; C5.4C; C5.4D; C5.4E; C2.2; C2.2A; C2.2B; C2.2X; C2.2C; C2.2D; C2.2E; C2.2F; C3.3; C3.3A; C3.3B; C3.3X; C3.3C;** **GAS LAWS (1-2 WKS)** **C4.5X; C4.5A; C4.5B; C4.5C**		
MONTH B2	**SCHOOL IMPROVEMENT STANDARDS**	**CLASSROOM INTERVENTION STANDARDS**
PHASE DIAGRAMS (1 WK) **C5.4; C5.4A; C5.4B;** **CHEMICAL CHANGES AND REACTIONS (3 WKS)** **C2.3X; C2.3A; C2.3B; C2.1X, C2.1A; C2.1B; C2.1C; C3.3X; C3.3C; C5.6X; C5.6A; C5.6B; C5.6C; C5.6D; C5.6E;** **STOICHIOMETRY** **C5.2; C5.2A; C5.2B; C5.2C; C5.2X; C5.2D; C5.2E; C5.2F; C5.2G; C5.3X; C5.3A; C5.3B; C5.3C** **SOLUTIONS** **C4.7; C4.7A; C4.7B**		
MONTH B3	**SCHOOL IMPROVEMENT STANDARDS**	**CLASSROOM INTERVENTION STANDARDS**
THERMODYNAMICS (2-3 WKS) **C3.4; C3.4A; C3.4B; C3.1X; C3.1A; C3.1B; C3.4X; C3.4C; C3.4D; C3.4E; C3.4F; C3.4G;**		

C5.R1; C5.R1A; C5.R1B **ACIDS AND BASES (2 WKS)** **C5.7; C5.7A; C5.7B; C5.7C; C5.7D; C5.7E; C5.7X; C5.7F; C5.7G; C5.7H; C5.7I; C5.8; C5.8A; C5.8B; C5.8C**		

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C2.1x**	**Standard:** Potential energy is stored whenever work must be done to change the distance between two objects. The attraction between the two objects may be gravitational, electrostatic, magnetic, or strong force. Chemical potential energy is the result of electrostatic attractions between atoms.		
	Unpacked Standard: **C2.1a** Explain the changes in potential energy (due to electrostatic interactions) as a chemical bond forms and use this to explain why bond breaking always requires energy. **C2.1b** Describe energy changes associated with chemical reactions in terms of bonds broken and formed (including intermolecular forces). **C2.1c** Compare qualitatively the energy changes associated with melting various types of solids in terms of the types of forces between the particles in the solid.		
	Board Objective: I can explain the change in energy by illustrating bonds breaking and forming during a chemical reaction in order to qualitatively explain forces between particles.		
NEXT GEN CODE: HS-PS3-1 HS-PS3-2	**Next Gen Standard:** HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).		
	ACT Alignment: Interpretation of Data – Compare or combine data from a complex data presentation. Determine how the value of one variable changes as the value of another variable changes in complex data presentations. Scientific Investigation – Predict the results of additional trail or measurement in an experiment.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Explain energy changes in chemical reactions <u>Pre-assessment:</u> • Vocabulary assessment –	Chemical bonds form either by the attraction of a positive nucleus and negative electrons or the attraction between a positive ion and a negative ion. The strength of chemical bonds can be measured by the changes in energy that occur during a chemical reaction.	Show a variety of animations to illustrate the idea of energy in chemical bonds. • This is a great link showing formation of NaCl and the release of energy as the crystal

students should be familiar with words such as chemical bond, ionic bond, covalent bond, endothermic and exothermic During: • Daily activities: guided and individual practice • Animations • Hands-on Activity • Demonstration Post-assessment: • Unit Test	Changes in energies that result from bonds breaking and being made can be calculated using bond energy charts located in the appendices of the chemistry textbook. Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. The availability of energy limits what can occur in any system. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. The heat of reaction is the quantity of heat released or absorbed during a chemical reaction. It is the difference between the stored heat energy (or heat content) of the reactants and products. For example, in an exothermic reaction, the heat evolved is the difference between the higher heat content of the reactants and the lower heat content of the products.	lattice forms. http://cwx.prenhall.com/petrucci/medialib/media_portfolio/text_images/015_ELECTANDNON.MOV • This is a great animation for the dissolving of sodium chloride. The ion dipole intermolecular force. http://programs.northlandcollege.edu/biology/Biology1111/animations/dissolve.html Hands-on Activity: Rubber-band Experiment (see experiment details below) Demonstration: Rocket Experiment (see demo details below) Compare a variety of substances, free elements (monatomic and/or diatomic), ionic compounds, molecular compounds, and something with hydrogen bonding. You might consider looking at melting points of common materials, such as Na, O_2, CH_4, H_2O, and NaCl.

	 Bond breaking is an endothermic (energy absorbing) process and bond breaking is and exothermic (energy releasing) process. Think of bond breaking like pulling two magnets apart. The magnets have stored (potential) energy. Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	

RESOURCES:	VOCABULARY:
Concept Resources • http://www.chem1.com/acad/webtext/chembond/cb01.html • http://cwx.prenhall.com/petrucci/medialib/media_portfolio/05.html Daily Activities: • http://cwx.prenhall.com/petrucci/medialib/media_portfolio/text_images/015_ELECTANDNON.MOV • http://programs.northlandcollege.edu/biology/Biology1111/animations/dissolve.html	BOND ENERGY CHEMICAL BOND COVALENT BOND DIPOLE-DIPOLE FORCE ENDOTHERMIC REACTION EXOTHERMIC REACTION HYDROGEN BONDING INTERMOLECULAR FORCES IONIC BONDS
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How is potential energy stored in a chemical bond? • Does breaking the bond require energy?	Hands-on Activity: Rubber band Experiment. A simple way to demonstrate elastic energy is to stretch a rubber band and not let go, the stretch demonstrates potential energy. Let go of the rubber aiming it toward a wall and it is converted to kinetic energy. The rubber band can also illustrate energy conversion. Place the band against your upper lip to measure its temperature. Stretch and release the band repeatedly. Test the temperature again. It should feel warmer. Why does it feel warmer and where do you think

	the heat energy came from? (Might want to look up the chemical structure of the polymer rubber) Demonstration: Rocket Experiment. This experiment can be used as a demo or experiment for students. Materials: Plastic flask, cork, 1/2 cup water, 1/2 cup vinegar, spoonful of baking soda, paper coffee filter **Note:** Only attempt this activity where this is overhead space and room to move away. Pour a 1/2 cup of water and a 1/2 cup of vinegar into the flask. Put a spoonful of baking soda into a coffee filter, roll and twist it closed. Put the coffee filter in the flask, cork it and move away…fast! Both the baking soda and vinegar contain molecules (which have potential energy in their bonds). When mixed together the bonds break and the molecules rearrange themselves to produce a gas releasing energy. The continued production of gas in a closed container increases the pressure (potential energy) in the container. This experiment demonstrates chemical energy converted to mechanical energy or movement. Design a film canister to look like a rocket (add fins, nose cones, etc.). Put a little baking soda and vinegar in the rocket and quickly close the lid and invert. Lift off! (NOTE: You'll need to use the type of canister where the lid fits inside the canister rather than the cap style)

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C2.2**	**Standard:** Molecules that compose matter are in constant motion (translational, rotational, vibrational). Energy may be transferred from one object to another during collisions between molecules.		
	Unpacked Standard: **C2.2A** Describe conduction in terms of molecules bumping into each other to transfer energy. Explain why there is better conduction in solids and liquids than gases. **C2.2B** Describe the various states of matter in terms of the motion and arrangement of the molecules (atoms) making up the substance.		
	Board Objective: I can describe conduction by illustration the molecules in order to detail the transfer of energy. I can describe solids, liquids and gases by illustrating the movement of molecules in order to explain properties of the states of matter.		
NEXT GEN CODE: HS-PS3-2 HS-PS3-4	**Next Gen Standard:** HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects). 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 the components in the system (second law of thermodynamics).		
	ACT Alignment: Evaluation of Models, Inferences, and Experimental Results – Identify key issues or assumptions in a model.		

<table>
<tr><th>ASSESSMENTS:</th><th>CONCEPT NOTES:</th><th>LESSON STRATEGIES:</th></tr>
<tr><td>Students should be able to:
• Describe conduction at a molecular level
• Describe solids, liquids and gases at a molecular level

<u>Pre-assessment:</u>
• Have students illustrate conduction at a molecular level
• Have students illustrate solids, liquids and gases at a molecular level

<u>During:</u>
• Daily activities
• Animations
• Inquiry Experiment #1
• Inquiry Experiment #2

<u>Post-assessment:</u>
• Unit Test</td>
<td>Particles in all matter are in constant motion until the temperature reaches absolute zero.

Conduction: If you have ever left a silver spoon in very hot soup, you will notice that the whole spoon gets hot. Thermal energy is transferred from the hot end of the spoon through the entire length, its called conduction.

Particles often collide with each other. When this happens, energy is transferred from the faster (hotter) moving particle to the slower (cooler) moving particle. This makes the slower moving particles increase in speed.

When molecules in a substance are made to move faster, they get warmer. The warmer an object gets the more kinetic energy and therefore, thermal energy it contains.

Structure of Matter

Matter is what makes up all substances, whether it is a solid, liquid or gas. Molecules, atoms and sub-atomic particles are all matter. The major properties of matter are that it takes up space, has mass and attracts other matter with gravity. All matter is made up of constantly jiggling atoms or molecules. The motion of these particles determines whether a substance is a solid, liquid, or a gas – the KINETIC THEORY OF MATTER!</td>
<td>Daily activities - Have students:
• Draw diagrams and pictures to illustrate heat conduction.
• Create models to demonstrate molecules in motion (translational, rotational, and vibrational).
• Act out the motion and arrangement particles in a substance.

Animation: Students learn about conduction from these animation:
• https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer--conduction--convection--radiation
• http://www.pbslearningmedia.org/asset/lsps07_int_heattransfer/

Animations: Solids, liquids and gases: http://www.chem.purdue.edu/gchelp/liquids/character.html

Inquiry Experiment #1: The States of Matter (see experiment details below)

Inquiry Experiment #2: Ice Cream in a Bag (see experiment details below)</td></tr>
</table>

<table>
<tr><th>RESOURCES:</th><th>VOCABULARY:</th></tr>
<tr><td>Animations:
• https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer--conduction--</td><td>CONDUCTION
KINETIC MOLECULAR MODEL
KELVIN TEMPERATURE</td></tr>
</table>

convection--radiation • http://www.pbslearningmedia.org/asset/lsps07_int_heattransfer/ • http://www.chem.purdue.edu/gchelp/liquids/character.html Inquiry Experiment #1: http://staff.concord.org/~btinker/workbench_web/states_of_matter/pdf/states_of_matter_whole.pdf Inquiry Experiment #2: http://scienceofeverydaylife.discoveryeducation.com/families/pdfs/activities/Kitchen-Chemistry.pdf http://www.school.cdfarmsite.com/labs/icecreamlab0506.doc	ORDER PRESSURE-TEMPERATURE RELATIONSHIP PRESSURE-VOLUME RELATIONSHIP ROTATIONAL MOTION TEMPERATURE-VOLUME RELATIONSHIP TRANSLATIONAL MOTION VIBRATIONAL MOTION
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• What is matter? • How are solids, liquids and gases different? How are they similar?	Inquiry Experiment #1: The States of Matter. Students investigate the states of matter at a molecular level. Click on the link for procedure and handouts: http://staff.concord.org/~btinker/workbench_web/states_of_matter/pdf/states_of_matter_whole.pdf Inquiry Experiment #2: Ice Cream in a Bag. Students investigate the different states of matter in this tasty experiment. Students use kitchen chemistry to make homemade ice cream. For procedure, click on the following links: http://scienceofeverydaylife.discoveryeducation.com/families/pdfs/activities/Kitchen-Chemistry.pdf http://www.school.cdfarmsite.com/labs/icecreamlab0506.doc

GRADE:	SUBJECT: Science	STRAND:	TRG Pacing Summary:
CODE: **C2.2x**	**Standard:** As temperature increases, the average kinetic energy and the entropy of the molecules in a sample increases.		
	Unpacked Standard: **C2.2c** Explain changes in pressure, volume, and temperature for gases using the kinetic molecular model. **C2.2d** Explain convection and the difference in transfer of thermal energy for solids, liquids, and gases using evidence that molecules are in constant motion. **C2.2e** Compare the entropy of solids, liquids, and gases. **C2.2f** Compare the average kinetic energy of the molecules in a metal object and a wood object at room temperature.		

<table>
<tr><td></td><td colspan="3">Board Objective:
I can explain energy changes in solids, liquids, and gases by using real world applications in order to model the kinetic molecular theory.</td></tr>
<tr><td rowspan="2">NEXT GEN CODE:
HS-PS3-4</td><td colspan="3">Next Gen Standard:
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 the components in the system (second law of thermodynamics).</td></tr>
<tr><td colspan="3">ACT Alignment:
Evaluation of Models, Inferences, and Experimental Results – Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.</td></tr>
<tr><td colspan="2">ASSESSMENTS:</td><td>CONCEPT NOTES:</td><td>LESSON STRATEGIES:</td></tr>
<tr><td colspan="2">Students should be able to:
Illustrate energy levels in solids, liquids and gases
Explain the kinetic molecular theory
<u>Pre-assessment:</u>
Have students illustrate solids, liquids, and gases at the molecular level.
<u>During:</u>
Daily activities: guided and individual Practice
Animation
Cooperative Learning Activities
Inquiry Experiment
<u>Post-assessment:</u>
Unit Test</td><td>One of the most important concepts for students to understand is that temperature affects the motion of molecules. As air is warmed, the energy from the heat causes the molecules of air to move faster and farther apart. Some students may have difficulty with this concept because they lack an appreciation of the very small size of particles or may attribute macroscopic properties to particles. Students might also believe that there must be something in the space between particles. Finally, students may have difficulty in appreciating the intrinsic motion of particles in solids, liquids, and gases; and have problems in conceptualizing forces between particles. In order to clarify student thinking about molecules and their relationship to temperature, instruction has to make the molecular world understandable to students.

Particles in all matter are in constant motion until the temperature reaches absolute zero. The order and organization in the universe is illustrated in the pressure, volume and temperature relationships which can be predicted by models, mathematical equations and graphs.

Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).

Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the</td><td>Animation: Particle movement of solids, liquids, and gases.
http://www.chem.purdue.edu/gchelp/liquids/character.html
Following the animation, asks students:
What happens when I blow hot air on the balloon? Why?
What is happening to the air inside the balloon?
What do you think would happen if the balloon was placed in a cold car?
What would happen to the balloon as the temperature increases in the car? Why?
Ask the students to think about what might happen to a balloon in a bottle when it is heated.
Animation: This animation shows phase changes of different materials:
http://www.miamisci.org/af/sln/phases/watersolid.html

Emphasize the understanding of the kinetic model by using people to demonstrate order and disorder.</td></tr>
</table>

	surrounding environment. Entropy increases (becomes more positive) as you go from solid to liquid to gas. The randomness or disorder increases from one phase to another. The randomness or disorder increases as the phase changes. There are more degrees of freedom and thus an increase in entropy. Temperature is a measure of the average kinetic energy of the particles. As the temperature increases, the average kinetic energy increases. The average kinetic energy of the molecules in a metal object and a wood object are the same at room temperature.	Be sure to check for understand of the concepts with these activities: • Have students make a list of activities that are encountered every day that exhibit high or low entropy. Make two columns in a table to show the highest state of entropy and the lowest state of entropy. Examples: deck of cards, clothes, room • Have students work individual or in groups to make a list of chemical reactions that are encountered every day that exhibit endothermic or exothermic properties. Examples: photosynthesis, rusting, food digestion, etc. • Worksheets: http://misterguch.brinkster.net/kineticmoleculartheory.pdf Cooperative Learning Activity: Cartoon Fun (see activity details below) Inquiry Experiment: The balloon and the bottle (see experiment details below)

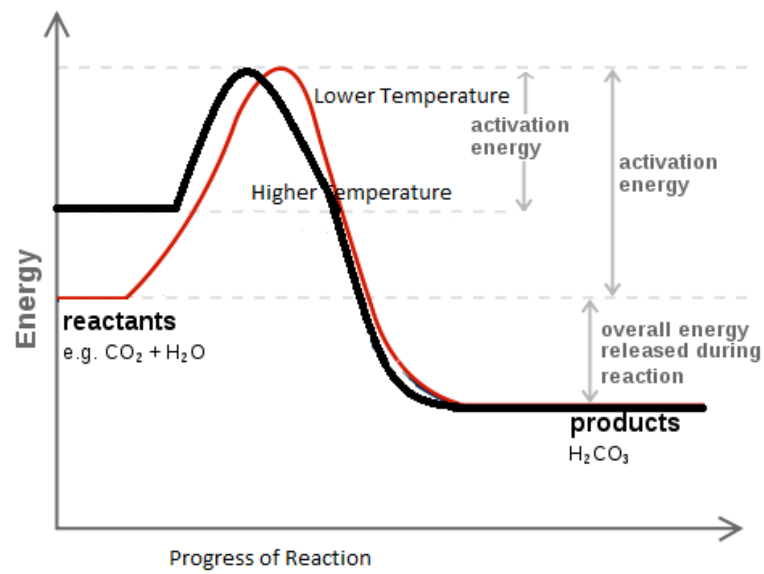
RESOURCES:	VOCABULARY:
Content Resources: • http://www4.uwsp.edu/cnr/wcee/keep/Mod1/Whatis/experiments.htm Animation: • http://www.chem.purdue.edu/gchelp/liquids/character.html • http://www.miamisci.org/af/sln/phases/watersolid.html	CONDUCTION ENTROPY KINETIC MOLECULAR MODEL KELVIN TEMPERATURE ORDER PRESSURE-TEMPERATURE RELATIONSHIP PRESSURE-VOLUME RELATIONSHIP ROTATIONAL MOTION TEMPERATURE-VOLUME RELATIONSHIP

Daily Activities:	TRANSLATIONAL MOTION VIBRATIONAL MOTION
Daily Activities: • http://sciencenetlinks.com/lessons/temperature-changes-everything/ • http://misterguch.brinkster.net/kineticmoleculartheory.pdf Inquiry Experiment: • http://sciencenetlinks.com/student-teacher-sheets/balloon-and-bottle/	TRANSLATIONAL MOTION VIBRATIONAL MOTION
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• How does temperature affect the movement or energy in an atom?	Cooperative Learning Activity: Cartoon Fun. In this activity, students will illustrate in a cartoon scene the idea of how temperature affects the motion of molecules. Students should present their cartoon to the class and explain how it relates to the idea of temperature affecting the motion of molecules and states of matter. Students should be assessed on how well their cartoons convey the following scientific ideas: • How heating and cooling affects the movement of particles. • How states of matter may change with heating and cooling. **Give the students these instructions:** You are a cartoonist. Your task is to create a cartoon scenario illustrating the effect of temperature on the movement of molecules in a solid, liquid, or a gas. You will use your cartoon to teach your classmates about the movement of molecules in the different states of matter and how an increase or decrease in temperature affects them. Inquiry Experiment: The Balloon and the Bottle. Students experience the effects of increased temperature on air inside a balloon. For full procedure, click on the following link: http://sciencenetlinks.com/student-teacher-sheets/balloon-and-bottle/

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE:	**Standard:** For molecules to react, they must collide with enough energy (activation energy) to break old chemical bonds before their atoms can be rearranged to form new substances.		

C2.3x	**Unpacked Standard:** **C2.3a** Explain how the rate of a given chemical reaction is dependent on the temperature and the activation energy. **C2.3b** Draw and analyze a diagram to show the activation energy for an exothermic reaction that is very slow at room temperature.
	Board Objective: I can analyze how temperature affects rates of reaction by designing an experiment using Alka-Seltzer in order to model the energy of chemical reactions.
NEXT GEN CODE: HS-PS3-2	**Next Gen Standard:** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
	ACT Alignment: Interpretation of data – Understand basic scientific terminology Scientific Investigation – Understand a complex experimental design

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students need to be able to: • Compare and contrast between exothermic and endothermic reactions • Design an experiment to test a hypothesis about how temperature effects rates of reaction • Graph the rate of reaction vs energy which illustrates activation energy <u>Pre-assessment:</u> • Vocabulary Assessment <u>During:</u> • Collision Theory Demonstration • Venn Diagram – compare and contrast endothermic and exothermic reactions • Guided/Individual Practice – Vocabulary practice and graphing worksheets • Inquiry Experiment – Alkali-Seltzer Lab	Chemical compounds and chemical reactions strive toward states of highest disorder as does everything in the universe. When exploring the energy of reactions, there are two types students should become experts in: exothermic and endothermic reactions. Exothermic reactions release energy and tend to be very spontaneous. Endothermic reactions tend to absorb energy overall and usually require an additional energy source (heat) or catalyst to get the reaction going. Rates of reactions tend to depend on the temperature of the reaction. This can be easily illustrated through a rate of reaction diagram. Students should be able to diagram endothermic and exothermic reactions through a rate of reaction vs energy graph. For this standard, students will design an experiment to illustrate how temperature affects the rate of reaction using Alka-Seltzer tablets. The final product of the graphs should show that a higher temperature will affect the activation energy and the rate of reaction. See below for an example:	Many skills students should master for this standards include vocabulary usage, graphing chemical reactions, and understanding how temperature effects chemical reactions. Students should have individual practice with vocabulary and labeling and creating graphs before moving onto inquiry experiment. Collision Theory Demo – introduction (see activity instructions below) Individual Practice: Students should practice vocabulary, graphing skills, and conceptual understanding. See resources for formative assessment worksheets. Check for understanding before conducting Inquiry experiment. Inquiry experiment: The effects of temperature on rate (see experiment details below).

• Concept Quizzes • Cold Call Questionnaire Post-assessment: • Unit Test		

RESOURCES:	VOCABULARY:
Guided/Individual Practice: • Vocabulary Practice – Crossword Puzzle Creator: http://www.discoveryeducation.com/free-puzzlemaker/ • Collision Theory Worksheets: http://misterguch.brinkster.net/HH005.doc http://www.misshuthchem.com/chem_18_collision%20theory.pdf • Graphing Worksheet: http://facweb.northseattle.edu/spal/WINTER%202014/NORTH%20SEATTLE/CHem%20121_NSCC/Worksheets/worksheet%209_answer%20key.pdf Inquiry Experiment: • http://www.alkaseltzer.com/as/student_experiment1.html • http://www.scientificamerican.com/article/bring-science-home-carbonation-time/	ACTIVATION ENERGY COLLISION THEORY DISORDER ENDOTHERMIC REACTION ENTHALPY ENTROPY EXOTHERMIC REACTION GIBB'S FREE ENERGY HESS'S LAW REACTION RATE RELEASE OF ENERGY SPONTANEOUS
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• How are reaction rates expressed? • What factors affect the reaction rate?	**Collision Theory Demonstration Instructions:** Overview: In this activity students will simulate the collision theory focusing

• How are chemical reactions expressed graphically?	on the orientation of molecules. Safety/Concerns: Remind students that though molecules have varying energies, we do not want to injure anyone. Therefore, take care in not creating a "mosh" pit in the classroom. Activity: - Move desks in room to create a large empty space - Divide students into two different types of molecules - 1 Type of "molecule" holds their arms out in front of them, parallel with the floor - The other "molecule hold their arms out "like a bird" - Both sets of molecules are to walk around the room, simulating molecules in motion. - When molecules collide, successful new compounds will be formed when one hand from each of the two separate molecules touch. **Sample Questions** 1. Describe the collision theory of reaction. 2. Although methane, the main component of natural gas, burns readily in oxygen, the reaction is so slow at room temperature that it is not detectable. Explain this observation. 3. Give two reasons why most molecular collisions do not lead to a molecule reaction. Inquiry Experiment: Have students design an experiment using Alka-Seltzer tablets to determine the effect temperature has on the reaction rate. After conducting the experiment construct a table and draw conclusions. Generate questions for further investigations. To guide students, use the following experiment: The effects of temperature on rate. Students explore the effects of temperature on rates of reactions using Alka-Seltzer tablets and different temperature water. Please see the following websites: • http://www.alkaseltzer.com/as/student_experiment1.html • http://www.scientificamerican.com/article/bring-science-home-carbonation-time/

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C2.4x**	**Standard:** For each element, the arrangement of electrons surrounding the nucleus is unique. These electrons are found in different energy levels and can only move from a lower energy level (closer to nucleus) to a higher energy level (farther from nucleus) by absorbing energy in discrete packets. The energy content of the packets is directly proportional to the frequency of the radiation. These electron transitions will produce unique absorption spectra for each element. When the electron returns from an excited (high energy state) to a lower energy state, energy is emitted in only certain wavelengths of light, producing an emission spectra.		
	Unpacked Standard: **C2.4a** Describe energy changes in flame tests of common elements in terms of the (characteristic) electron transitions. **C2.4b** Contrast the mechanism of energy changes and the appearance of absorption and emission spectra. **C2.4c** Explain why an atom can absorb only certain wavelengths of light. **C2.4d** Compare various wavelengths of light (visible and nonvisible) in terms of frequency and relative energy.		
	Board Objective: I can identify common elements by conducting a flame test in order to explain the energy level of electrons. I can compare and contrast wavelengths of different atoms by reading their absorption and emission spectra in order to identify the element and energy level of the electrons		
NEXT GEN CODE: HS-PS3-2	**Next Gen Standard:** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).		
	ACT Alignment: Scientific Investigation – Identify an alternate method for testing a hypothesis. Determine the experimental conditions that would produce specified results.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Identify common elements based on flames tests, emission spectra, and absorption spectra. • Explain the electromagnetic spectrum in terms of electron energy. <u>Pre-assessment:</u> • KWL • Vocabulary Assessment – oral or written <u>During:</u> • Daily Assignments: Guided and individual practice	The emission spectrum of individual elements is always identical and can be used to identify the elements. Electron transition within energy levels can account for a specific energy emission or absorption within atoms. Gamma rays, X-rays, ultra violet rays, infrared, microwaves radio waves and visible light are several different types of electromagnetic (EM) radiation (or waves). All types of electromagnetic radiation are produced by alternating electrical and magnetic fields (or electromagnetic fields). Understanding the wave model helps explain characteristics of both waves and particles. Real world applications include understanding of how rainbows form, why objects look distorted underwater and how magnifying glasses work. All electromagnetic waves have the same speed, 3.00 x 108 m/s in	Real World Context • Fireworks produce specific colors because of the compounds used and the energy released when they burn. • Lighting, both commercial (neon lights) and highway or backyard lighting (mercury vapor or sodium) are a result of excited state electrons. • A rainbow is an example of a continuous spectrum being broken down into its different wavelengths as a result of rain droplets in the air. • Scientists can learn what stars

• Flame Tests Demonstration and Activity • Spectrometry Activity <u>Post-assessment</u> • Unit Test	a vacuum. Other types of media such as air or water only slightly slow the speed of light and other types of EM waves. When a wave strikes the boundary of the media the change in speed causes a change in direction, causing the wave to continue at a different angle. This process causes white light to disperse or separate into its component colors, similar to how light looks when it passes through a prism. EM waves vary in types according to changes in both frequency (ν) and wavelength (λ). Wavelengths are measure in nm (nanometers), and measure the distance between any point on a wave and the corresponding point on the next crest (or trough) of the wave or the distance that the wave travels during one cycle. Frequency which is the number of cycles that a wave undergoes per second is measured in Hz (1/s (seconds)). Amplitude is the height of the crest or depth of the trough of each wave and is related to the intensity of the radiation, which is perceived as brightness in the case of visible light. When sunlight is sent through a thin slit and then through one of the prisms, it formed a rainbow-colored spectrum but the spectrum also contains a series of dark lines. This also happens when an element is heated. In terms of the Bohr model, heating the atoms gives them some extra energy, so some of their electrons can jump up to higher energy levels. However electrons are not able to stay in the higher levels. When one of the electrons drops back down to a lower level, it emits a photon --at one of that element's special frequencies. This is called an emission spectrum. But there is another way in which elements can produce spectra. **Emission spectra** are produced by thin gases in which the atoms do not experience many collisions (because of the low density). The emission lines correspond to photons of discrete energies that are emitted when excited atomic states in the gas make transitions back to lower-lying levels. A **continuum spectrum** results when the gas pressures are higher. Generally, solids, liquids, or dense gases emit light at	are made of by observing the spectrum they emit. • The use of UV blockers in suntan lotions. • Gas discharge tubes are used in UPC scanners. • Photoelectric panels on solar houses, cars, and calculators. • Aurora borealis (northern lights) or aurora australis (southern lights) Daily Assignments: Formulas can be used to calculate energy changes and then related to specific wavelengths and type of radiation. Be sure to guide students through a few practice problems before giving them individual practice. You can check for understanding individually or as a group with show mes or displays. Flame Tests: There are two options for these flame tests. You may either conduct a demonstration for students where you can control the flame or have students conduct a virtual lab where their safety is ensured. Or, you can choose both. • Demonstration: Flame Test (see demo details below) • Virtual Lab: Flame Test Lab (see lab details below) Inquiry Experiment: Spectrometry. Spectroscopes can be used to observe different light sources. Light sources might include the following: sunlight;

	all wavelengths when heated. An **absorption spectrum** occurs when light passes through a cold, dilute gas and atoms in the gas absorb at characteristic frequencies; since the re-emitted light is unlikely to be emitted in the same direction as the absorbed photon, this gives rise to dark lines (absence of light) in the spectrum. **Summary** • An electron absorbs heat or electrical energy and is promoted to a higher level • The electron returns to the original level and emits the difference as a specific electromagnetic radiation. • The wavelength seen is related to the energy of the emission by Planck's equation E=hv E = energy of the emission h = Planck's constant (6.02 x 10-34) ν = frequency of the radiation (the frequency is related to the wavelength by c = λν, c is the speed of light and λ is the wavelength)	lights in classroom; gas tubes containing hydrogen, neon, or other. (See experiment details below)

RESOURCES:	VOCABULARY:
Daily Activities: • http://analyticalchem.community.uaf.edu/files/2013/12/Mass-Spectrometry-Worksheet.pdf • http://www.adriandingleschemistrypages.com/ap/summary-of-additions-to-the-new-ap-chemistry-curriculum-part-2-mass-spectrometry/ • http://www.rsc.org/learn-chemistry/resource/listing?searchtext=&fSubject=SUB000B2760 • http://www.nclark.net/epatterns_act.pdf • http://www.nclark.net/Atom Flame Test: • Virtual Lab: http://www.trschools.com/staff/g/cgirtain/weblabs/spectrolab.htm	ABSORBANCE SPECTRUM ATOMIC MOTION BRIGHT LINE SPECTRUM CHEMICAL BOND ELECTROMAGNETIC FIELD ELECTROMAGNETIC RADIATION ELECTROMAGNETIC SPECTRA ELECTROMAGNETIC WAVE ELECTRON ELECTRON CONFIGURATION EMISSION SPECTRA ENERGY LEVEL EXCITED STATE KERNEL GROUND STATE ORBITALS

http://www.mrpalermo.com/virtual-lab-spectroscopy.html http://www.800mainstreet.com/spect/emission-flame-exp.html • Demonstration: https://www.flinnsci.com/media/817675/95011r.pdf http://www.youtube.com/watch?v=QzQI8Cg1iXU – video https://teacher.ocps.net/john.lien/sciencezone/Handouts/Oooh_Aaah_flame_test.pdf Inquiry Experiment: • http://mos.seti.org/pages/tools-spectroscopy.html • http://iiith.vlab.co.in/?sub=19&brch=206 • http://www.trschools.com/staff/g/cgirtain/weblabs/spectrolab.htm	PROBABILITY QUANTUM ENERGY QUANTUM NUMBERS RELEASE OF ENERGY SUBLEVEL VALENCE ELECTRONS WAVE AMPLITUDE WAVELENGTH
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• Why can you identify an element by its flame test results? • How can you identify an element using only its electrons?	Flame Tests (click on the following links for specific details): • Virtual Lab: http://www.trschools.com/staff/g/cgirtain/weblabs/spectrolab.htm http://www.mrpalermo.com/virtual-lab-spectroscopy.html http://www.800mainstreet.com/spect/emission-flame-exp.html • Demonstration: https://www.flinnsci.com/media/817675/95011r.pdf http://www.youtube.com/watch?v=QzQI8Cg1iXU – video https://teacher.ocps.net/john.lien/sciencezone/Handouts/Oooh_Aaah_flame_test.pdf Inquiry Experiment: Can you identify the composition of an unknown light source? Using a hand held spectroscope, examine a variety of light sources. (Light sources might include the following: sunlight; lights in classroom; gas tubes containing hydrogen, neon, or other). Also observe the resulting spectrum of white light that is passed through a colored solution. Using colored pencils, draw what is observed in each case. Explain why they are not all the same. Classify them as line spectra, absorption spectra, or continuous spectra. After observing the hydrogen spectra, draw what has been observed. The spectra should have four lines showing up in difference colors. Next, draw two diagrams which represent a hydrogen atom. In one, have the electron in n=1. In the second, have the electron in n=5. Which of the drawings represents

	a ground state configuration? If the electron in the second diagram was to fall to n=2, would a continuous or line spectra be produced? What color light would be admitted, based on what you observed earlier? Extension: Determinate the actual wavelength of the light that was produced. This is possible using the information provided below. ΔE = Ehigher orbit – Elower orbit = Ephoton En = -2.178 x 10-18 J / n2 Ephoton = hv λv = c h=Planck's constant (6.626 x 10-34J· s) v = frequency λ = wavelength; c = speed of light (2.998 x 108 m/s) If you do not have access to spectroscopes, pick from the list of the following activities: • http://mos.seti.org/pages/tools-spectroscopy.html • http://iiith.vlab.co.in/?sub=19&brch=206 • http://www.trschools.com/staff/g/cgirtain/weblabs/spectrolab.htm

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C2.5x**	**Standard:** Nuclear stability is related to a decrease in potential energy when the nucleus forms from protons and neutrons. If the neutron/proton ratio is unstable, the element will undergo radioactive decay. The rate of decay is characteristic of each isotope; the time for half the parent nuclei to decay is called the half-life. Comparison of the parent/daughter nuclei can be used to determine the age of a sample. Heavier elements are formed from the fusion of lighter elements in the stars.		
	Unpacked Standard: **C2.5a** Determine the age of materials using the ratio of stable and unstable isotopes of a particular type. **C2.r5b** Illustrate how elements can change in nuclear reactions using balanced equations. *(recommended)* **C2.r5c** Describe the potential energy changes as two protons approach each other. *(recommended)* **C2.r5d** Describe how and where all the elements on earth were formed. *(recommended)*		
	Board Objective: I can determine the age of a material by calculating the amount of daughter and parent material in order to date material. I can balance a nuclear reaction by identifying the nuclear particle that is emitted in order to see how nuclear reactions shape our lives.		
NEXT GEN CODE: HS-PS1-8	**Next Gen Standard:** 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.		
	ACT Alignment: Scientific Investigation – Predict the results of an additional trial or measurement in an experiment.		

	Evaluation of Models, Inferences, and Experimental Results – Identify key issues or assumptions in a model. Interpretation of Data – Analyze given information when presented with new, simple information.

ASSESSMENTS:

Students should be able to:

- Identify fission and fusion in their everyday life
- Determine the age of a material based the half-life
- Balance nuclear equations

<u>Pre-assessment:</u>

- Chemical Equations – be sure students understand the basis of chemical reactions: reactants, products, elemental symbols, etc.
- Vocabulary Review – Definitions

<u>During:</u>

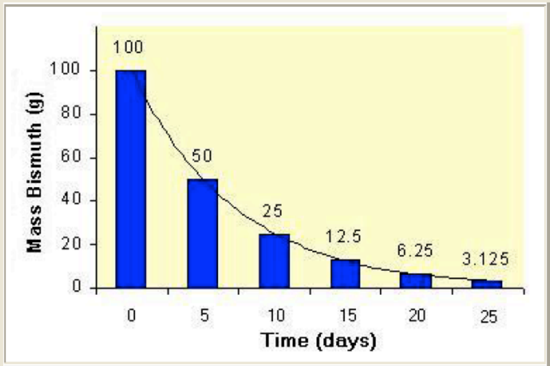
- Daily Activities – real world context, crossword puzzles, radioactive dose chart, animation, guided practice, and individual practice
- Cooperative Learning Activity
- Inquiry Experiment #1
- Inquiry Experiment #2

<u>Post-assessment:</u>

- Unit Test

CONCEPT NOTES:

Half-Life: Radioactive decay proceeds according to a principal called the half-life. The half-life (T½) is the amount of time necessary for one-half of the radioactive material to decay. For example, the radioactive element bismuth (Bi-210) can undergo alpha decay to form the element thallium (Tl-206) with a reaction half-life equal to five days. If we begin an experiment starting with 100 g of bismuth in a sealed lead container, after five days we will have 50 g of bismuth and 50 g of thallium in the jar. After another five days (ten from the starting point), one-half of the remaining bismuth will decay and we will be left with 25 g of bismuth and 75 g of thallium in the jar. As illustrated, the reaction proceeds in halves, with half of whatever is left of the radioactive element decaying every half-life period.



Radioactive Decay of Bismuth-210 ($T_{½}$ = 5 days)

The decay reaction and T½ of a substance are specific to the isotope of the element undergoing radioactive decay. For example, Bi-210 can undergo decay to Tl-206 with a T½ of five days. Bi-215, by comparison, undergoes b decay to Po-215 with a T½ of 7.6 minutes, and Bi-208 undergoes yet another mode of radioactive decay (called electron capture) with a T½ of

LESSON STRATEGIES:

Real World Context:
Radioactive isotopes are used in the health fields to monitor internal bodily functions or to kill cancerous tissue. Historical items may be placed in proper chronology using radioactive decay. A process called radioactive dating compares quantities of an isotope present in the item with the same isotopes present in a contemporary item. Half-life of drugs in the body can be used in forensic science. Examples of half-life: caffeine, 4.9 hours; aspirin, 0.25 hours; nicotine, 2.0 hours; Bromide ion, 168 hours.

Crossword Puzzle: Have students practice vocabulary.
http://www.docbrown.info/ks3chemistry/9Fxw1print.htm

Radioactive dose chart. Have students fill out a radioactive dose chart to see how nuclear chemistry is a part of their everyday life. Have students complete the chart located:
http://www.ans.org/pi/resources/dosechart/

Animation: Help students understand radiation with animation.
http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/radioa7.swf

	368,000 years! Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	Cooperative Learning Activity: Fission vs Fusion (see activity details below) Inquiry experiment #1: Radioactive Decay of Candium (see experiment details below) Inquiry experiment #2: Radioactive Isotope (see experiment details below)

RESOURCES:	VOCABULARY:
Daily Activities: • http://misterguch.brinkster.net/jan2003.pdf • http://chem.lapeer.org/Chem1Docs/HalflifeWorksheet.html • http://www.docbrown.info/ks3chemistry/9Fxw1print.htm • http://www.ans.org/pi/resources/dosechart/ • http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/radioa7.swf Cooperative Learning Activity: • http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/radioa7.swf Inquiry Experiment #1: • http://www.thesciencehouse.org/images/stories/learningactivities/ctc/expt27.pdf Inquiry Experiment #2: • http://chem.lapeer.org/Chem1Docs/Halflife/Halflife.html	ATOMIC MASS ATOMIC NUCLEUS ATOMIC NUMBER ATOMIC THEORY ATOMIC WEIGHT CHARGED OBJECT DECAY RATE ELECTRICALLY NEUTRAL ELECTRON ELECTRON CLOUD ELEMENTARY PARTICLE ION ISOTOPE NUCLEAR REACTION NEUTRON MASS TO ENERGY CONVERSION PROTON RADIOACTIVE DATING RADIOACTIVE DECAY RADIOACTIVE ISOTOPE RELATIVE MASS STABLE STRONG FORCE TRANSFORMING MATTER AND/OR ENERGY WEIGHT OF SUBATOMIC PARTICLES
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• How do nuclear reactions power our life?	Cooperative Learning Activity: Fission vs Fusion. Students get to understand the difference between fission and fusion in this activity. http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/radioa7.sw

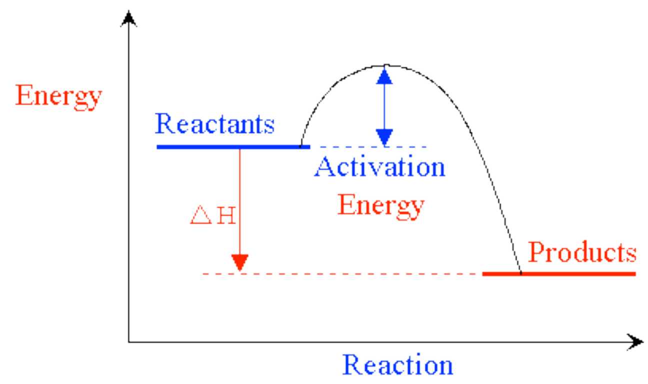
	f Inquiry Experiment #1: Radioactive Decay of Candium. This simulation provides a simple example of the rate at which a radioactive isotope decays. Students get to model radioactive decay with candy. For procedure details visit the link: http://www.thesciencehouse.org/images/stories/learningactivities/ctc/expt27.pdf Inquiry Experiment #2: Half-life of a Radioisotope. The purpose of this experiment is to determine the half-life of a radioisotope. Half-life is defined as the time it takes for one half of the atoms in a radioactive sample to decay. Data will be collected on the activity of a radioactive isotope vs. elapsed time. The half-life will then be determined by two different types of graphical analysis. http://chem.lapeer.org/Chem1Docs/Halflife/Halflife.html

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C3.1x**	**Standard:** For chemical reactions where the state and amounts of reactants and products are known, the amount of energy transferred will be the same regardless of the chemical pathway. This relationship is called Hess's law. **Unpacked Standard:** **C3.1a** Calculate the ΔH for a given reaction using Hess's Law. **C3.1b** Draw enthalpy diagrams for exothermic and endothermic reactions. **C3.1c** Calculate the ΔH for a chemical reaction using simple coffee cup calorimetry. **C3.1d** Calculate the amount of heat produced for a given mass of reactant from a balanced chemical equation. **Board Objective:** I can calculate the enthalpy of a given chemical reaction by using Hess's Law in order to predict if a reaction is endothermic or exothermic. I can illustrate endothermic and exothermic reactions by using a graphical representation in order to calculate the amount of heat produced for a given chemical reaction.		
NEXT GEN CODE: HS-PS3-1	**Next Gen Standard:** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. **ACT Alignment:** Interpretation of Data – Identify and/or use a complex mathematical relationship between data. Determine how the value of one variable changes as he value of another variable changes as the value of another variable changes in a complex data presentation.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to:	Many chemical reactions are difficult to carry out separately or	Practice: Have students practice daily

• Calculate enthalpy using Hess's Law • Graph endothermic and exothermic reactions Pre-assessment: • Chemical equations – give students a chemical equation and have them label reactants and products. • KWL – endothermic, exothermic, chemical reactions. During: • Daily Activities: guided and individual practice • Virtual Lab • Inquiry Experiment Post-assessment: • Unit Test	under standard lab conditions. Therefore, an indirect and alternate method for determining the enthalpy change (heat change) for a specific thermochemical reaction in question can be obtained using Hess's law of heat summation. This law states that the enthalpy change for an overall process may be obtained by adding the enthalpy changes involved in a set of given thermochemical reactions, whose ΔH's are known. For a given problem, the following steps should be followed: • Identify the thermochemical reaction whose ΔH is unknown and note the number of moles of reactants and products. • Manipulate the thermochemical equations, whose ΔH values are known, such that the moles of reactants and products are on the correct side. There are two ways in which these given equations may be manipulated. • Reverse the equation and change the sign of ΔH. • Multiply numbers of moles and ΔH by the same factor. • Add the manipulated equations to obtain the thermochemical reaction who's ΔH are desired. NOTE - all substances except those in the desired reaction must cancel. • Add the ΔH values to obtain the unknown ΔH. Students should be able to work with Hess's law problems where two thermochemical equations are given to formulate the ΔH for a third reaction. **Enthalpy Diagrams:** An enthalpy diagram may be used to illustrate the difference between the enthalpy of the reactants and products in any given chemical reaction. The enthalpy change of a reaction, aka heat of reaction, refers to the Hproducts (final) minus the Hreactants (initial). Enthalpy diagrams can be drawn to illustrate the difference between an exothermic and endothermic chemical reaction. Note in the diagrams below that the ΔH is positive for the endothermic reaction and is negative for the exothermic reaction. Students should be able to label the change in enthalpy (ΔH), reactants,	with some guided practice and individual practice. See links below: • http://mail.avon.k12.ct.us/~mburgess/FOV1-00028E08/FOV1-0002DA6D/Hess's%20Law%20Worksheet.pdf • http://www.nthurston.k12.wa.us/cms/lib/WA01001371/Centricity/Domain/589/Hess%20Law%20Problems.pdf • http://awesomeness.ca/highschool/bin/12%20Chemistry%20Handouts/SCH4U%20-%20PKG%203%20-%20Hess%20Law%20Worksheet.pdf • http://www.limestone.on.ca/~brennanb/FOV1-0012C55D/FOV1-00130733/Enthalpy%20worksheets%201%26%202.pdf • http://fileserver.net-texts.com/asset.aspx?dl=no&id=10122 • http://www.jensenchemistry.com/ib_chemistry/worksheets/ib_ch5_worksheet_answers.pdf Virtual Lab: Reactions and Rates (see lab details below) Inquiry Experiment: Heat of Reactions - Hess's Law (see experiment details below)

products and activation energy (Ea). The activation energy is the minimal amount of reactant collision energy that is required for the chemical reaction to occur.



Exothermic Enthalpy Diagram
This diagram illustrates an exothermic reaction because energy is released and the products possess less energy than the reactants. This gives a negative change in enthalpy and when the heat is released by the system, the released energy will be observed by temperature increasing.

RESOURCES:	VOCABULARY:
Daily Activities: • http://mail.avon.k12.ct.us/~mburgess/FOV1-00028E08/FOV1-0002DA6D/Hess's%20Law%20Worksheet.pdf • http://www.nthurston.k12.wa.us/cms/lib/WA01001371/Centricity/Domain/589/Hess%20Law%20Problems.pdf • http://awesomeness.ca/highschool/bin/12%20Chemistry%20Handouts/SCH4U%20-%20PKG%203%20-%20Hess%20Law%20Worksheet.pdf • http://www.limestone.on.ca/~brennanb/FOV1-0012C55D/FOV1-00130733/Enthalpy%20worksheets%201%26%202.pdf • http://fileserver.net-texts.com/asset.aspx?dl=no&id=10122 • http://www.jensenchemistry.com/ib_chemistry/worksheets/ib_ch5_worksheet_answers.pdf	ACTIVATION ENERGY DISORDER ENDOTHERMIC REACTION ENTHALPY EXOTHERMIC REACTION HESS'S LAW JOULE REACTION RATE SPONTANEOUS

Virtual Lab: • http://phet.colorado.edu/en/simulation/reactions-and-rates Inquiry Experiment: • http://www2.ucdsb.on.ca/tiss/stretton/chem2/enthlab2.htm	
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How do we measure the heat absorbed or released in a reaction?	Virtual lab: Reactions and Rates. Students explore what makes a reaction happen by colliding atoms and molecules. Design experiments with different reactions, concentrations, and temperatures. When are reactions reversible? What affects the rate of a reaction? Follow the link: http://phet.colorado.edu/en/simulation/reactions-and-rates Inquiry Experiment: Heat of Reactions – Hess's Law. In this experiment students investigate several chemical reactions. For full procedure details, visit the following link: http://www2.ucdsb.on.ca/tiss/stretton/chem2/enthlab2.htm

GRADE:	**SUBJECT: Science**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C3.2x**	**Standard:** Chemical reactions involve breaking bonds in reactants (endothermic) and forming new bonds in the products (exothermic). The enthalpy change for a chemical reaction will depend on the relative strengths of the bonds in the reactants and products.		
	Unpacked Standard: **C3.2a** Describe the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond making. **C3.2b** Describe the relative strength of single, double, and triple covalent bonds between nitrogen atoms.		
	Board Objective: I can describe the energy changes in a chemical reaction by estimating the relative strengths of the bonds in order to illustrate the process of common chemical reactions such as photosynthesis and the combustion of sugars.		
NEXT GEN CODE: HS-PS3-1	**Next Gen Standard:** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.		
	ACT Alignment: Scientific Investigation – Understand the methods and tools used in a simple experiment. Evaluation of Models, Inferences, and Experimental Results – Identify strengths and weaknesses in one or more models. Determine whether new information supports or weakens a model and why.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to:	Chemical compounds and chemical reactions strive toward	Photosynthesis Pre-assessment. Have

• Describe the energy changes in a chemical reaction • Estimate relative strength of bonds <u>Pre-assessment:</u> • Photosynthesis assessment <u>During:</u> • Demonstration • Daily activities: worksheets, illustrations, guided and individual practice • Reading Comprehension/Research • Virtual Lab <u>Post-assessment</u> • Unit Test	states of highest disorder as does everything in the universe. Bond formation releases energy to the system. A single covalent bond is formed when two atoms share a pair of electrons. Each atom provides one of the electrons of the pair. If the two atoms are alike in electronegativity, the bond is said to be nonpolar covalent. If the atoms differ in electronegativity, the more electronegative element exerts a greater attractive force on the electrons, and the bond is polar covalent. More than one pair of electrons may be shared. This results in a double or triple bond. The strength of chemical bonds can be measured by the changes in energy that occur during a chemical reaction. The three bond examples in increasing order of strength are: Single < double < triple. The availability of energy limits what can occur in any system.	students write a summary of Photosynthesis. Students should be able to recall what they learned in Biology and how photosynthesis powers autotrophs. In this standard, they will review photosynthesis using chemistry concepts and terminology. Demonstration: Bond Energy. Show students how bonds break and reform from this demonstration (see demo instructions below). Reading Comprehension: Have students read and annotate article entitled "Promising News for Solar Fuels from Berkeley Lab Researchers at JCAP". Article can be accessed through the following website: http://newscenter.lbl.gov/2014/03/07/promising-news-for-solar-fuels/#sthash.xVmMI9Hu.dpuf. Students should conduct further research. Have students write a 1 page paper to answer the question: Why artificial photosynthesis would provide efficient and green energy? Students should include chemistry concepts on energy storage through bonds breaking and bonds forming. Photosynthesis stores energy in high-energy bonds of sugars. Virtual Lab: Molecular Modeling (see activity details below)

RESOURCES:	VOCABULARY:
Daily Activities: • http://misterguch.brinkster.net/ioniccovalentworksheets.	BOND ENERGY CHEMICAL BOND

html • http://centralhighchem.com/ChemLevel2/2ndSemester/Entries/2008/4/8_Bonding,_Ionic_and_Covalent_files/wkbondL2_07.pdf Demonstration: • https://www.youtube.com/watch?v=zXYMZxcV18U Reading Comprehension: • http://newscenter.lbl.gov/2014/03/07/promising-news-for-solar-fuels/#sthash.xVmMI9Hu.dpuf Virtual Lab: • http://www.glencoe.com/sites/common_assets/science/virtual_labs/E02/E02.swf • http://genchem1.chem.okstate.edu/1314SP04/Laboratory/Experiment13.pdf	COMBUSTION COVALENT BONDS DOUBLE BOND ENDOTHERMIC EXOTHERMIC IONIC BONDS METALLIC BONDS SINGLE BOND TRIPLE BOND
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• How does bond energy affect the properties of a compound? • How does photosynthesis power life?	Demonstration: Bond Energy. Show students how bonds break and reform from this demonstration. A Hydrate is a substance that has water bonded to it. In order to dehydrate you must add energy (endothermic) to break the bond to water. When hydrating you are forming a bond to water and will release energy (exothermic). This visual demonstration reinforces the concept. https://www.youtube.com/watch?v=zXYMZxcV18U Virtual Lab: Molecular Modeling Lab. Students build molecules based on the chemical formula. For some molecules, there is more than one way to build a model. Some atoms have multiple bonds between the atoms. Students will use single, double, and triple bonds to construct models. • http://www.glencoe.com/sites/common_assets/science/virtual_labs/E02/E02.swf • http://genchem1.chem.okstate.edu/1314SP04/Laboratory/Experiment13.pdf

GRADE:	SUBJECT: Science	STRAND:	TRG Pacing Summary:

CODE: **C3.3**	**Standard:** Heating increases the kinetic (translational, rotational, and vibrational) energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic (translational) energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a sample of a crystalline solid increases the kinetic (vibrational) energy of the atoms, molecules, or ions. When the kinetic (vibrational) energy becomes great enough, the crystalline structure breaks down, and the solid melts.
	Unpacked Standard: **C3.3A** Describe how heat is conducted in a solid. **C3.3B** Describe melting on a molecular level.
	Board Objective: I can describe melting by illustrating how heat is conducted in a solid in order to understand the molecular energy of chemical compounds.
NEXT GEN CODE: HS-PS3-1 HS-PS3-4	**Next Gen Standard:** HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. 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 the components in the system (second law of thermodynamics).
	ACT Alignment: Interpretation of Data – Understand basic scientific terminology.

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Describe conduction • Describe melting at a molecular level <u>Pre-assessment:</u> • Have students illustrate conduction and melting at a molecular level <u>During:</u> • Daily Activities • Real world connections • Animations • Demonstration • Inquiry Experiment <u>Post-assessment:</u> • Unit Test	Particles in all matter are in constant motion until the temperature reaches absolute zero. Conduction: If you have ever left a silver spoon in very hot soup, you will notice that the whole spoon gets hot. Thermal energy is transferred from the hot end of the spoon through the entire length, its called conduction. Particles often collide with each other. When this happens, energy is transferred from the faster (hotter) moving particle to the slower (cooler) moving particle. This makes the slower moving particles increase in speed. When molecules in a substance are made to move faster, they get warmer. The warmer an object gets, the more kinetic energy and therefore, thermal energy it contains In solids (especially metals), electrons in atoms collide with each other inside the object being heated. • Good conductors of heat are metals with loose electrons – silver, copper, iron, etc.	Real World Context: • Hot liquids can make the handle of a metal spoon hot through conduction. • Cooking pans get hot because of conduction of heat. Daily Practice. Have students: • Draw diagrams and pictures to illustrate heat conduction. • Create models to demonstrate molecules in motion (translational, rotational, and vibrational). • Act out the motion and arrangement particles in a substance. Animation: Students learn about conduction from these animation:

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- Poor conductors are called insulators. These don't have loose electrons – wool, wood, paper, Styrofoam, etc.
- Air is a poor conductor of heat, so things with air spaces in them are sometimes used as insulators.

Melting on a Molecular Level: Melting involves the disruption of the crystal lattice of a solid via the absorption of kinetic energy by the molecules in the lattice from their surroundings. As the forces holding the lattice together increase in strength so does the melting point of the solid.

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- https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer--conduction--convection--radiation
- http://www.pbslearningmedia.org/asset/lsps07_int_heattransfer/

Animation: Students learn about melting at a molecular level:

- http://www.youtube.com/watch?v=CDTZoFGmZoc

Demonstration: Conduction (see demo details below)

Inquiry Experiment: Melting (see experiment details below)

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<tr>
<td colspan="2">RESOURCES:</td>
<td>VOCABULARY:</td>
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<td colspan="2">

Animations:

- http://www.youtube.com/watch?v=CDTZoFGmZoc
- https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer--conduction--convection--radiation
- http://www.pbslearningmedia.org/asset/lsps07_int_heattransfer/

Demonstration:

- http://www.uen.org/Lessonplan/preview.cgi?LPid=21567

Inquiry Experiment:

- http://www.atozteacherstuff.com/pages/5881.shtml

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CONDUCTION
KINETIC MOLECULAR MODEL
KELVIN TEMPERATURE
ORDER
ROTATIONAL MOTION
TRANSLATIONAL MOTION
VIBRATIONAL MOTION

</td>
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<tr>
<td colspan="2">ESSENTIAL QUESTIONS:</td>
<td>EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)</td>
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<tr>
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- How does the transfer of heat affect molecules?

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<td>Demonstration: Conduction. Teacher shows students how conduction works in</td>
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</table>

• How does melting occur?	this demonstration. See link for full details: http://www.uen.org/Lessonplan/preview.cgi?LPid=21567 Inquiry Experiment: Melting. Students Investigate melting at a molecular level. For procedure, click on the following link: http://www.atozteacherstuff.com/pages/5881.shtml

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C3.3x**	**Standard:** Chemical bonds possess potential (vibrational and rotational) energy. **Unpacked Standard:** **C3.3c** Explain why it is necessary for a molecule to absorb energy in order to break a chemical bond. **Board Objective:** I can explain why energy is needed to break a chemical bond by analyzing chemical reactions in order to illustrate the bond energy of different compounds.		
NEXT GEN CODE: HS-PS3-2	**Next Gen Standard:** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects). **ACT Alignment:** Scientific Investigation – Determine the experimental conditions that would produce specified results.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Explain why energy is needed to break a chemical bond Pre-assessment: • Review ionic and covalent bonds During: • Daily Activities: guided and individual practice • Animation • Demonstration • Inquiry Experiment Post-assessment: • Unit Test	There is a potential energy change when two atoms come together to form a bond. All the repulsive and attractive forces are balanced. At this point, the same amount of energy must be added (absorbed) to break the bond and create neutral molecules.	Animation: Ionic Bonding. Show students how ionic bonds are formed by absorbing energy in order to break bonds. Follow the link below: http://www.pbslearningmedia.org/resource/lsps07.sci.phys.matter.ionicbonding/ionic-bonding/ Demonstration: Bond Energies (see demo details below) Inquiry Experiment: Measuring Bond Energy of an Ionic Compound (see experiment details below)

RESOURCES:	VOCABULARY:

Animations: • http://www.pbslearningmedia.org/resource/lsps07.sci.phys.matter.ionicbonding/ionic-bonding/ Inquiry Experiment: • http://www.pbslearningmedia.org/resource/lsps07.sci.phys.matter.lpbondenergy/measuring-bond-energy-of-an-ionic-compound/	BOND ENERGY CHEMICAL BONDS POTENTIAL ENERGY ROTATIONAL ENERGY VIBRATIONAL ENERGY
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• What powers chemical reactions? • How does the structure of a compound relate to the amount of potential energy stored in a compound?	Demonstration: Bond Energies. Students observe two reactions in which bonds are formed and compare ionic and covalent bond energies. **Materials:** 10-15 cm piece of clean magnesium ribbon, a small piece of charcoal, tongs, Bunsen burner, filters for viewing. **Safety:** Goggles and lab apron **Procedure:** Using tongs, hold the piece of magnesium in a Bunsen burner. Do not look directly at flame. Observe through filters. Discuss with students the large amount of heat and light given off in the formation of MgO. Write the balanced equation on the board for magnesium plus oxygen yields magnesium oxide plus energy. Using tongs place a small piece of charcoal in the Bunsen burner flame and try to ignite it. Write the balanced chemical equation for carbon plus oxygen yields carbon dioxide and energy. **Expected Outcome:** Students note that much less energy is given off in forming CO_2 than in forming MgO Ask, **What kind of bond is MgO?(Ionic) What kind of bonds are in CO_2? (Covalent)** Ionic bond energies are, in general, greater that covalent bond energies due to the energy stored in the crystal lattice. Inquiry Experiment: Measuring Bond Energy of an Ionic Compound. Have students perform this experiment to understand bond energies. See the link for full procedure and experiment details: http://www.pbslearningmedia.org/resource/lsps07.sci.phys.matter.lpbondenergy/measuring-bond-energy-of-an-ionic-compound/

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE:	**Standard:** Chemical interactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).		
	Unpacked Standard:		

C3.4	**C3.4A** Use the terms endothermic and exothermic correctly to describe chemical reactions in the laboratory. **C3.4B** Explain why chemical reactions will either release or absorb energy.	
	Board Objective: I can describe the total energy output of a chemical reaction by using the proper terms (endothermic and exothermic) in order to properly classify chemical reactions.	
NEXT GEN CODE: HS-PS1-4 HS-PS3-5	**Next Gen Standard:** 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-PS3-5 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 the components in the system (second law of thermodynamics).	
	ACT Alignment: Interpretation of Data – Understand basic scientific terminology	

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Use the terms endothermic and exothermic to explain chemical reactions • Explain why chemical reactions will either release or absorb energy <u>Pre-assessment:</u> • Vocabulary Review • Have students explain a basic chemical reaction based on its chemical equation <u>During:</u> • Daily Activities: Guided and Independent Practice, Animation, and Demonstrations • Inquiry Experiment <u>Post-assessment:</u> • Unit Test	Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. Use the terms endothermic and exothermic to describe chemical reactions in which heat is transferred between the system and surroundings. Possible demos/reactions include zinc or magnesium with hydrochloric acid or steel wool with vinegar for exothermic. Endothermic reactions would be vinegar with baking soda or ammonium chloride with barium hydroxide. Reactions either release or absorb energy based on the net energy change of the bonds.	Demonstration: Examples: exothermic, steel wool plus vinegar; endothermic, vinegar plus sodium bicarbonate (see demo details below). Have students make a list of situations in a day that are encountered that could be improved if either heat was added or heat was absorbed. Suggest some ways that this might be done chemically. Animation: Students see what happens at a molecular level during a chemical reaction. It also gives the energy profile for endothermic and exothermic reactions. http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/activa2.swf Inquiry Experiment: Endothermic vs Exothermic Reactions (see experiment details below)

RESOURCES:	VOCABULARY:
Daily Activities: • http://www.learnnc.org/lp/media/uploads/2009/12/endot	ENDOTHERMIC REACTION EXOTHERMIC REACTION

hermic_exothermic_reactions.pdf • http://www.cfep.uci.edu/cspi/docs/lessons_secondary/Endo%20vs%20Exo%20Lab.pdf • http://www.docbrown.info/page03/3_51energy.htm Animation: • http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/activa2.swf Demonstrations: • http://www.nclark.net/Iron_Oxidation_Lab.pdf • http://www.nclark.net/MagicGenie.pdf Inquiry Experiment: • http://mypages.iit.edu/~smile/ch8623.html	PRODUCT REACTANT
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• What type of endothermic and exothermic reactions do you encounter in your everyday life?	Demonstration #1: Steel wool vs. Vinegar. This Lab can be used as a demonstration or a lab that students can complete. The purpose is to study heat energy of a chemical reaction. See below link for procedure details: http://www.nclark.net/Iron_Oxidation_Lab.pdf Demonstration #2: Magic Genie. This demonstration is sure to get your students attention. In this demonstration published by Flinn Scientific, you will create a "magic genie" or water vapor and oxygen. See link for procedure details: http://www.nclark.net/MagicGenie.pdf Inquiry Experiment: Endothermic vs Exothermic. See procedure Details Below: http://mypages.iit.edu/~smile/ch8623.html

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C3.4x**	**Standard:** All chemical reactions involve rearrangement of the atoms. In an exothermic reaction, the products have less energy than the reactants. There are two natural driving forces: (1) toward minimum energy (enthalpy) and (2) toward maximum disorder (entropy).		
	Unpacked Standard: **C3.4c** Write chemical equations including the heat term as a part of equation or using ΔH notation. **C3.4d** Draw enthalpy diagrams for reactants and products in endothermic and exothermic reactions.		

<table>
<tr><td rowspan="2"></td><td colspan="2">C3.4e Predict if a chemical reaction is spontaneous given the enthalpy (ΔH) and entropy (ΔS) changes for the reaction using Gibb's Free Energy, $\Delta G = \Delta H - T\Delta S$
C3.4f Explain why some endothermic reactions are spontaneous at room temperature.
C3.4g Explain why gases are less soluble in warm water than cold water.</td></tr>
<tr><td colspan="2">Board Objective:
I can illustrate the enthalpy of a reaction by drawing enthalpy graphs in order to better understand Hess's Law.
I can predict the spontaneity of a chemical reaction by calculating Gibb's free energy in order to understand how enthalpy and entropy affect chemical reactions.</td></tr>
<tr><td rowspan="2">NEXT GEN CODE:
HS-PS3-4</td><td colspan="2">Next Gen Standard:
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 the components in the system (second law of thermodynamics).</td></tr>
<tr><td colspan="2">ACT Alignment:
Interpretation of Data – Identify and/or use a complex mathematical relationship between data. Determine how the value of one variable changes as he value of another variable changes as the value of another variable changes in a complex data presentation.</td></tr>
<tr><th>ASSESSMENTS:</th><th>CONCEPT NOTES:</th><th>LESSON STRATEGIES:</th></tr>
<tr><td>Students should be able to:
Illustrate enthalpy of reactions
Calculate enthalpy, entropy, and Gibbs free energy
Predict the spontaneity of a chemical reaction
<u>Pre-assessment:</u>
Chemical equations – give students a chemical equation and have them label reactants and products.
KWL – endothermic, exothermic, chemical reactions.
<u>During:</u>
Daily activities – guided and individual practice
Cooperative Learning
Hands-on Activity
Inquiry Experiment</td><td>Spontaneous change – When reference is made to a change being spontaneous, the implication is that it occurs by itself under the given conditions, without an ongoing input of energy from outside the system. For a nonspontaneous change to occur, the system must be supplied with a continuous input of energy from the surrounding. Under a given set of conditions, if a change is spontaneous in one direction, it is nonspontaneous in the other. Also, the term spontaneous doesn't mean instantaneous and in fact, thermodynamic forces are independent of rate. Many spontaneous processes are slow such as ripening, rusting, and aging.

Chemists examine two thermodynamic forces when making predictions about whether a change will occur. Enthalpy – H – is basically the internal heat energy locked into the bonds of a structure. Entropy – S – is basically the randomness or disorder in a system. Typically reactions that have a ΔH that is negative (reduction in energy as the reaction proceeds from reactant to product) are spontaneous and a ΔS that is positive (increase in randomness/disorganization) are spontaneous.

Gibbs free energy – This constant is one criterion that combines the system's enthalpy and entropy to determine whether a reaction will be spontaneous at a particular</td><td>Daily Activities - Guided and Individual Practice. Students will need daily practice for reading enthalpy graphs, Gibbs free energy charts, and completing mathematical calculations of enthalpy, entropy, and Gibbs free energy (see resources for practice.

Cooperative Learning: Have students get in groups to write down real life chemical reactions and physical changes. Have the students make a table to label the ideas as either exothermic or endothermic and include whether ΔH would be positive or negative. Share the ideas as a whole and discuss if their assumptions where correct.

Hands-on Activity: Entropy and Rubber bands (see activity details below)

Inquiry Experiment: Gibbs Free Energy</td></tr>
</table>

Post-assessment:

- Unit Test

temperature. The sign of ΔG tells if a reaction is spontaneous.

If ΔG < o, the reaction is spontaneous as written,

ΔG >o, the reaction is nonspontaneous as written,

ΔG =o, the reaction is at equilibrium.

The table below provides a method for qualitatively determining whether a reaction will be spontaneous or not, when considering all the variables that play a role.

ΔH	ΔS	-TΔS	ΔG	**Description**
_	+	_	_	Spontaneous at all T
+	_	+	+	Nonspontaneous At all T
+	+	_	+ or _	Spontaneous at higher T; nonspontaneous at lower T
_	_	+	+ or _	Spontaneous at lower T; nonspontaneous at higher T

NOTE - One specific standard requires students to explain why some endothermic reactions (ΔH = +, typically non-spontaneous) are spontaneous at room temperature. This would best be explained by noting that the driving force for this reaction is an increase in entropy (ΔS = +; aka-randomness). It is also important to note that if addressing this concept qualitatively – the product of temperature and change in entropy must be larger than the change in enthalpy for such a reaction to occur spontaneously.

Connecting Entropy, Enthalpy and Gibbs Free Energy:
$\Delta G = \Delta H - T\Delta S$
Where G represents Gibbs Free Energy; T represents temperature in K; H represents enthalpy; and S represents entropy.

and Rubber bands (see experiment details below)

RESOURCES:	VOCABULARY:
Daily Activities:	ACTIVATION ENERGY

• http://www.msduncanchem.com/Unit_15/unit_15_ws.pdf • http://butane.chem.illinois.edu/cyerkes/104_S_2011/new%20worksheets/Worksheet-Entropy.pdf • https://teacher.ocps.net/patricia.sayers-o'neill/documents/AP%20notes%20worksheet/ThermodynamicsWorksheet.pdf • https://scilearn.sydney.edu.au/fychemistry/tutorial_assignments/chem1101/ws11.pdf • http://chem-faculty.lsu.edu/stanley/webpub/1422-Chapt-15-Thermodynamics.pdf • http://new.schoolnotes.com/files/podber/keyfreeenergy.pdf • http://ch301.cm.utexas.edu/pdfs/Entropy-and-Gibbs-Free-Energy-Wkst-KEY.pdf • http://myclass.peelschools.org/sec/12/35471/Lessons/03%20-%20Chemical%20Systems%20and%20Equilibrium/28%20-%20Gibbs%20Problems.pdf Inquiry Experiment: • http://highschoolenergy.acs.org/content/hsef/en/energy-theories/energy-entropy-rubber-band/_jcr_content/toparticleparsys/columnsbootstrap/column1/acscontainer/containerPar/download/file.res/Teacher's_Key.pdf	DISORDER ENDOTHERMIC REACTION ENTHALPY ENTROPY EQUILIBRIUM EXOTHERMIC REACTION GIBB'S FREE ENERGY HESS'S LAW REACTION RATE RELEASE OF ENERGY SOLUTE SPONTANEOUS
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• What conditions must be met for a chemical reaction to take place spontaneously? • How do we measure the total energy required for a chemical reaction? • How are Gibbs free energy and entropy related? • Why is it important to calculate entropy and enthalpy for chemical reactions?	Hands-on Activity: Entropy and the Rubber Band. Stretch a rubber band against your forehead or lips (note the relative temperature). Stretch the rubber band and hold it tight. Touch it back to your skin again (note the temperature change). Release the rubber band allowing it to return to its original shape. Touch it to your skin again (note the temperature change). Questions: 1) Is this process of stretching the rubber band exothermic or endothermic? 2) If there is no change in enthalpy because there is no reaction, what do you expect to be the order for the entropy (positive or negative)? 3) Is there more order or more disorder?

	4) What would account for the change in entropy? Inquiry Experiment: Gibbs Free Energy and the Rubber band. In this investigation, students work with a real-world item, a rubber band, to explore the concepts of Gibbs free energy, enthalpy, and entropy and their relation to the spontaneity of a physical process. To see full experiment details, visit the following link: http://highschoolenergy.acs.org/content/hsef/en/energy-theories/energy-entropy-rubber-band/_jcr_content/topparticleparsys/columnsbootstrap/column1/acscontainer/containerPar/download/file.res/Teacher's_Key.pdf

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C3.5x**	**Standard:** Nuclear reactions involve energy changes many times the magnitude of chemical changes. In chemical reactions matter is conserved, but in nuclear reactions a small loss in mass (mass defect) will account for the tremendous release of energy. The energy released in nuclear reactions can be calculated from the mass defect using $E = mc^2$.		
	Unpacked Standard: **C3.5a** Explain why matter is not conserved in nuclear reactions.		
	Board Objective: I can illustrate how elements can change in nuclear reactions by balancing nuclear equations in order to explain how matter is not conserved in nuclear reactions.		
NEXT GEN CODE: HS-PS3-3	**Next Gen Standard:** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.		
	ACT Alignment: Scientific Investigation – Predict the results of an additional trial or measurement in an experiment. Evaluation of Models, Inferences, and Experimental Results – Identify key issues or assumptions in a model. Interpretation of Data – Analyze given information when presented with new, simple information.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Illustrate the power that is released nuclear reactions Pre-assessment: • Differentiate between fusion and fission • Understand the parts of the atom	This standard should be taught with standard C2.5x. Calculations are not necessary here except to illustrate $E=mc^2$. The large amount of energy available from nuclear reactions (fission in nuclear reactors, or fusion in stars) comes from the mass defect in atoms. Mass defect is the difference between the sums of the mass of individual particles in an atom (neglecting the electrons) compared to the actual mass of the same atom from the periodic table. The actual mass is always	Real World Context: Radioactive isotopes are used in the health fields to monitor internal bodily functions or to kill cancerous tissue. The large amount of energy available from nuclear reactions (fission in nuclear reactors, or fusion in stars) comes from the mass defect in atoms. Mass defect is the difference between

During (when taught in with standard C2.5x) • Daily Activities – real world context, crossword puzzles, radioactive dose chart, animation, guided practice, and individual practice • Inquiry Experiment Post-assessment: Unit Test	larger than the experimental mass whenever the nucleus contains more than one particle. The difference in mass (mass defect) is converted into energy that holds the nucleus together and can be released in nuclear reactions. With nuclear reactions, the energies involved are so great that the changes in mass become easily measurable. One no longer can assume that mass and energy are conserved separately, but must take into account their interconversion via Einstein's relationship, E = mc. If mass is in grams and the velocity of light is expressed as c = 3 x 10 cm sec, then the energy is in units of g cm sec, or ergs. A useful conversion is from mass in amu to energy in million electron volts (MeV): 1 amu = 931.4 MeV What holds a nucleus together? If we attempt to bring two protons and two neutrons together to form a helium nucleus, we might reasonably expect the positively charged protons to repel one another violently. Then what keeps them together in the nucleus? The answer is that a helium atom is lighter than the sum of two protons, two neutrons, and two electrons. Some of the mass of the separated particles is converted into energy and dissipated when the nucleus is formed. Before the helium nucleus can be torn apart into its component particles, this dissipated energy must be restored and turned back into mass. Unless this energy is provided, the nucleus cannot be taken apart. This energy is termed the binding energy of the helium nucleus.	the sums of the mass of individual particles in an atom (neglecting the electrons) compared to the actual mass of the same atom from the periodic table. The actual mass is always larger than the experimental mass whenever the nucleus contains more than one particle. The difference in mass (mass defect) is converted into energy that holds the nucleus together and can be released in nuclear reactions. Inquiry Experiment: Penetrating Power (see experiment details below)

RESOURCES:	VOCABULARY:
Daily Activities: • http://misterguch.brinkster.net/jan2003.pdf • http://chem.lapeer.org/Chem1Docs/HalflifeWorksheet.html • http://www.docbrown.info/ks3chemistry/9Fxw1print.htm • http://www.ans.org/pi/resources/dosechart/ • http://www.mhhe.com/physsci/chemistry/essentialchemistry/flash/radioa7.swf Inquiry Experiment:	DECAY RATE ELEMENTARY PARTICLE ION ISOTOPE MATTER MASS DEFECT NUCLEAR REACTION PROTON RADIOACTIVE DATING RADIOACTIVE DECAY

• http://www2.lbl.gov/abc/experiments/Experiment4.html	RADIOACTIVE ISOTOPE RELATIVE MASS
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• How do nuclear reactions power our life?	Inquiry Experiment: Penetrating Power. Students experience the power that is released form nuclear reactions. For full procedure and activity, visit the following link: http://www2.lbl.gov/abc/experiments/Experiment4.html

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C4.1x**	**Standard:** Compounds have a fixed percent elemental composition. For a compound, the empirical formula can be calculated from the percent composition or the mass of each element. To determine the molecular formula from the empirical formula, the molar mass of the substance must also be known.		
	Unpacked Standard: 4.1A – Calculate the percent by weight of each element in a compound based on the compound formula. 4.1B – Calculate the empirical formula of a compound based on the percent by weight of each element in the compound. 4.1C – Use the empirical formula and molecular weight of a compound to determine the molecular formula.		
	Board Objective: I can compare and contrast between empirical and molecular formulas by calculating the formulas based on the percent weight of a compound in order to properly identify the chemicals.		
NEXT GEN CODE: HS-PS2-6	**Next Gen Standard:** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.		
	ACT Alignment: Evaluation of Models, Inferences, and Experimental Results – Identify similarities and differences between models.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students need to be able to: • Use a periodic table to identify individual elements in a chemical compound • Calculate percent weight of individual elements in a chemical compound • Calculate empirical formula based on percent weight of each element. • Calculate the molecular formula using the empirical formula and molecular weight	Chemical compounds always have the same formula and the same composition. Students will need a periodic table to calculate percent weight. Compounds should include two or three different elements. Examples of formulas in the real world are usually expressed in proportions of various compounds mixed together. Molecular formulas are whole number ratios of empirical formulas. Using the empirical and molecular formula of a chemical compound allows students to communicate scientific and technical information in multiple formats.	Students calculate formulas in the real world. An example is concrete which changes strength when the volume ratio of cement: sand: ravel is changed (1:2:4 is stronger than 1:3:6, a 1:1:2 mixture is used when concrete is used underwater.) Another example is steel which changes properties when the formula of percent carbon is changed (carbon steel, 1% carbon; cast iron, 4% carbon; cementite, 6.7% carbon). Individual Practice: Worksheets for calculations of percent weight,

• Compare and contrast between molecular and empirical formulas • Identify the chemical compound based on molecular formula <u>Pre-assessment:</u> • KWL • Vocabulary Assessment • Periodic Table Assessment (ensuring students know what information can be obtain from the PT) <u>During:</u> • Daily Assignments: Guided Practice, Exit Slips – Example: Calculate the percent weight of individual elements in glucose, $C_6H_{12}O_6$ and Individual Practice – worksheets (see resources below) • Cooperative Learning Activity • Inquiry Experiment <u>Post Assessment:</u> • Unit Test		empirical formulas, and molecular formulas to check for understanding before moving forward to cooperative learning and inquiry activity. Cooperative Learning: Use a laboratory balance to find masses and then calculate percent composition (See experiment details below). Inquiry experiment – Crime Scene Investigation (see experiment details below)

RESOURCES:	VOCABULARY:
Periodic Table Practice: • Periodic Table Game – http://www.funbrain.com/periodic/ • Online Periodic Table – www.ptable.com Guided & Individual Practice/Worksheets: • Percent Composition:	EMPIRICAL FORMULA HYDROCARBONS ISOMERS MOLECULAR FORMULA MOLECULAR WEIGHT ORGANIC MATTER PERCENT COMPOSITION/WEIGHT

http://misterguch.brinkster.net/PRA023.pdf • Empirical Formula: http://jsuniltutorial.weebly.com/uploads/7/8/7/0/7870542/empirical_and_molecular_formaul_practice_paper_with_solution.pdf • Molecular Formula: http://kurtniedenzu.cmswiki.wikispaces.net/file/view/Empirical+Formula+Worksheet+5.pdf	
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How is percent weight of a compound used in the real world? • Why do scientists use empirical formulas? • How do molecular formulas distinguish individual chemical compounds? • What are the similarities and differences between a chemical compound's empirical and molecular formula?	Cooperative Learning Activity: Make a compound out of common items such as marshmallows and jelly beans. Take the compound apart to find the mass of each component and determine the percent by weight of each component. Inquiry Experiment: Crime Scene Investigation – Create a crime scene in classroom. Separate students into groups of 2 "officers and hand students "investigation file" that you have created previously. This file will include crime scene report with pictures. The report includes 4 possible scenarios of who committed the crime: Scenarios: 1. An unlabeled drug bottle was found in the medicine cabinet of DeMoy's bathroom. A 532.99 g sample of the drug was analyzed and found to contain 346.12 g C, 23.98 g H, 108.52 g O, and 54.36 g S. The molar mass of the compound was found to be 314.38 g/mol. It may be a drug prescribed for osteoarthritis. Coincidentally, DeMoy's arthritis has become so intolerable within recent weeks that he's had to rely on the aid of a crutch for mobility. Prolonged ingestion of this drug is thought to lead to heart attack. DeMoy's doctor, Finley Finch has a quiet reputation of prescribing dangerous drugs to "dispose of" unwanted patients. Lately, DeMoy has been gaining more recognition in the community due to his latest research on aromatic hydrocarbons. Could Finch's jealousy be the cause of Tony DeMoy's death? 2. Several of DeMoy's full or partial fingerprints were retrieved from a tipped cup found near the crime scene. A faint almond scent was detected around the rim. A 823.15 g liquid sample of the compound was found to contain 3.74% H, 44.43% C, and 51.83% N. The molar

	mass was determined to be ~27.03 g/mol. A friend of DeMoy's noticed a disgruntled neighbor, Shay Lemarck, uncharacteristically eager to provide refills. Could this be the answer? 3. DeMoy's wife mentioned that the osteoarthritis had become so debilitating as of late that he was "popping painkillers like candy". Certain painkillers are even more dangerous in large quantities than others. One indication that this may be the cause of death was a partially full acetaminophen bottle found on the scene. Chemical analysis of one pill (1454.10 g) revealed 924.08 g C, 87.39 g H, 134.80 g N, and 307.83 g O. The molar mass of the drug is known to be 151.18 g/mol. Could it be that the crime scene is not a crime scene at all? 4. DeMoy's latest and most brilliant research was on a specific type of aromatic hydrocarbon. DeMoy, being a paranoid individual, wouldn't specify which one, but a 453.28 g sample was shown to contain only carbon and hydrogen. Hydrogen contributed 7.76 % of the total mass and the molar mass was determined to be approximately 78.12 g/mol. The laboratory had a carefully regulated air flow to prevent high-level inhalation. DeMoy periodically mentioned to his wife that he suspected his lab partner, Kasey Hatterson, was altering the flow rates. Curiously, without DeMoy, the published research could mean thousands of dollars for Hatterson. With money as motive, could this solve the mystery? Students must calculate the empirical and molecular formula for each scenario and then access the autopsy report to see who the criminal master mind was. Teacher picks the scenario for the winning outcome.

GRADE: 10^{th}	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE:	**Standard:** All compounds have unique names that are determined systematically.		
C4.2	**Unpacked Standard:** **C4.2A** Name simple binary compounds using their formulae. **C4.2B** Given the name, write the formula of simple binary compounds.		

Board Objective:
I can identify the name of a binary compound by using the rules of nomenclature in order to understand the compounds involved in chemical reactions.

NEXT GEN CODE:
HS-PS2-6

Next Gen Standard:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials

ACT Alignment:
Interpretation of Data – Understand basic scientific terminology

ASSESSMENTS:

Students should be able to:

- Name binary compounds based on rules of nomenclature
- Identify chemical formulas based on the names of the compound

Pre-assessment:

- KWL
- Vocabulary Assessment
- Periodic Table Assessment (ensuring students know what information can be obtain from the PT)

During:

- Daily Assignments: Guided Practice, Exit slips, word search, and Individual Practice
- Cooperative Learning Activity
- Inquiry Experiment

Post Assessment:
Unit Test

CONCEPT NOTES:

Binary Molecular Compounds
Usually consists of 2 nonmetals. Names use prefixes to indicate subscripts. Names still use –ide endings
1=mono 2=di 3=tri 4=tetra 5=penta etc.

Ex. CO = carbon monoxide
N_2O_4 = dinitrogen tetraoxide
PCl_3 = phosphorus trichloride
SCl_6 = sulfur hexachloride
N_2O_3 = dinitrogen trioxide

LESSON STRATEGIES:

Real world connections: Formula nomenclature is helpful when chemical formulas and/or chemical compounds are mentioned in news reports or in medical information. Have students determine the compounds on an MSDS sheet or those listed on common household items: laundry detergent, dish soap, furniture polish, etc.

Chemical Compounds Word search: http://www.world-english.org/wordsearchchemistry.htm

Cooperative Learning Activity: Sweet 16 Chemistry Compound Tournament (see activity details below)

Inquiry Experiment: Naming Covalent Compounds (see experiment details below)

RESOURCES:

Daily Activities:

- http://www.world-english.org/wordsearchchemistry.htm
- http://www.chymist.com/Formulas.pdf
- http://www.nclark.net/Compounds – many, many

VOCABULARY:

BINARY
CHEMICAL FORMULA
ISOMERS
MOLECULAR FORMULA

downloadable activities and labs • http://misterguch.brinkster.net/ioniccovalentworksheets.html Cooperative Learning Activity: • http://www.nclark.net/ChemistryCompoundTournament.pdf	
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• What type of chemicals do you use in everyday life?	Cooperative Learning Activity: Sweet 16 Chemistry Compound Tournament. Break students into teams. Each team must complete the brackets. The team that completes the bracket in the fast amount of time wins. Bracket and activity instructions can be found at http://www.nclark.net/ChemistryCompoundTournament.pdf Inquiry Experiment: Naming Covalent Compounds. Teacher sets up clear vials with tops with a few grams of solid. The vial is labeled EITHER with the name OR the formula. The students are to determine the missing piece. Teachers can set up as many or as few sets as they wish and choose which ever compounds they have available. Suggestion: use a variety of colored compounds and compounds with different crystal size. If you are worried about students opening the vials, then place 2 or 3 in a Ziploc bag.

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C4.2x**	**Standard:** All molecular and ionic compounds have unique names that are determined systematically.		
	Unpacked Standard: **C4.2c** Given a formula, name the compound. **C4.2d** Given the name, write the formula of ionic and molecular compounds. **C4.2e** Given the formula for a simple hydrocarbon, draw and name the isomers.		
	Board Objective: I can identify the name of ionic and molecular compounds by using the rules of nomenclature in order to understand the compounds involved in chemical reactions.		
NEXT GEN CODE: HS-PS2-6	**Next Gen Standard:** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials		
	ACT Alignment: Interpretation of Data – Understand basic scientific terminology		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to:	**Nomenclature/Chemical Bonds:**	Real world connections: Formula

<table>
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<td>

Name ionic compounds based on rules of nomenclature
Identify chemical formulas based on the names of the compound

<u>Pre-assessment:</u>

KWL
Vocabulary Assessment
Periodic Table Assessment (ensuring students know what information can be obtain from the PT)

<u>During:</u>

Daily Assignments: Guided Practice, Exit slips, word search, and Individual Practice
Cooperative Learning Activity
Inquiry Experiment

<u>Post Assessment:</u>
Unit Test
</td>
<td>
Nomenclature involves the naming and formula writing for molecular and ionic compounds. Molecular compounds are limited to two nonmetals using the first 20 elements. Ionic compounds are limited to the first 20 elements plus copper, iron, lead, and mercury and common ions. Common ions are limited to: acetate, hydroxide, sulfate, sulfite, nitrate, nitrite, carbonate, and ammonium. See examples below:

<u>Ionic Compounds</u>
<u>Type 1</u>
Name the metal, then name the nonmetal-but change ending to ide
Ex. $NaCl$ sodium chloride
AlF_3 aluminum fluoride
<u>Type 2</u>
Name the metal, and then name the polyatomic ion
Ex. $NaNO_3$ sodium nitrate
$Li_3(PO_4)$ lithium phosphate
<u>Type 3</u>
Transition metals must include charge as a Roman numeral. This is the stock system.
Ex. Fe_2O_3 iron (III) oxide
$CuCl$ copper (I) chloride
$CuCl_2$ copper (II) chloride

Writing Formulas – Ionic Compounds
Steps:
1) Write symbols for each ion.
2) Determine charge of each ion.
3) Add more of either ion, as needed in order to get a neutral charge on the compound.
4) Put parentheses around polyatomic ions.
5) Subscripts indicate the number of each ion used.

EX: calcium iodide
Ca I Ca^{+2} I^{-1} CaI_2
EX: aluminum sulfate
Al SO_4 Al^{+3} SO_4^{-2} $Al_2(SO_4)_3$
</td>
<td>
nomenclature is helpful when chemical formulas and/or chemical compounds are mentioned in news reports or in medical information. Have students determine the compounds on an MSDS sheet or those listed on common household items: laundry detergent, dish soap, furniture polish, etc.

Cooperative Learning Activity: Sweet 16 Chemistry Ionic Compound Tournament (see activity details below)

Inquiry Experiment: Naming Ionic Compounds (see experiment details below)
</td>
</tr>
</table>

RESOURCES:	VOCABULARY:
Daily Activities: • http://www.chymist.com/Formulas.pdf • http://www.nclark.net/Compounds – many, many downloadable activities and labs • http://misterguch.brinkster.net/ioniccovalentworksheets.html Cooperative Learning Activity: • HTTP://WWW.NCLARK.NET/SWEET_SIXTEEN_IONS.PDF	EMPIRICAL FORMULA HYDROCARBONS IONIC COMPOUNDS ISOMERS MOLECULAR FORMULA
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• What type of chemicals do you use in everyday life?	Cooperative Learning Activity: Sweet 16 Chemistry Ionic Compound Tournament. Break students into teams. Each team must complete the brackets. The team that completes the bracket in the fast amount of time wins. Bracket and activity instructions can be found at http://www.nclark.net/Sweet_Sixteen_Ions.pdf Inquiry Activity: Naming ionic Compounds. Teacher sets up clear vials with tops with a few grams of solid. The vial is labeled EITHER with the name OR the formula. The students are to determine the missing piece. Teachers can set up as many or as few sets as they wish and choose which ever compounds they have available. Suggestion: use a variety of colored compounds and compounds with different crystal size. If you are worried about students opening the vials, then place 2 or 3 in a Ziploc bag.

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.3**	**Standard:** Differences in the physical and chemical properties of substances are explained by the arrangement of the atoms, ions, or molecules of the substances and by the strength of the forces of attraction between the atoms, ions, or molecules.		
	Unpacked Standard: **C4.3A** Recognize that substances that are solid at room temperature have stronger attractive forces than liquids at room temperature, which have stronger attractive forces than gases at room temperature. **C4.3B** Recognize that solids have a more ordered, regular arrangement of their particles than liquids and that liquids are more ordered than gases.		

<table>
<tr><td></td><td colspan="2">Board Objective:
I can recognize the properties of solids and liquids by describing the forces between atoms in the substance in order to explain the difference in movement of atoms in solids, liquids, and gases.</td></tr>
<tr><td rowspan="2">NEXT GEN CODE:
HS-PS2-6</td><td colspan="2">Next Gen Standard:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials</td></tr>
<tr><td colspan="2">ACT Alignment:
Evaluation of Models, Inferences, and Experimental Results – Select a simple hypothesis, prediction or conclusion that is supported by two or more data presentations or models.</td></tr>
<tr><td>ASSESSMENTS:</td><td>CONCEPT NOTES:</td><td>LESSON STRATEGIES:</td></tr>
<tr><td>Students should be able to:
• Recognize properties of solids, liquids, and gases based on the molecular movement

<u>Pre-assessment:</u>
• Vocabulary Assessment

<u>During:</u>
• Daily activities
• Animation
• Flipbook activity
• Inquiry Experiment

<u>Post-Assessment:</u>
• Unit Test</td><td>Solids are more orderly because of the strong intermolecular forces (forces between molecules) of attractive between molecules. As temperature rises, the intermolecular forces begin to weaken as individual molecules begin to move around. When a solid melts into a liquid, energy is absorbed and breaks some of the intermolecular forces among the individual molecules. This allows liquids to maintain some order while creating freer movement. As temperature is further increased, more intermolecular forces break. Therefore, when a liquid evaporates into a gas, all of intermolecular forces are broken and the individual gas molecules are free to move around. There are no intermolecular forces in gases and this is the reason why gases are so disordered.</td><td>Daily activities – have students:
• Create models to demonstrate molecules in motion
• Act out the motion and arrangement particles in a substance.
• Create models that show changes in disorder for the following conditions: water at -5 ^{o}C, water at room temperature, water at 75 ^{o}C, and above 100 ^{o}C. For example, create flipbooks to show the motion of particles in a solid, liquid, or a gas.

Animation:
http://www.chem.purdue.edu/gchelp/liquids/character.html

Flipbook activity: Have students create a flipbook to illustrate the movement of molecules in a substance as temperature increases. The book should show transition states where the substance exists as in 2 states at once.

Inquiry Experiment: Evaporation and Intermolecular Forces (see experiment details below)</td></tr>
</table>

RESOURCES:	VOCABULARY:
Content Information: • http://www.chem4kids.com/files/matter_intro.html Animation: • http://www.chem.purdue.edu/gchelp/liquids/character.html Inquiry Experiment: • http://dwb4.unl.edu/chem/chem869e/chem869emats/cwcbl09.pdf	STATES OF MATTER SOLID LIQUID GAS ORDER INTERMOLECULAR FORCES DIPOLE-DIPOLE FORCE LONDON DISPERSION FORCE HYDROGEN BONDING
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• How are solids, liquids, and gases different? How are they similar?	Inquiry experiment: Evaporation and Intermolecular forces. For full procedure see the following link: http://dwb4.unl.edu/chem/chem869e/chem869emats/cwcbl09.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.3x**	**Standard:** Solids can be classified as metallic, ionic, covalent, or network covalent. These different types of solids have different properties that depend on the particles and forces found in the solid.		
	Unpacked Standard: **C4.3c** Compare the relative strengths of forces between molecules based on the melting point and boiling point of the substances. **C4.3d** Compare the strength of the forces of attraction between molecules of different elements. (For example, at room temperature, chlorine is a gas and iodine is a solid.) **C4.3e** Predict whether the forces of attraction in a solid are primarily metallic, covalent, network covalent, or ionic based upon the elements' location on the periodic table. **C4.3f** Identify the elements necessary for hydrogen bonding (N, O, F). **C4.3g** Given the structural formula of a compound, indicate all the intermolecular forces present (dispersion, dipolar, hydrogen bonding). **C4.3h** Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid's structure and bonding. **C4.3i** Explain why ionic solids have higher melting points than covalent solids. (For example, NaF has a melting point of 995°C while water has a melting point of 0° C.)		
	Board Objective: I can predict the relative strength and type of intermolecular forces of a chemical compound by evaluating the melting points and boiling points of substances in order to understand the properties of the compound. I can compare and contrast the intermolecular forces (dipole-dipole forces, London dispersion forces, and hydrogen bonding) by illustrating the bonds present in the chemical compound in order to evaluate the properties of the compound. I can predict the type of attractive forces in a solid by using the element's location on the periodic table in order to understand the properties of		

	the compound. I can explain properties of various solids by illustrating the solid's structure and bonding in order to evaluate the energy level of the compound.
NEXT GEN CODE: HS-PS2-6	**Next Gen Standard:** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials
	ACT Alignment: Scientific Investigation – Determine experimental conditions that would produce specified results Evaluation of Models, Inferences, and Experimental Results – Use new information to make a prediction based on a model.

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Compare the strength of forces of attraction between molecules • Predict the forces of attraction in a solid • Identify and explain intermolecular forces • Explain properties of solids <u>Pre-assessment:</u> • Have students illustrate the molecular structure of solids, liquids, and gases. • Vocabulary assessment: intermolecular forces, intramolecular forces <u>During:</u> • Daily activities: guided and individual practice • Real world application • Research • Inquiry Experiment • Cooperative Learning Activity <u>Post-Assessment:</u> • Unit Test	Many physical properties of substances can be determined by knowing the type of bond structure that exists within the substance. Forces that exist between atoms can be classified into specific categories. Within chemical compounds, intermolecular forces as well as intramolecular forces determine the properties of the chemical compound. In addition, the strength of intermolecular forces determines the melting and boiling points of compounds as well as the molecular structure of the compound. Students can determine the strength of the intermolecular forces of compounds based on the melting points and boiling points. The higher the melting an boiling points of a compound, the stronger the intermolecular forces. Also, strength of intermolecular forces are ranked as: London Dispersion < Dipole-Dipole < Hydrogen Bonding **Strong Forces:** Ionic bonding, metallic bonding, and network-covalent bonding. Strong intermolecular forces result in room temperature solids with high melting and boiling points. **Weak Forces:** Hydrogen bonding, dipole-dipole interactions, London dispersion forces. Hydrogen bonding is the unusually strong dipole-dipole interaction that occurs when a highly electronegative atom (N, O, or F) is bonded to a hydrogen atom. This bond nearly strips the hydrogen atom of its electrons leaving, essentially, a naked proton. This proton is highly attracted to the electron pairs on nearby molecules. Hydrogen bonding is significantly stronger than the dipole-dipole interactions which are in turn stronger than London	Real world connections: • Water drops that form on plant blossoms from the early morning's dew are based on strong attractive forces between the highly polar water molecules. • Water striders are able to stay on top of the water, rather than sink, because of the water tension or attractive forces of the water molecules for one another. • In addition, life is supported by intermolecular forces. Hydrogen bonding is present in DNA. Without hydrogen bonding, DNA would not have the structure or strength that it has presently. Daily activities: Guided and Independent practice (see resources for guided and independent practice ideas). Research: Have students research the following materials which are both ionic compounds and used in over-the-counter drugs: magnesium hydroxide and magnesium sulfate. What are they

	dispersion forces. Hydrogen bonding exists only in molecules with an N-H, O-H, or F-H bond. Dipole-dipole interaction is the attraction between a partially negative portion of one molecule and a partially positive portion of a nearby molecule. Dipole-dipole interaction occurs in any polar molecule as determined by molecular geometry. London dispersion forces result from instantaneous non-permanent dipoles created by random electron motion. London dispersion forces are present in all molecules and are directly proportional to molecular size. **Effects of Intermolecular Forces:** The strength of intermolecular forces present in a substance is related to the boiling point and melting point of the substance. Stronger intermolecular forces cause higher melting and boiling points. EXAMPLES: CH_4 – Methane: has an only very weak London dispersion force (lowest b.p. & m.p.) $CHCl_3$ – Chloroform: has dipole-dipole interaction (moderate b.p. & m.p.) NH_3 – Ammonia: has hydrogen bonding and dipole-dipole interaction (high b.p. & m.p.)	used in and what purpose(s) do they serve. Have students evaluate their findings and make a presentation of the results. Check-In: Have students place the following compounds in increased order of melting point: potassium chloride, paraffin and ice. Have students explain your ordering system using what they know about bonding structure. Inquiry Experiment: Polymer Activity (see experiment details below) Cooperative Learning Activity: Investigating Intermolecular Forces (see activity details below)

RESOURCES:	VOCABULARY:
Daily Activities: • http://butane.chem.uiuc.edu/anicely/chem102Dfa10/Worksheets/Worksheet15_IMF_Key.pdf • http://woodridge.k12.oh.us/ourpages/users/dweaver/Chemistry/PracticeWorksheets/CandMMWorksheets/IMF2Worksheet.pdf • http://www.foothill.edu/psme/larson/1B_assets/Chapter%2011%20Quiz.pdf • http://web.gccaz.edu/~jaszi38221/2014/Summer/CHM%20151%20Practice%20Worksheets/Ch%2010%20Practice%20Spring%202010%20KEY.pdf • http://apchemistrynmsi.wikispaces.com/file/view/10+IMFs,Solids+%26+Liquids.pdf • http://www.hasdpa.net/cms/lib7/PA01001337/Centricity/D	CHEMICAL BOND DIPOLE-DIPOLE BOND DISPERSION FORCES HYDROGEN BONDING ION IONIC SOLID MELTING POINT METAL NETWORK SOLID STATES OF MATTER TEMPORARY DIPOLE

omain/169/Chapter%2010/Forces%20of%20Attraction,%20Phase%20Change,%20and%20Solids%20Worksheet%20Answer%20Key%2011-12.pdf • http://digitalcommons.trinity.edu/cgi/viewcontent.cgi?article=1092&context=educ_understandings Inquiry Experiment: • http://jbjones.iweb.bsu.edu/portfolio/resources/Artifacts-&-Rationales/PolymerInquiryActivityIntermolecularForces.pdf Cooperative Learning Activity: • http://spot.pcc.edu/~tjenkins/chem105/labs/105.W10/Lab%202%20Intermolecular%20Forces%20W10.pdf	
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• If hydrogen bonding did not exist, especially with oxygen, what changes would exist on earth? • How do the forces of attraction between and within molecules (intermolecular and intramolecular forces) affect the physical and chemical properties of substances?	Inquiry Experiment: Polymer Activity. Students will observe the effects of changing intermolecular forces on the properties of a Substance. For full procedure and handout, click on the following link: http://jbjones.iweb.bsu.edu/portfolio/resources/Artifacts-&-Rationales/PolymerInquiryActivityIntermolecularForces.pdf Cooperative Learning Activity: Investigating Intermolecular Forces. In this activity, students examine the attractive forces that hold molecules together and the disruptive forces that break them apart. For full activity instructions and handouts, visit the following site: http://spot.pcc.edu/~tjenkins/chem105/labs/105.W10/Lab%202%20Intermolecular%20Forces%20W10.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.4x**	**Standard:** The forces between molecules depend on the net polarity of the molecule as determined by shape of the molecule and the polarity of the bonds.		
	Unpacked Standard: **C4.4a** Explain why at room temperature different compounds can exist in different phases. **C4.4b** Identify if a molecule is polar or nonpolar given a structural formula for the compound.		
	Board Objective: I can compare and contrast different compounds by identifying the bonding strength of the atoms within the compounds in order to determine		

<table>
<tr><td></td><td>the phase of matter at a specific temperature.
I can identify forces in compounds by illustrating its structural formula in order to explain why different substances exist in different phases.
I can identify if a molecule is polar or nonpolar by illustrating the structural formula for the compound in order to predict the substance's physical and chemical properties.</td></tr>
<tr><td rowspan="2">NEXT GEN CODE:
HS-PS2-6</td><td>Next Gen Standard:
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials</td></tr>
<tr><td>ACT Alignment:
Evaluation of Models, Inferences, and Experimental Results – Determine whether given information supports or contradicts a complex hypothesis or conclusion and why</td></tr>
</table>

<table>
<tr><th>ASSESSMENTS:</th><th>CONCEPT NOTES:</th><th>LESSON STRATEGIES:</th></tr>
<tr>
<td>Students should be able to:
• Identify forces in compounds – both intermolecular and intramolecular
• Identify polar and nonpolar compounds

<u>Pre-assessment:</u>
• Have students draw Lewis structures for common compounds such as NaCl, CO_2 and C_3H_8. Have students identify the intramolecular forces (covalent bonds or ionic bonds) that keep the compound together
• Have students list all intermolecular forces and rate them from strongest to weakest: London Dispersion<Dipole-Dipole<Hydrogen Bonding

<u>During:</u>
• Hands-on Activity
• Research Project
• Cooperative Learning Activity

<u>Post-assessment:</u></td>
<td>Chemical bonds form either by the attraction of a positive nucleus and negative electrons or the attraction between a positive ion and a negative ion.

The strength of chemical bonds can be measured by the changes in energy that occur during a chemical reaction.

The polarity of a molecule is based on two ideas. One is the bonding itself, whether it is polar or nonpolar. The second part is the geometry or shape of the molecule and whether or not the polar bonds cancel out. Symmetric molecules are always nonpolar. Polar molecules will align themselves a set way within an electric field because they have a greater electron density on one side then another. CH_2Cl_2 is polar molecule whereas CCl_4 is nonpolar molecule. They both have the same geometry but one is symmetrical and the polar bonds cancel out.

Strong Forces: Ionic bonding, metallic bonding, and network-covalent bonding. Strong intermolecular forces result in room temperature solids with high melting and boiling points.

Weak Forces: Hydrogen bonding, dipole-dipole interactions, London dispersion forces.</td>
<td>Hands-on Activity: Structural formulas of simple hydrocarbon can be drawn along with any isomers that exist. Build models (using marshmallows and toothpicks) and draw structural representations for the following substances:
HCN, O_2, CO_2, $CHCl_3$, PH_3, and H_2S. (If isomers also exist, construct them as well.) After the model is built, then pretend to place it in an electric field and decide if the molecule will be polar or nonpolar. Identify the bonds in the molecule as being polar or nonpolar covalent.

Research Project: Access the internet and learn how a microwave oven works. Predict what would happen in the following cases and justify your answers.
a) Would the microwaves have the same effect on a piece of ice as it has on liquid water?
b) If a sample of liquid carbon dioxide is placed in a microwave oven, would it heat the sample like it would a sample of liquid water?</td>
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• Unit Test		Cooperative Learning Activity: Polarity Stations (see activity details below)

RESOURCES:	VOCABULARY:
Cooperative Learning Activity: • http://www.oakland.k12.mi.us/Portals/0/Learning/bonding.pdf	BOND ENERGY CHARGED OBJECT CHEMICAL BOND ELECTRON ELECTRON SHARING ELECTRON TRANSFER INTRAMOLECULAR FORCE ION ISOMERS MOVING ELECTRIC CHARGE POLARITY
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How do intermolecular and intramolecular forces in a compound affect the properties? • How can different compounds exist in different phases at room temperature?	Cooperative Learning Activity: Polarity Stations. Students will explore the difference between polar and Non-polar compounds. See Activity #5 at http://www.oakland.k12.mi.us/Portals/0/Learning/bonding.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.5x**	**Standard:** The forces in gases are explained by the ideal gas law. **Unpacked Standard:** **C4.5a** Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-volume relationship in gases. **C4.5b** Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-temperature relationship in gases. **C4.5c** Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the temperature-volume relationship in gases. **Board Objective:** I can compare and contrast pressure, volume, and temperature relationships of a gas by using the gas laws in order to explain the properties of a gas.		
NEXT GEN CODE: HS-PS3-2	**Next Gen Standard:** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects). **ACT Alignment:** Scientific Investigation – Determine how the value of one variable changes as the value of another variable changes in a complex data		

	presentation. Interpretation of Data – Identify and/or use a simple mathematical relationship between data. Evaluation of Models, Inferences, and Experimental Results – Identify key issues or assumptions in a model.

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Verbally, mathematically, and graphically explain the gas laws • Describe the kinetic molecular theory <u>Pre-assessment:</u> • KWL • Vocabulary Assessment <u>During:</u> • Daily Activities: real world connections/research activity, math skills practice, demonstration, videos, individual and guided practice • Inquiry Experiment • Virtual Lab <u>Post-assessment</u> • Unit Test	**Kinetic Theory**: all matter consists of tiny particles that are in constant motion **Kinetic Theory Assumptions (characteristics of an Ideal Gas):** These statements are made only for what is called an ideal gas. They cannot all be rigorously applied (i.e. mathematically) to real gases, but can be used to explain their observed behavior qualitatively. 1. All matter is composed of tiny, discrete particles (molecules or atoms). 2. Ideal gases consist of small particles (molecules or atoms) that are far apart in comparison to their own size. The molecules of a gas are very small compared to the distances between them. 3. These particles are considered to be dimensionless points which occupy zero volume. The volume of real gas molecules is assumed to be negligible for most purposes. This above statement is NOT TRUE. Real gas molecules do occupy volume and it does have an impact on the behavior of the gas. This impact WILL BE IGNORED when discussing ideal gases. 4. These particles are in rapid, random, constant straight line motion. This motion can be described by well-defined and established laws of motion. 5. There are no attractive forces between gas molecules or between molecules and the sides of the container with which they collide. In a real gas, there actually is attraction between the molecules of a gas. Once again, this attraction WILL BE IGNORED when discussing ideal gases. 6. Molecules collide with one another and the sides of the	Real World Connections: • Air pressure in automobile tires increases while driving due to friction within the tire and friction between the road and the tire. Recommended tire pressure is based on cold pressure (before driving). • Weather balloons are never filled to capacity because they continue to inflate as they rise due to changes in the air pressure. • Pressure relief values are used on hot water boilers and in pressure cookers as safety devices. Regulators are used in SCUBA diving to match water pressure with the air pressure going into the lungs. Research: Investigate a hobby, sport, or activity that involves changes in gas pressure, volume, or temperature. (Some Possible choices are hot air ballooning, SCUBA diving, mountain climbing.) Report your results by writing a paper, making a poster presentation or small group presentation. Demonstration: To give students good visuals of gas laws and gas properties, you can conduct a multitude of

	container. 7. Energy can be transferred in collisions among molecules. 8. Energy is conserved in these collisions, although one molecule may gain energy at the expense of the other. 9. Energy is distributed among the molecules in a particular fashion known as the Maxwell-Boltzmann Distribution. 10. At any particular instant, the molecules in a given sample of gas do not all possess the same amount of energy. The average kinetic energy of all the molecules is proportional to the absolute temperature. **Boyle's Law:** If temperature and amount of gas is constant, as the volume of a gases container decreases, the pressure of the gas increases (inverse): $P_1 \times V_1 = P_2 \times V_2$ **Charles' Law:** If pressure and amount of gas is constant, as the temperature of an enclosed gas increases, the volume increases (direct) $V_1 \times T_2 = V_2 \times T_1$ **Gay-Lussac's Law:** If volume and amount of gas is constant, as the temperature of an enclosed gas increases, the pressure increases (direct) $P_1 \times T_2 = P_2 \times T_1$ **Combined Gas Law:** A single expression that combines Boyle's, Charles', and Gay-Lussac's laws; only the amount of gas is held constant (see above). Number of moles is held constant. $P_1 \times V_1 \times T_2 = P_2 \times V_2 \times T_1$ **Ideal Gas Law:** This equation makes the assumption that in most environments, real gases behave like an ideal gas. An ideal gas does not actually exist, but real gases differ from the	demonstrations. These can be used to introduce the topic or expand on a concept (see resources). Videos: While explaining the gas laws and properties, have visual animations to help students understand the concepts. Choose from the list below: • http://ed.ted.com/lessons/1207-1-a-bennet-brianh264 • http://ed.ted.com/lessons/describing-the-invisible-properties-of-gas-brian-bennett • http://www.youtube.com/watch?v=BxUS1K7xu30 Math Skills: • Graph relationships between pressure and volume (P & V),

	ideal gas concept only at low temperatures and high pressures (Why? Real gases have volume and there are attractions between the particles). For a more thorough description of ideal gas assumptions, please refer to the Kinetic Theory Assumptions at beginning of this section (Instructional Background). PV = nRT; R is the ideal gas constant	pressure and temperature (P & T), and volume and temperature (V & T). • Calculate the relationships between the variables changing in each situation (all other variables remain constant). Pressure varies inversely with the volume, $P_1V_1 = P_2V_2$. Pressure varies directly with the Kelvin temperature, $P_1/T_1 = P_2/T_2$. Volume varies directly with the Kelvin temperature, $V_1/T_1 = V_2/T_2$. Inquiry Experiment: Volume and Pressure of a Gas (see experiment details below) Virtual Lab: Investigating gases (see lab details below)

RESOURCES:	VOCABULARY:
Videos: • http://ed.ted.com/lessons/1207-1-a-bennet-brianh264 • http://ed.ted.com/lessons/describing-the-invisible-properties-of-gas-brian-bennett • http://www.youtube.com/watch?v=BxUS1K7xu30 Math Skills: • http://misterguch.brinkster.net/gaslawworksheets.html • http://misterguch.brinkster.net/pra_gaslawsworksheets.html • http://misterguch.brinkster.net/kineticmoleculartheory.pdf Demonstrations: • http://ncsu.edu/project/chemistrydemos/GasLaw/Gas%20	BOYLE'S LAW CHARLES' LAW COMBINED GAS LAW IDEAL GAS LAW KINETIC MOLECULAR MODEL PRESSURE TEMPERATURE VOLUME

Law.pdf • http://www.flinnsci.com/teacher-resources/teacher-resource-videos/best-practices-for-teaching-chemistry/gas-laws/ • http://www.nclark.net/GasLaws Virtual Labs: • http://phet.colorado.edu/en/simulation/gas-properties • http://www.chem.ufl.edu/~itl/2045/MH_sims/gas_sim.html • http://www.jdenuno.com/Chemistry/Labs/GasLaws.swf • http://jersey.uoregon.edu/vlab/Piston/	
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• What is the relationship between temperature, volume, and pressure of a gas? • How do gases travel through a room? • What are characteristics of most gases?	Inquiry Experiment: Volume and Pressure of a Gas. How exactly does volume change with changes in pressure? Using the provided equipment, a rubber-plugged or capped syringe, textbooks, ring stand, utility clamp, and graph paper, conduct an experiment to collect the necessary data. Graphically and mathematically present your results. Set a syringe volume at the maximum, seal the tip with a solid rubber stopper and support the syringe with a clamp attached to a ring stand. Read the volume of air in the syringe before adding any weights (books work best) and then read the volume after adding each weight. NOTE: The books represent added pressure on the gas. Each book is additional pressure and can be graphed as books or can be changed to mass. Virtual Lab: Investigating gases. There are multiple labs that simulate all of the gas laws. Here are links to several simulations: • http://phet.colorado.edu/en/simulation/gas-properties • http://www.chem.ufl.edu/~itl/2045/MH_sims/gas_sim.html • http://www.jdenuno.com/Chemistry/Labs/GasLaws.swf • http://jersey.uoregon.edu/vlab/Piston/

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.6x**	**Standard:** The mole is the standard unit for counting atomic and molecular particles in terms of common mass units.		
	Unpacked Standard: **C4.6a** Calculate the number of moles of any compound or element given the mass of the substance. **C4.6b** Calculate the number of particles of any compound or element given the mass of the substance.		

	Board Objective: I can calculate the number of moles of a compound or element given the mass of the sample by using Avogadro's constant and math conversions in order to determine the proper measurements needed for experimentation. I can calculate the number of particle of a compound or element in a given mass sample by using Avogadro's Constant in order to determine the proper measurements needed for experimentation.
NEXT GEN CODE: HS-PS1-3	**Next Gen Standard:** 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.
	ACT Alignment: Interpretation of Data – Determine how the value of one variable changes as the value of another variable changes in a complex data presentation. Identify and/or use a complex mathematical relationship between data. Understand basic scientific terminology.

ASSESSMENTS:

Students should be able to:

- Calculate the number of moles of compound given the mass
- Calculate the number of particles of a compound given the mass

Pre-assessment:

- Write it downs – have students answer questions regarding atom sizes and molar mass. Ask students how they can obtain molar mass of a compound (see examples under concept notes)

During:

- Daily Activities: video, mole day projects, guided and individual practice
- Cooperative Learning Activities

Post-assessment:

- Unit Test

CONCEPT NOTES:

The mole (named after the unit's founder—Avogadro) is a standard unit of counting particles, atoms, and molecules in chemistry, similar to the unit of the dozen. A mole contains 6.022×10^{23} things—cows, pennies, people, molecules, atoms, etc. Because the molar masses of different compounds differ so greatly, the only reasonable way to compare the number of particles of each is by using a like unit, the mole. The molar mass of any object equals the mass of 6.022 x 1023 pieces of that object. For example, if one cow weighs 1,000 kg, one mole of cows (6.022 x 1023 cows) weighs 6.022 x 1026 kg.

Why use the mole? One mole of protons or neutrons (which are very similar in mass) equals approximately 1 gram. The mole is simply a convenient way to mass different substances.

EX: Calculate the number of moles found in 23 grams of NaCl.

The molar mass of NaCl can be found on the Periodic Table. Na has a molar mass of 23 grams/mol and Cl has a molar mass of 17 grams/mol; adding those together gives a molar mass for the compound of 40 grams/mol.

$$23\text{grams NaCl} \times \frac{1\text{ mol NaCl}}{40\text{ grams}} = 0.58\text{ moles of NaCl}$$

Converting the number of particles or molecules to the number of moles is a similar conversion; an example follows.

LESSON STRATEGIES:

10/23 is considered Mole Day. Go to the following website to get a variety of different project ideas to celebrate "The Mole": http://www.moleday.org/. Or, celebrate any time of the year!

Video: The Mole is a Unit. Introduce "The Mole" with this catchy video: http://www.youtube.com/watch?v=1R7NiIum2TI

Students should be guided through these mathematic equations. Makes sure to include many practice problems during class and many individual practice problems. Find worksheets and ideas at the following websites:

- http://misterguch.brinkster.net/freeworksheet.pdf
- http://misterguch.brinkster.net/oct2000.pdf
- http://misterguch.brinkster.net/WKS001_012_750921.pdf
- http://misterguch.brinkster.net/WKS001_014_857767.pdf
- http://misterguch.brinkster.net/WKS001_022_047472.pdf

EX: How many molecules are present if you start with 0.84 moles of NaCl?

0.84 mol NaCl	6.022×10^{23} molecules NaCl	=	5.06×10^{23} molecules NaCl
	1 mol NaCl		

The molar mass is related to the number of particles in that substance through Avogadro's Number, 6.022 x 1023.

EX: How many molecules of NaCl do you have if you mass out 32.7 grams?

32.7 grams NaCl	1 mol NaCl	6.022×10^{23} molecules NaCl	=	4.92×10^{23}
	40 grams NaCl	1 mole NaCl		molecules

- http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/avogad2.html
- http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/avogad2.html

Cooperative learning activity: Calculations see activity details below)

Cooperative Learning Activity #2: The Mole Conversions Stations (see activity details below)

RESOURCES:

Daily Activities:

- http://www.moleday.org/
- http://www.youtube.com/watch?v=1R7NiIum2TI
- http://misterguch.brinkster.net/freeworksheet.pdf
- http://misterguch.brinkster.net/oct2000.pdf
- http://misterguch.brinkster.net/WKS001_012_750921.pdf
- http://misterguch.brinkster.net/WKS001_014_857767.pdf
- http://misterguch.brinkster.net/WKS001_022_047472.pdf
- http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/avogad2.html
- http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/avogad2.html

Cooperative Learning activity:

- http://www.kentschools.net/ccarman/files/2009/08/chemistry-molar_conversions_stations_activity.pdf

VOCABULARY:

ATOMIC MASS
ATOMS
AVOGADRO'S CONSTANT
MASS
MOLE
PARTICLE
PERIODIC TABLE
UNIT

ESSENTIAL QUESTIONS:

- Why is the mole an important measurement in chemistry?

EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)

Cooperative learning activity #1: Calculations. Calculate the number of moles of a material in large quantities. Examples: If 2 billion people eat one egg each day how many dozen eggs are eaten in 100 days? How many moles of eggs are eaten in 100 days? If there are 20 drops in one milliliter, how many moles of drops are in a 100,000 liter swimming pool?

Cooperative Learning Activity #2: Students practice mathematical concepts in a stations activity. See the following link for details:

	http://www.kentschools.net/ccarman/files/2009/08/chemistry-molar_conversions_stations_activity.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.7x**	**Standard:** The physical properties of a solution are determined by the concentration of solute. **Unpacked Standard:** **C4.7a** Investigate the difference in the boiling point or freezing point of pure water and a salt solution. **C4.7b** Compare the density of pure water to that of a sugar solution. **Board Objective:** I can compare and contrast solubility of a water salt solution by designing an experiment in order to show case how the concentration affects solubility. I can compare the density of water by varying its concentration of the solvent in the solution in order to explain ocean water properties.		
NEXT GEN CODE: HS-PS2-6	**Next Gen Standard:** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. **ACT Alignment:** Interpretation of Data – Understand basic scientific terminology Scientific Investigation – Predict how modifying the design or methods of an experiment will affect the results.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Compare and contrast solubility of water salt solution • Compare the density of water in differing solutions <u>Pre-assessment:</u> • Vocabulary Assessment – have students use the terms solutions, mixtures, compounds, solvent, solute, density, boiling point and melting point correctly in sentences <u>During:</u> • Daily activities: vocabulary practice • Density Demonstration • Inquiry Experiments	Compare properties that influence density. i.e. particle mass and packing of particles. The solubility of a substance is the amount of that substance that will dissolve in a given amount of solvent. Solubility is a quantitative term. Solubility very enormously. The concentration of a solvent in a solute can affect varies properties such as boiling point, melting point, and density.	Density Demonstration: Ocean Water properties (see demonstration details below) Inquiry Experiment #1: Solubility Lab (see experiment details below) Inquiry Experiment #2: Solubility Curve (see experiment details below)

Post-assessment: • Unit Test		

RESOURCES:	VOCABULARY:
Daily activities: • http://misterguch.brinkster.net/pra_solutionworksheets.html Demonstration: • http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/lab8.html Inquiry Experiment #1: • http://www.cpet.ufl.edu/wp-content/uploads/2013/03/%E2%80%98Solubility-of-a-Salt%E2%80%99-Constructing-a-Solubility-Curve-for-Potassium-Nitrate-in-Water.pdf • http://chemwiki.ucdavis.edu/Organic_Chemistry/Organic_Chemistry_With_a_Biological_Emphasis/Chapter__2%3A_Introduction_to_organic_structure_and_bonding_II/Section_2.4%3A_Solubility,_melting_points_and_boiling_points Inquiry Experiment #2: • http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/lab8.html	COMPOUND CONCENTRATION DENSITY MASS MIXTURE SOLUTE SOLVENT VOLUME
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How does the concentration of a solute affect basic properties of a solution? • What are some real world applications of the solubility principle? (i.e. salt on icy roads)	Density Demonstration: Ocean Water Properties. In this demonstration students examine how salt affects the density of water. Click on the link below for demonstration details: http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/lab8.html Inquiry Experiment: Solubility Lab. Have students design a lab that demonstrates how the amount of solute in a solution affects its boiling temperature. Using equal amounts of water dissolve different amounts of the same solute in the water and determine the boiling point of the resulting solution. What conclusions can you reach regarding the solute used? What conclusions can you reach about amount of solute? For guidance, click on the following links:

	• http://www.cpet.ufl.edu/wp-content/uploads/2013/03/%E2%80%98Solubility-of-a-Salt%E2%80%99-Constructing-a-Solubility-Curve-for-Potassium-Nitrate-in-Water.pdf • http://chemwiki.ucdavis.edu/Organic_Chemistry/Organic_Chemistry_With_a_Biological_Emphasis/Chapter__2%3A_Introduction_to_organic_structure_and_bonding_II/Section_2.4%3A_Solubility,_melting_points_and_boiling_points Inquiry Experiment #2: Solubility Curve. Students investigate solubility in this experiment. See the following link for procedure and handouts: http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/lab8.html

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.8**	**Standard:** Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.		
	Unpacked Standard: **C4.8A** Identify the location, relative mass, and charge for electrons, protons, and neutrons. **C4.8B** Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus. **C4.8C** Recognize that protons repel each other and that a strong force needs to be present to keep the nucleus intact. **C4.8D** Give the number of electrons and protons present if the fluoride ion has a -1 charge.		
	Board Objective: I can define the atomic theory by modeling the structure of the atom in order to understand how the atoms interact with each other. I can create a model of an element's atom by using the periodic table in order to determine how the atom will react with other atoms. I can determine the number and location of electrons, protons, and neutrons of any given element by creating a table and sketch of any given element's atom in order to understand that the structure of each element is different and gives rise to the uniqueness of properties of each element.		
NEXT GEN CODE: HS-PS1-3 HS-PS2-6	**Next Gen Standard:** 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-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials		
	ACT Alignment: Evaluation of Models, Inferences, and Experimental Results – Identify strengths and weaknesses in one or more models. Determine whether new information is supported or weakened by new information.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to:	Order in the universe is exhibited through the location and	Review with students the atomic theory

• Compare and contrast between protons, neutrons, and electrons • Illustrate the structure of the atom • Describe that a strong force exists within the nucleus of an atom • Model the atom of any element <u>Pre-assessment:</u> • Periodic Table Assessment – See if students know what information is on the periodic table • Vocabulary Quiz • Just 3 things – have students list 3 things they understand about the atomic theory and the structure of the atom <u>During:</u> • Daily Activities: guided practice and individual practice worksheets, vocabulary assessment (crossword puzzles, illustrations, definitions, etc.) • Journey of the Atom through Time Poster • Inquiry Experiment • Modeling the Atom <u>Post-assessment</u> • Unit Test	function of subatomic particles and the likeness of atoms of individual elements. A strong force is needed to hold the nucleus together in all atoms. Review the human perspective on the atom beginning with the early times before the Greek philosophers. Include the early Greeks, Dalton, J.J. Thompson, Rutherford, Bohr, and the Quantum Mechanical Theory. The relative mass of the proton is 1, the neutron is 1 and the electron is approximately zero. The relative charge of the electron is -1, the proton is +1 and the neutron is zero. Protons and neutrons are located in the nucleus whereas the electrons are located in the electron cloud. It is not necessary to teach the electron orbital concept in detail a general discussion relating electron orbitals to a region of space (electron cloud) with higher probability regions that electrons are most likely to be found will suffice. Reinforce that the strong force is one of the four fundamental forces. The Strong Nuclear Force (also referred to as the strong force) is one of the four basic forces in nature (the others being gravity, the electromagnetic force, and the weak nuclear force). As its name implies, it is the strongest of the four. However, it also has the shortest range, meaning that particles must be extremely close before its effects are felt. Its main job is to hold together the subatomic particles of the nucleus (protons, which carry a positive charge, and neutrons, which carry no charge. These particles are collectively called nucleons). As most people learn in their science education, like charges repel (+ +, or - -), and unlike charges attract (+ -). A force which can hold a nucleus together against the enormous forces of repulsion of the protons is strong indeed. A modern periodic table must be made available.	through time to show the evolution of the atom has allowed us to better understand chemistry. Have students illustrate the structure of the atom throughout history by drawing a "Journey of the Atom through Time" Poster. Click on the following link for an example: http://www.nclark.net/Atom_Journey.pdf Inquiry experiment: What's inside an Atom? (see experiment details below) Cooperative learning Activity – Relative mass (see activity details below) Modeling the atom: Construct a two dimensional or a three dimensional model to represent the number and location of the three subatomic particles in a fluoride ion with a -1 charge and represent the path (toward or away from the model) that the extra particle took to change the neutral fluorine atom to the fluoride ion.

RESOURCES:	VOCABULARY:
Atomic Structure Worksheets:	ATOMIC MASS

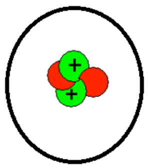
• http://misterguch.brinkster.net/propertyworksheets.html • http://www.nclark.net/Atom • http://www.nclark.net/AtomicStructure.htm • http://sciencespot.net/Media/AtomicBasics.pdf Journey of Atom through Time Poster: • http://www.nclark.net/Atom_Journey.pdf Modeling the Atom: • http://www.exo.net/~emuller/activities/M%20and%20M%20Atom%20Model.pdf • http://phet.colorado.edu/en/simulation/hydrogen-atom	ATOMIC NUCLEUS ATOMIC NUMBER ATOMIC THEORY ATOMIC WEIGHT ELECTRICALLY NEUTRAL ELECTRONS ELECTRON CLOUD ELEMENTARY PARTICLE IONS ISOTOPE PROTONS NEUTRONS RELATIVE MASS
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• What scientist and experiments contributed to the atomic theory throughout time? • How many protons, neutrons, and electrons are in an atom? • What are ions and isotopes?	Inquiry Experiment: What is the location and shape of the object inside? Use a hat pin to probe a clay ball with a penny embedded inside. Students should collect data each time they probe into the clay. They should record position, hit or no miss and depth if the object hits something solid. Explain the analogy of the clay ball to our model of the atom. Extend the inquiry by asking another related question and experimenting to find the answer. Cooperative Learning Activity: Find the relative mass of several common objects, (ex. Various seeds, bean, pencils, pen, 15 cm ruler, etc.). Find the actual mass of each object and arrange the objects in a table with the lowest to highest mass. Add a column to the table listing the relative mass of each object if the lightest object has a mass of 1.00. Arrange the objects again with the second smallest object having the relative mass of 1.00. Modeling Activity: Construct a two dimensional or a three dimensional model to represent the number and location of the three subatomic particles in a fluoride ion with a -1 charge and represent the path (toward or away from the model) that the extra particle took to change the neutral fluorine atom to the fluoride ion. For additional ideas, visit the websites below: • http://www.exo.net/~emuller/activities/M%20and%20M%20Atom%20Model.pdf • http://phet.colorado.edu/en/simulation/hydrogen-atom

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:

CODE: **C4.8x**	**Standard:** Electrons are arranged in main energy levels with sublevels that specify particular shapes and geometry. Orbitals represent a region of space in which an electron may be found with a high level of probability. Each defined orbital can hold two electrons, each with a specific spin orientation. The specific assignment of an electron to an orbital is determined by a set of 4 quantum numbers. Each element and, therefore, each position in the periodic table is defined by a unique set of quantum numbers.
	Unpacked Standard: **C4.8e** Write the complete electron configuration of elements in the first four rows of the periodic table. **C4.8f** Write kernel structures for main group elements. **C4.8g** Predict oxidation states and bonding capacity for main group elements using their electron structure. **C4.8h** Describe the shape and orientation of *s* and *p* orbitals. **C4.8i** Describe the fact that the electron location cannot be exactly determined at any given time.
	Board Objective: I can write the electron configuration and kernel structure for elements by using the periodic table in order to predict bonding capability of an atom. I can describe the shape and orientation of the s and p orbitals by illustrating their location in the atom in order to show the probable location s of electrons.
NEXT GEN CODE: HS-PS1-1	**Next Gen Standard:** 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.
	ACT Alignment: Interpretation of Data – Compare or combine data from two or more simple data presentations. Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Write electron and kernel configuration for all atoms in the periodic table • Determine the bonding capacity and orientation of an atom based on the electron configuration • Illustrate the shape and orientation of the s and p orbital • Explain probability and how it relates to the location of the electrons <u>Pre-assessment:</u>	The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. The number of protons in the nucleus of an atom determines the element, but the electrons determine the element's chemical behavior. The outermost or valence electrons are those that can be shared with other atoms to form molecules, or can be transferred to or from other atoms, forming ionic salts. The <u>Aufbau principle</u> just means the way the electrons fit into the atomic orbitals in order of ascending energy. The first electron goes into the lowest energy orbital available (the 1s orbital) the next electron pairs up with it in the same orbital and the third electron (that of lithium) fits into the next	This standard allows for many hands-on activities and labs. Choose from the list of the following or complete all of them during lessons. Hands-on Activity: Locating the "s" orbital (see activity details below). Periodic Table Activity: Have students rearrange the periodic table to reflect the electron configuration and the Aufbau Principle (see below for possible results). Virtual Lab: Building up Elements (see

- Vocabulary Assessment
- Structure of the Atom: Have students draw a model of an element based on the atomic number, atomic mass, and oxidation state of the atom. For example, He^{+2}:



During:

- Daily Assignments: guided and individual practice
- Hands-on Activity
- Periodic Table Activity
- Virtual Lab
- Interactive Game

Post-assessment

- Unit Test

orbital up, the 2s orbital. Below shows the order in which the electrons fill up the orbitals using the Aufbau principle: $\mathbf{1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^6\ 7s^2\ 5f^{14}\ 6d^{10}\ 7p^6}$

Introduce the kernel to simplify electron configurations. The kernel is a structure used to shorten an electron configuration. A kernel is an inert gas symbol in brackets that stands in place of all of the filled orbitals contained in the inert gas. It is also called the base unit or shortened version. Example: [Ne] is a kernel, it represents an electron configuration of 1s22s22p6; Na= [Ne],3s1). Limit to elements 1-20.

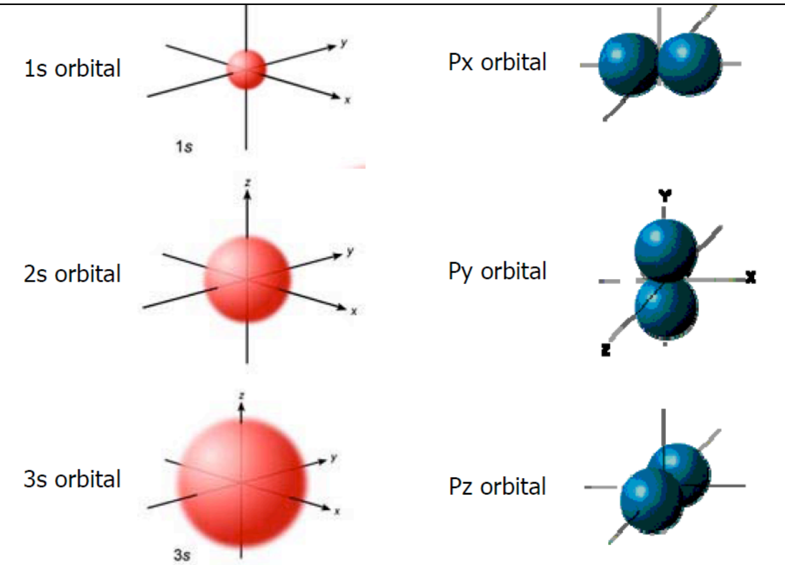
Main group elements are those in columns 1 – 2 and 13-18. (Transition elements are not included in the main groups.)

Emphasize the idea that orbitals are three dimensional not two and that the orbitals represent space with high probability of where electrons would be located. The probable location of an electron depends on the amount of energy an electron has. The electrons with a low amount of energy are found in the lowest energy levels (closest to the nucleus); electrons with a high amount of energy are found on the outermost energy levels (furthest from the nucleus).

The shape of the **s** subshells is spherical around the nucleus. The shape of the **p** subshells is the shape of three barbells at ninety degrees to each other around the nucleus. The shape of the **d** and **f** subshells is very complex.

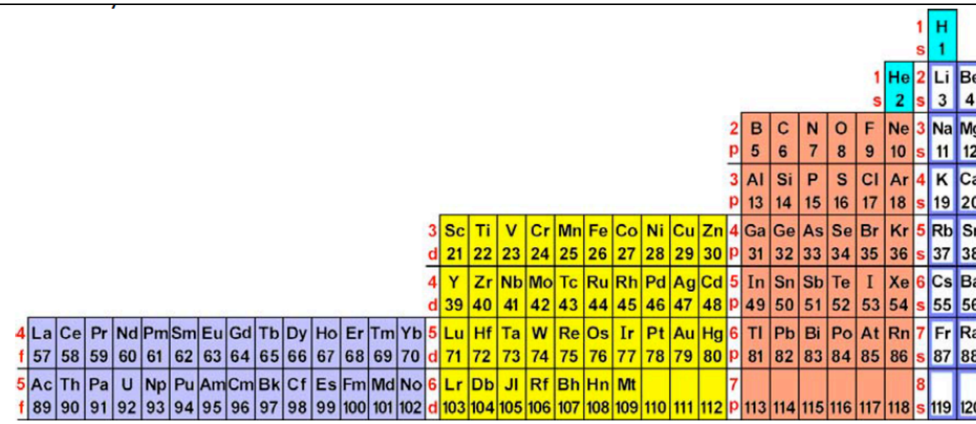
lab details below).

Interactive Game: Electron Configuration Battleship. This is a great review activity. Students place “battleships” in a blank periodic table. Students should have the following “battleships: an aircraft carrier (5 elements), a battleship (4 elements), a submarine (3 elements), a destroyer (3 elements), and a PT boat (2 elements). Their opponent tries to guess the location of the battleship by calling out the electron configuration. It must be noted if there is a hit or miss. This activity can be used with the kernel configuration as well. The player who sinks all of the other player’s “battleships” wins.



RESOURCES:	VOCABULARY:
Daily Activity: • http://misterguch.brinkster.net/PRA014.pdf • http://dbhs.wvusd.k12.ca.us/apps/download/2/nqGd3ifusxLccmPfPonRHy8i4qDUPsT5pRN4OsyPoKqeAj7O.pdf/Electron%20Config%20Intro%20WS.pdf • http://misterguch.brinkster.net/jan2006.pdf • http://learn.bcbe.org/pluginfile.php/485524/mod_resource/content/0/Electron_Config_homework_combined.pdf Hands-on Activity: • http://classroom.kleinisd.net/users/3185/docs/locating_electron_by_analogy.pdf Periodic Table Activity: • http://www.sandi.net/cms/lib/CA01001235/Centricity/Domain/8812/electron-configuration-lab-activity.pdf Virtual Lab: • http://www.learner.org/interactives/periodic/elementary_interactive.html	CHEMICAL BOND ELECTRON ELECTRON CONFIGURATION ENERGY LEVEL EXCITED STATE GROUND STATE KERNEL STRUCTURE ORBITALS PROBABILITY QUANTUM ENERGY QUANTUM NUMBERS SUBLEVEL VALENCE ELECTRONS

Battleship/Interactive Games: • http://www4.esc13.net/uploads/science/docs/MiniCast/Electron_Configuration_Battleship.pdf • http://nobel.scas.bcit.ca/chemed2005/tradingPost/TUPM_S2_4_15ChemFunGames.pdf	
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How do electrons affect the properties of an atom? • How can you find the location of a single electron? • How are electrons distributed throughout different energy levels? • How do electrons fall into orbitals as they increase in number?	Hands-on Activity: Locating the "s" orbital. This is a mini-probability exercise. This exercise can be accomplished by having them drop small ball bearings onto a target which consists of ten concentric rings, each one centimeter wide. Balls should be dropped from a height of about six feet, at arm's length while aiming at the bulls-eye. By attaching a second target to the first and placing a piece of carbon paper between them, the hits will be recorded on the bottom target. Use 100 drops into the rings to make probability of a given area easier. After counting the number of hits in rings in each ring, the hit density (hits/ring area) can be calculated for each concentric ring. This will generally show that the likelihood of hitting a given ring decreases with the distance from the bulls-eye. This can then be related to the likelihood of where electrons would be found in the hydrogen atom and the probable shape of the s orbital. The electron charge density is greatest at the nucleus. (Graphing hit density vs. distance from center of target can help support the idea that the electrons will be close to the nucleus but not generally in it.) Caution should be used since this exercise will have a directional effect to it which electron probability does not. (This is only representative of an s orbital.) http://classroom.kleinisd.net/users/3185/docs/locating_electron_by_analogy.pdf Periodic Table Activity Results:



For a different approach to this activity, visit
http://www.sandi.net/cms/lib/CA01001235/Centricity/Domain/8812/electron-configuration-lab-activity.pdf

Virtual Lab: Building up Elements. In this virtual activity, students will build up orbital and electrons piece by piece in order to construct an element. Students get excellent practice with electron configurations and up-to-date results for their work. Visit the following link for activity:
http://www.learner.org/interactives/periodic/elementary_interactive.html

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.9**	**Standard:** In the periodic table, elements are arranged in order of increasing number of protons (called the atomic number). Vertical groups in the periodic table (families) have similar physical and chemical properties due to the same outer electron structures.		
	Unpacked Standard: **C4.9A** Identify elements with similar chemical and physical properties using the periodic table.		
	Board Objective: I can identify trends in families of elements by interpreting the periodic table in order to predict chemical and physical properties of elements.		
NEXT GEN CODE: HS-PS1-1	**Next Gen Standard:** 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.		
	ACT Alignment: Interpretation of Data – Analyze given information when presented with new complex information. Evaluation of Models, Inferences, and Experimental Results – Determine whether given information supports or contradicts a simply hypothesis or conclusion and why		

<table>
<tr><th>Assessments:</th><th>Concept Notes:</th><th>Lesson Strategies:</th></tr>
<tr>
<td>Students should be able to:
• Identify individual elements based on their symbol and vice versa
• Identify trends in families of elements in the periodic table
• Predict physical and chemical properties of an element based on its location in the periodic table

Please note: The amount of information that students can gain from the periodic table will help them throughout their science career; therefore, it is extremely important that you monitor progress of this standard.

<u>Pre-assessment:</u>
• KWL
• Label the periodic table – have students label the periodic table. See if students know where to find important information such as symbols, atomic mass, and atomic number.

<u>During:</u>
• Daily Activities: individual practice, video, vocabulary review, and quizzes
• Virtual Quiz
• Cooperative Learning Activities
• Virtual Lab
• Inquiry Activity</td>
<td>Periodic Law

Mendeleev's principle of chemical periodicity is known as the periodic law, which states that when the elements are arranged according to their atomic numbers, elements with similar properties appear at regular intervals.

Organization of the Periodic Table

The periodic table organizes the known elements into periods and families with similar properties. The periodic table is organized to display trends in the characteristics of elements. The type of chemical bonding determines some characteristic properties of materials.

The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.

Elements in each column of the periodic table have the same number of electrons in their outer energy level. The electrons in the outer shell are called valence electrons. Elements with the same number of valence electrons tend to react in similar ways.

A vertical column on the periodic table is called a group. Elements in a group share chemical properties.

A horizontal row on the periodic table is called a period. Elements in the same period have the same number of occupied energy levels.</td>
<td>While introducing the periodic table and the trends that it houses. Have students learn the symbols of the elements as well. This will provide beneficial knowledge for students throughout their chemistry career. Students can practice their knowledge with the following worksheets and activities:
• The elemental kid: A Gold Dust Tale. Students fill in the appropriate element based on the symbol for an entertaining story: http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/audust.html
• Riddles: Students answer the questions by using the element's name as a pun in this activity: http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/elemrid1.html
• Identifying the element: Students use their knowledge, chemistry textbook, or any other appropriate chemistry resource book to identify the element by following clues. http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/elem2.html

Video: Watch this video to help students examine the trends in the periodic table. Have students answer questions while the watch.
• Video link: http://www.learner.org/resources/series61.html?pop=yes&pid=7</td>
</tr>
</table>

Post-assessment: • Unit Test		99. • Hand out link: http://www.learner.org/resources/series61.html?pop=yes&pid=799 Cooperative learning Activity #1: Elemental March Madness (see activity details below) Cooperative learning Activity #2: Alien Periodic Table (see activity details below) Virtual Lab: Periodic Table Simulation (see lab details below) Inquiry Activity: Density as a periodic table property (see activity details below)

RESOURCES:	VOCABULARY:
Daily Activities: • Virtual Quiz: http://www.elementsdatabase.com/periodic-table-quiz.php • Video and handout – http://www.learner.org/resources/series61.html?pop=yes&pid=799 and http://www.learner.org/resources/series61.html?pop=yes&pid=799 • Identifying the Elements: http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/elem2.html, http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/elemrid1.html, and http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/audust.html Cooperative learning Activities:	ACTUAL MASS ALKALINE METALS ALKALI EARTH METALS ATOMIC BONDING PRINCIPLES ATOMIC RADII CHEMICAL PROPERTIES CONDUCTIVITY ELECTRONEGATIVITY FAMILY GROUP HALOGENS ENERGY SUBLEVELS IONIZATION ENERGY MAIN GROUP ELEMENTS MALLEABILITY METALLOIDS METALS

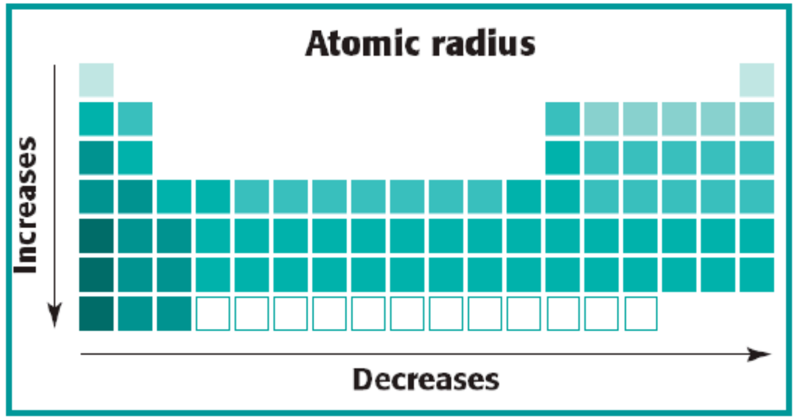
• http://www.nclark.net/ElementaryMarchMadness.pdf • http://www.nclark.net/PtableTrends.htm • http://www.nclark.net/AlienPTanalysisfillin.pdf Virtual Lab: • http://genesismission.jpl.nasa.gov/educate/scimodule/cosmic/ptable.html Inquiry Experiment: • http://www.nclark.net/DensityPeriodicTrend.htm	NOBLE GASES NONMETALS PERIOD REACTIVITY WITH ACIDS
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How does the placement of an element in the Periodic Table determine relate to its physical and chemical properties? • Why is the Periodic Table called the "Periodic" Table, not just the "Table of Elements"? • How does knowing the trends on the Periodic Table help scientists predict properties of the representative elements? • In what ways does the information in the Periodic Table help us to discover new elements?	Cooperative Learning Activity#1: Elementary March Madness. Students define each of the following properties of the elements and briefly describe any periodic trend in the property across a row or down a column in the periodic table. For handouts and procedures, see the following link: http://www.nclark.net/ElementaryMarchMadness.pdf Cooperative Learning Activity #2: Alien Periodic Table. There is a discovery of a new planet that contains the same elements as earth. The students have been asked to help sort out what is known about the alien elements and to arrange them onto a blank periodic table. Once this table is organized, scientists on both planets will understand each other better and will be able to work to share scientific information and make new discoveries. See procedure details at the following link: http://www.nclark.net/PtableTrends.htm . Follow assessment located at this link: http://www.nclark.net/AlienPTanalysisfillin.pdf Virtual Lab: Periodic Table Simulation. This interactive science activity focuses on the origin and evolution of the modern Periodic Table. . http://genesismission.jpl.nasa.gov/educate/scimodule/cosmic/ptable.html Inquiry Activity: Density as a periodic table property. Students explore how density changes as you moved down a family on the periodic table. See procedure details at the following link: http://www.nclark.net/DensityPeriodicTrend.htm

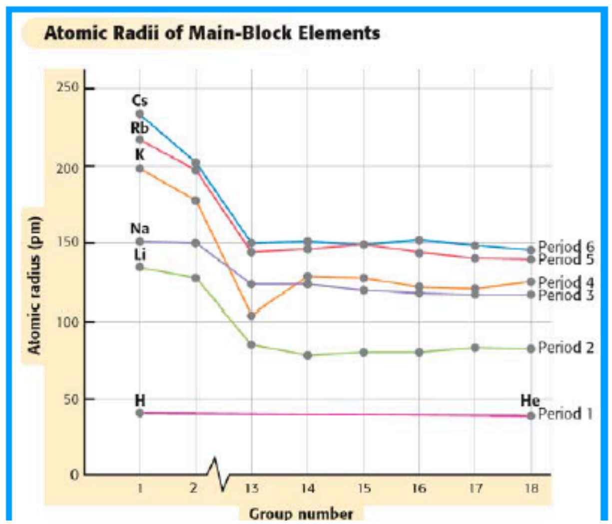
GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:

CODE: **C4.9x**	**Standard:** The rows in the periodic table represent the main electron energy levels of the atom. Within each main energy level are sublevels that represent an orbital shape and orientation.
	Unpacked Standard: **C4.9b** Identify metals, non-metals, and metalloids using the periodic table. **C4.9c** Predict general trends in atomic radius, first ionization energy, and electronegativity of the elements using the periodic table.
	Board Objective: I can identify trends in families of elements by interpreting the periodic table in order to predict chemical and physical properties of elements.
NEXT GEN CODE: HS-PS1-1	**Next Gen Standard:** 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.
	ACT Alignment: Interpretation of Data – Analyze given information when presented with new complex information. Evaluation of Models, Inferences, and Experimental Results – Determine whether given information supports or contradicts a simply hypothesis or conclusion and why

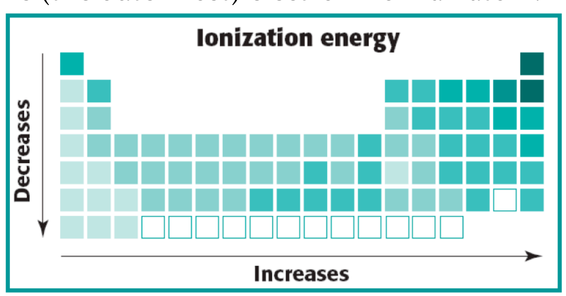
ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Identify trends in families of elements in the periodic table • Predict physical and chemical properties of an element based on its location in the periodic table Please note: The amount of information that students can gain from the periodic table will help them throughout their science career; therefore, it is extremely important that you monitor progress of this standard. <u>Pre-assessment:</u> • KWL • Label the periodic table – have students label the periodic table. See if students know where to find important information such as symbols, atomic mass, atomic number, periods, groups, and	The "stair step" on the right side of the periodic table conveniently separates the elements with physical properties of metals from the nonmetals. The metalloids are approximately on the "stair step". **Metals**: The majority of elements, including many main-group ones, are metals. Metals are recognized by its shiny appearance, but some nonmetal elements, plastics, and minerals are also shiny. All metals are excellent conductors of electricity. Electrical conductivity is the one property that distinguishes metals from the nonmetal elements. Some metals, such as manganese, are brittle. Other metals, such as gold and copper, are ductile and malleable. Ductile means that the metal can be squeezed out into a wire. Malleable means that the metal can be hammered or rolled into sheets. **Metalloids:** Metalloids are found on the periodic table between the metals and nonmetals. A metalloid is an element that has some characteristics of metals and some characteristics of nonmetals. All metalloids are solids at room temperature. Metalloids are less malleable than metals but not as brittle as nonmetals. Metalloids tend to be semiconductors of electricity.	This standard should be a continuation of standard 4.9. Use the following activities in conjunction with those from standard 4.9: Inquiry Experiment: Metals, Nonmetals, Metalloids (see activity details below) Cooperative Learning Activity #1: Graphing Activity (see activity details below) Cooperative Learning Activity #2: Periodic Table Tell Me Why Stations (see activity details below) Periodic Table Project: A culminating project where students apply what they learned about the Periodic Table. Students pick from the following projects: <u>The projects:</u> 1. *Out with the old, in with the new –*

families During: • Daily Activities: individual practice, video, vocabulary review, and quizzes • Inquiry Activity • Cooperative Learning Activity • Periodic Table Project Post-assessment: • Unit Test	**Nonmetals:** Many nonmetals are gases at room temperature; however, bromine is a liquid at room temperature. Solid nonmetals include carbon, phosphorus, selenium, sulfur, and iodine. These solids are brittle at room temperature. A nonmetal is an element that is a poor conductor of heat and electricity. Nonmetals are found on the right hand side of the periodic table. **Periodic Trends:** The arrangement of the periodic table reveals trends in the properties of the elements. A trend is a predictable change in a particular direction. Understanding a trend among the elements enables you to make predictions about the chemical behavior of the elements. These trends in properties of the elements in a group or period can be explained in terms of electron configurations. Atomic radius – distance from the center of an atom's nucleus to its outer most electron	Redesign and construct your redesign Periodic Table. Your redesigned table will need to improve on the table's utility as a learning instrument and must aid in the learning of at least two of the concepts below as it relates to the elements: a. Periodic properties – atomic size, electronegativity, ionization energy b. Electron configuration c. Atomic structure – numbers of protons, neutrons, electrons d. Ionic charge - +1, +2, +3, -1, -2, -3 e. Tendency of an atom to gain, lose, or share electrons f. Family names and characteristics – halogens, noble gases, transition metals, etc. 2. *Table of Stuff*– Design your own unique periodic table characterizing and organizing everyday things. The table will be arranged in the same shape with the same information such as symbols, atomic masses, etc. You will come up with a topic and must have at least 50 "elements" on your table; you must arrange





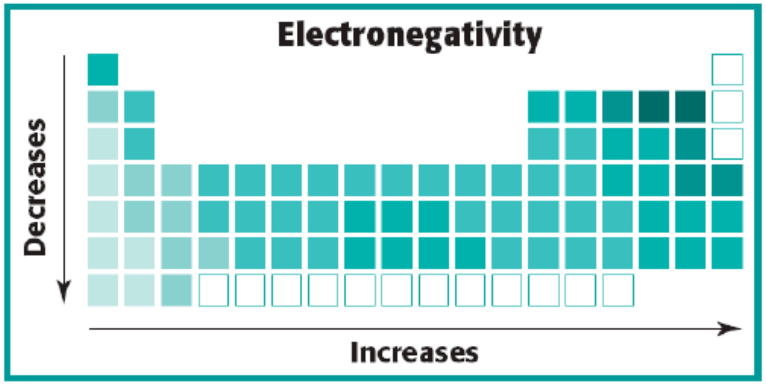
First ionization energy – the amount of energy needed to remove one (the outermost) electron from an atom.

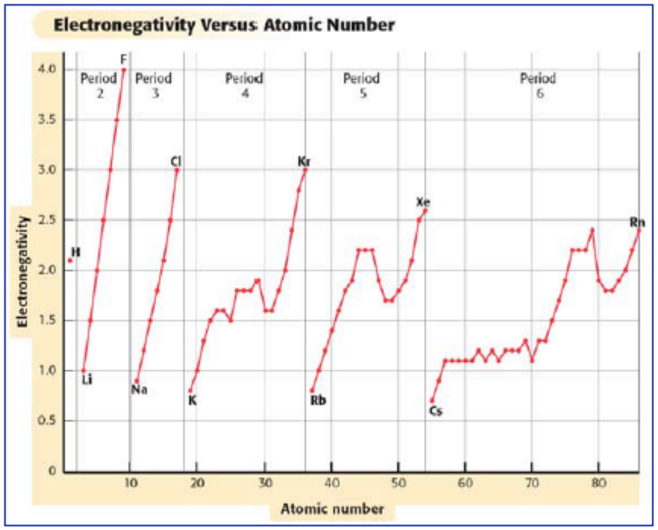


them in such an order that you have trends on your table that represents the trends on the Periodic Table. Before beginning work, you must have your topic approved by your teacher.

3. *Kryptonite* – you are a chemist who has discovered a new element that has practical uses for humanity. You must create an element and give it physical and chemical properties, explain the position on the periodic table and how it affects its physical and chemical properties, describe the practical uses for the element, explain what family it belongs to, and make a 3D model of the element.
4. *Adopt-an-Element* – you will adopt an element from the periodic table and use information from the table to express and showcase the element's physical and chemical properties. As a proud parent of your element you will create a family album (scrap book) to remember each stage of your element's life including but not limited to the birth (discovery), informational essay, practical uses, illustrations, commercial advertisement with a jingle, etc.

Electronegativity – the measure of an atoms attraction for electrons in a chemical bond





5. *How*-to Book – you will write a book about how-to-read the Periodic Table. You will detail the trends of the periodic table including the families and characteristics, periodic properties, electron configuration, and atomic structure, etc. This project must be turned in as a hardcopy and bound at the seams to simulate a real published book.

RESOURCES:	VOCABULARY:
Daily Activities: • Virtual Quiz: http://www.elementsdatabase.com/periodic-table-quiz.php • Video and handout – http://www.learner.org/resources/series61.html?pop=yes&pid=799 and http://www.learner.org/resources/series61.html?pop=yes&	ACTUAL MASS ALKALINE METALS ALKALI EARTH METALS ATOMIC BONDING PRINCIPLES ATOMIC RADII CHEMICAL PROPERTIES CONDUCTIVITY

pid=799 • Identifying the Elements: http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/elem2.html, http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/elemrid1.html, and http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/audust.html • Virtual Periodic Tables: www.ptable.com, www.chemicool.com, http://www.webelements.com/ and http://www.chem4kids.com/files/elem_intro.html Inquiry Experiment: http://www.nclark.net/MetalNonmetalLab.htm Cooperative Learning Activity #2: http://ms.wiatrek.org/page13/files/Periodic%20Trends%20.pdf	Electronegativity Family Group Halogens Energy sublevels Ionization energy Main group elements Malleability Metalloids Metals Noble Gases Nonmetals Period Reactivity with Acids
Essential Questions:	**Experiment/Demonstration/Activity: (Science Processes/Eng. Design)**
• How does the placement of an element in the Periodic Table determine relate to its physical and chemical properties? • Why is the Periodic Table called the "Periodic" Table, not just the "Table of Elements"? • How does knowing the trends on the Periodic Table help scientists predict properties of the representative elements? • In what ways does the information in the Periodic Table help us to discover new elements?	Inquiry Experiment: Metals, Metalloids, Nonmetals. Students will investigate several properties of seven elements and based on those properties identify each element as metal, nonmetal, or metalloid. See full procedure at the following link: http://www.nclark.net/MetalNonmetalLab.htm Cooperative Learning Activity #1: Graphing Activity a) Graph the atomic number vs. the atomic radius for atoms in the 2nd period or row in the periodic table. Find the atomic radius values from resources. Emphasize in drawings the characteristics that help determine the trend observed. b) Repeat part a using the 1st ionization energy. c) Repeat part a using the electronegativity. d) Graph atomic radius versus electronegativity and atomic radius versus ionization energy. Cooperative Learning Activity #2: Periodic Table Show me Why Stations. Students go to stations to determine what are the periodic trends and patterns of atomic radius, electronegativity, and ionization energy?

	http://ms.wiatrek.org/page13/files/Periodic%20Trends%20.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:

CODE: **C4.10**	**Standard:** A neutral atom of any element will contain the same number of protons and electrons. Ions are charged particles with an unequal number of protons and electrons. Isotopes are atoms of the same element with different numbers of neutrons and essentially the same chemical and physical properties.
	Unpacked Standard: **C4.10A** List the number of protons, neutrons, and electrons for any given ion or isotope. **C4.10B** Recognize that an element always contains the same number of protons.
	Board Objective: I can compare and contrast between the different isotopes, ions, and neutral charge atoms of any given element by calculating and comparing the number of electron, protons, and neutrons of the atom in order to explain the variety of elements found on Earth. I can identify an atom by its atomic number in order classify its elemental composition.
NEXT GEN CODE: HS-PS1-3 HS-PS1-8	**Next Gen Standard:** 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.
	ACT Alignment: Interpretation of Data – Determine how the value of one variable changes as the value of another variable changes in a complex data presentation. Identify and/or use a simple mathematical relationship between data.

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Calculate the number of protons, neutrons, and electrons of any given atom • Identify an atom by the number of protons <u>Pre-assessment:</u> • Draw it out: Have students draw a model of an atom. Make sure students label protons, neutrons, electrons, nucleus, and electron cloud • Vocabulary assessment – Crossword puzzle	Order in the universe is exhibited through the location and function of subatomic particles and the likeness of atoms of individual elements. Elements are identified by their atomic number or the number of protons in the nucleus. Numbers of neutrons and electrons may vary in an element. These are called isotopes and ions, respectively. Isotopes are atoms of elements with different atomic masses. Ions are atoms of an element with a charge. Meaning the number of protons and electrons are not equal. A positively charged ion, called a cation, has more protons than electrons. A negatively charged ion, called an anion, has more electrons than protons. Since the number of protons for a particular element never changes, it is the electrons that are being removed or added to the atom.	Hand-on Activity: Using cut out shapes that represent protons, neutrons and electrons including mass and charge. Students should demonstrate their understanding of obtaining the number of protons, electrons and neutrons from the atomic number and the atomic mass. Students should demonstrate their understanding of the following elements through use of manipulatives.

Ele.	Atomic #	Atomic Mas	Neutron	Electrons	protons

During:

- Daily Assignments: Vocabulary work (crossword puzzle, definitions, worksheets), guided and individual practice,
- Hands-on activity
- Inquiry Lesson

Post-assessment

- Unit Test

To determine the number of protons, neutrons, and electrons of an atom, use the following equations:

Atomic number = protons
Atomic Mass = protons + neutrons
In a neutral atom: Electrons = Protons
In an ion : Electrons = protons – charge on atom

		s			
H^1_1					
Li^6_3					
O^{-2}					

Daily assignments for practicing the math skills will be required. Start by determining the number of protons, neutrons, and electrons of neutral atoms. Then move onto isotopes and then ions. Finally, have the students complete activities where they will have to determine the protons, neutrons, and electrons of all types of atoms.

Inquiry Experiment: Bag 'O M&Ms (see experiment details below).

Resources:

Guided and Independent Practice:

- http://nshs-science.org/chemistry/common/pdf/WS2-isotope_notation.pdf
- http://www.rocklin.k12.ca.us/staff/lbrun/chemweb/Unit_3/Ions_worksheet.pdf
- http://misterguch.brinkster.net/PRA007.pdf

Inquiry Experiment:

- http://serc.carleton.edu/sp/mnstep/activities/20116.html
- http://extension.uga.edu/k12/science-behind-our-food/lesson-plans/BagOIsotopes.pdf

Vocabulary:

Anion
Atom
Atomic mass
Atomic number
Cation
Charge
Electron
Electron Cloud
Ion
Isotope
Neutron
Neutral Atom
Nucleus
Proton

Essential Questions:

- How are neutral atoms, isotopes, and ions the same?
- How are neutral atoms, isotopes, and ions different?

Experiment/Demonstration/Activity: (Science Processes/Eng. Design)

Inquiry Experiment: Bag 'O M&Ms In this chemistry laboratory activity, students will be given a random sample of the fictitious element "M&Mium." This sample contains at least three different "isotopes" of M&Mium (examples

• What identifies an atom?	include plain, peanut, almond, peanut butter, etc.). The students will design and carry out a procedure to determine the average "atomic" mass of the element M&Mium. See link below for activity instructions. • http://serc.carleton.edu/sp/mnstep/activities/20116.html • http://extension.uga.edu/k12/science-behind-our-food/lesson-plans/BagOIsotopes.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C4.10x**	**Standard:** The atomic mass listed on the periodic table is an average mass for all the different isotopes that exist, taking into account the percent and mass of each different isotope.		
	Unpacked Standard: **C4.10c** Calculate the average atomic mass of an element given the percent abundance and mass of the individual isotopes. **C4.10d** Predict which isotope will have the greatest abundance given the possible isotopes for an element and the average atomic mass in the periodic table. **C4.10e** Write the symbol for an isotope, $^{A}_{Z}X$, where *Z* is the atomic number, *A* is the mass number, and *X* is the symbol for the element.		
	Board Objective: I can determine the most common isotope of a particular element by calculating the average atomic mass of the element in order to determine the type of atom to use in future problems.		
NEXT GEN CODE: HS-PS1-3	**Next Gen Standard:** 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.		
	ACT Alignment: Interpretation of Data – Determine how the value of one variable changes as the value of another variable changes in a complex data presentation. Identify and/or use a simple mathematical relationship between data.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Calculate average atomic mass of an element • Predict which isotope is the most abundant • Identify the symbol for isotopes Pre-assessment: • Draw it out: Have students draw a model of an atom, isotope, and ion. Make sure students label protons, neutrons, electrons, nucleus, and electron cloud	Percentage occurrence of isotopes is used to predict average atomic mass. Average atomic mass is a weighted average. Weighted average is an average in which each quantity to be averaged is assigned a weight. These weightings determine the relative importance of each quantity on the average. Weightings are the equivalent of having that many like items with the same value involved in the average. Atomic mass numbers of isotopes will be given. Use the following equation to determine average atomic mass: Avg_{mass} = (Atomic Mass Isotope 1 * Relative abundance Isotope 1) + (Atomic Mass Isotope 2 * Relative abundance Isotope 2) + (Atomic Mass Isotope 3 * Relative abundance Isotope 3) +… Note: Students must convert % abundance to relative	Math practice will be required for students to calculate average atomic mass. Students can practice weighted averages by calculating grades, average atomic masses, etc. Teacher should show multiple examples. Make sure to use exit slips and show me strategies. Example: Rubidium has two common isotopes, 85Rb and 87Rb. If the abundance of85Rb is 72.2% and the abundance of 87Rb is 27.8%, what is the average atomic mass of rubidium?

• Vocabulary assessment – Crossword puzzle During: • Daily Assignments: Vocabulary work (crossword puzzle, definitions, worksheets), guided and individual practice, exit slips, and show me • Hands-on activity • Inquiry Lesson • Virtual Lab Post-assessment Unit Test	abundance by dividing % abundance by 100. This expectation should just require conceptualizing the isotope in greatest amount. Example: If B has only isotopes of B11 and B10 but the atomic mass is listed as B10.81; atoms of isotope 11 must be more abundant than isotope 10. To teach this topic for conceptual understanding students should be given exercises with the location of the A and Z switched so students don't memorize the location as the key to the answer. Example: $X^A{}_z$ or $X^z{}_A$	Avg_{mass} = (85 * 0.722) + (87 * 0.278) = 61.37 + 21.19 = 85.56 amu Hand-on activity: Isotopes (see activity details below) Inquiry experiment: Isotopes and Average Atomic Mass (see experiment details below) Virtual Lab: Average Atomic Mass (see experiment details below)

RESOURCES:	VOCABULARY:
• www.ptable.com Weighted Average Worksheets: • http://www.howellschools.com/webpages/kschwartz/files/weighted%20averages%20worksheet.pdf • http://www.howellschools.com/webpages/kschwartz/files/more%20weighted%20averages%20practice.pdf • http://www.glencoe.com/sec/math/algebra/algebra1/algebra1_03/study_guide/pdfs/alg1_pssg_G027.pdf Average atomic Mass worksheets: • http://westwood.sjsd.net/~shoesmith/FOV1-0003789A/FOV1-000378A1/average%20atomic%20mass.pdf • http://www.nhvweb.net/nhhs/science/apost/files/2013/08/chap-2-worksheets-key.pdf • http://campus.kellerisd.net/Teachers/23042/Classroom%20Information/Average%20Atomic%20Mass%20Worksheet%20-%20answers.pdf • http://chemistryconnections.com/Atomic%20Theory/aver	ABUNDANCE ACTUAL ATOMIC MASS ATOMIC MASS ATOMIC NUMBER AVERAGE ATOMIC MASS ELECTRONS ELEMENT ISOTOPE MASS NUMBER NEUTRONS PERCENT ABUNDANCE PROTONS RELATIVE ABUNDANCE

age%20atomic%20mass%20(4).pdf

Hands-on Activity:

- http://www.wccusd.net/cms/lib03/CA01001466/Centricity/domain/1040/grade%208%20lessons/IsotopesCardSortV1.pdf
- http://www.ionsource.com/Card/Mass/mass.htm

Inquiry Experiment:

- http://www.dsisd.txed.net/documentcenter/view/15736

Virtual Lab:

- http://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass

ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)

ESSENTIAL QUESTIONS:

- How do you determine the average atomic mass of an element?
- How do you calculate weighted averages?
- How do you determine the most abundant isotope of an element?

EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)

Hands-on activity: Isotopes. See link below for detailed instructions:
http://www.wccusd.net/cms/lib03/CA01001466/Centricity/domain/1040/grade%208%20lessons/IsotopesCardSortV1.pdf

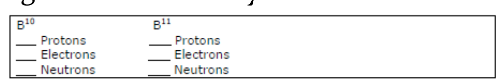
4) Using paper cut-outs (shown below) of isotopes of Boron, (B10 and B11). Fill in the subatomic particle inventory for each atom – using 5 atoms of B10 and

5 atoms of B11

b) Find the total mass in atomic mass units of all the 10 atoms (sum of the protons and neutrons for all 10 atoms)

c) Find the hypothetical atomic mass or the average mass of 1 atom.

d) Write the symbol for B and write the new average mass to 2 significant figures beside the symbol.



e) Make up a new hypothetical percentage of B10 and B11 and repeat part a. For example B10.5 or B10.2.

- http://www.ionsource.com/Card/Mass/mass.htm

f) Illustrate the relative abundance of isotopes by using familiar objects like M&Ms – plain and peanut.

Inquiry experiment: Isotopes and Average atomic mass: In this lab students

	will carry out experiments and perform the necessary calculations to determine the average atomic mass of the fictitious element Vegium. The three different isotopes of vegium are beanium, peaium and cornium. To determine the average Atomic Mass, they must take into account the percent abundance of each isotope. http://www.dsisd.txed.net/documentcenter/view/15736 Virtual Lab: Average Atomic Mass. Are all atoms of an element the same? How can you tell one isotope from another? Use the simulation to learn about isotopes and how abundance relates to the average atomic mass of an element. http://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C5.R1X**	**Standard:** The rate of a chemical reaction will depend upon (1) concentration of reacting species, (2) temperature of reaction, (3) pressure if reactants are gases, and (4) nature of the reactants. A model of matter composed of tiny particles that are in constant motion is used to explain rates of chemical reactions. *(recommended)*		
	Unpacked Standard: **C5.r1a** Predict how the rate of a chemical reaction will be influenced by changes in concentration, temperature, and pressure. *(recommended)* **C5.r1b** Explain how the rate of a reaction will depend on concentration, temperature, pressure, and nature of reactant. *(recommended)*		
	Board Objective: I can predict how the rate of a reaction will be affected by changing concentrations, pressure, and temperature in order to model the nature of the reaction.		
NEXT GEN CODE: HS-PS1-5	**Next Gen Standard:** 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		
	ACT Alignment: Scientific Investigation – Predict the results of an additional trial or measurement in an experiment.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to : • Predict how the rate of reaction is affected by changing concentrations, pressure, and temperature Pre-assessment: • Chemical Reactions evaluation – see if students understand how a	In order for a reaction to occur, the reactant particles must collide with one another with sufficient energy to cause a change (known as collision theory). The minimum amount of energy needed to initiate a reaction is called the activation energy. In the graph below, the activation energy of the forward reaction is given by (a). Overall the graph describes the energy change for an endothermic reaction. The ΔH is given by (c). If it is a reversible reaction, (b) represents the activation energy of the reverse reaction.	Be sure to students understand chemical reactions and the equations that represent them before introducing this standard. It is important for students to understand rates of reactions and equilibrium. It is important to direct students through this standard. One of the best ways for students to master this topic is to

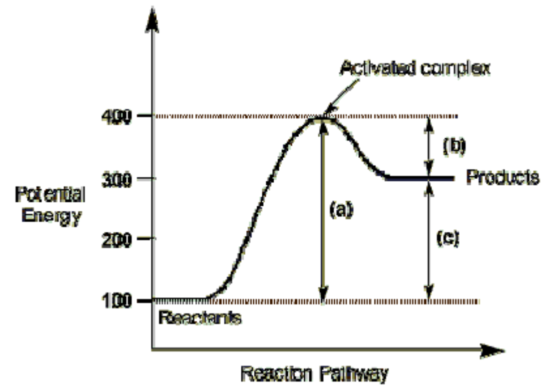
chemical reaction is modeled by a chemical equation. Make sure students understand basics such as reactants, products, coefficients, concentration, pressure, and temperature.

During:

- Daily Activities: Do Nows, guided practice, individual practice, vocabulary practice, and cold call.
- Inquiry Experiment

Post-assessment

- Unit Test



In general, a reaction with low activation energy would tend to be fast because more of the collisions would have enough energy for the reactants to react. Similarly, at a high temperature the reactants will have a high kinetic energy and more of the collisions result in reaction. Therefore, reactions at high temperature and low activation energy tend to react quickly. Other variables that affect the rate of a chemical reaction include concentration of reactants and pressure of gaseous reactants. The higher the concentration of reactants, the more frequently they collide and the faster the reaction. Also, the higher the pressure of gaseous reactants, the more frequently they collide, which speeds up the reaction.

conduct the inquiry experiment.

Inquiry Experiment: Rates of Reactions (see experiment details below)

Resources:

Daily Activities:

- http://www.docbrown.info/page03/3_31rates/11_31ratesJXprint.htm
- http://www.docbrown.info/page03/3_31rates/11_31ratesJXprint.htm

Inquiry Experiment:

- http://mypages.iit.edu/~smile/

Vocabulary:

Activated complex
Activation energy
Equilibrium
Equilibrium constant
Le Chatelier's Principle
Rate of reaction
Reversible reaction

Essential Questions:

- How is the rate of a reaction affected by temperature, concentration of aqueous reactants, pressure of gaseous reactants, surface area of solid reactants, and the presence

Experiment/Demonstration/Activity: (Science Processes/Eng. Design)

Inquiry Experiment: Rates of reaction. Students investigate how changes in concentration, pressure, and temperature affect the rate of the reaction. See link below for full procedure details: http://mypages.iit.edu/~smile/

of catalysts?	

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:

CODE: **C5.2**	**Standard:** Chemical changes can occur when two substances, elements, or compounds interact and produce one or more different substances whose physical and chemical properties are different from the interacting substances. When substances undergo chemical change, the number of atoms in the reactants is the same as the number of atoms in the products. This can be shown through simple balancing of chemical equations. Mass is conserved when substances undergo chemical change. The total mass of the interacting substances (reactants) is the same as the total mass of the substances produced (products).
	Unpacked Standard: **C5.2A** Balance simple chemical equations applying the conservation of matter. **C5.2B** Distinguish between chemical and physical changes in terms of the properties of the reactants and products. **C5.2C** Draw pictures to distinguish the relationships between atoms in physical and chemical changes.
	Board Objective: I can balance chemical equations by illustrating the atoms in order to explain the conservation of matter. I can compare and contrast between chemical and physical changes by illustrating the atoms in each change in order to understand the molecular properties of compounds.
NEXT GEN CODE: HS-PS1-2	**Next Gen Standard:** 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.
	ACT Alignment: Interpretation of Data – Determine how the value of one variable changes as the value of another variable changes in a complex data presentation. Identify and/or use a complex mathematical relationship between data. Understand basic scientific terminology.

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Balance chemical equations • Identify chemical and physical properties and changes Pre-assessment: • Have students identify all the components of a chemical equations: reactants, products, and coefficients • Have students explain and give examples of chemical and physical properties and changes During:	Balance chemical equations using coefficients to obey the law of conservation of matter. Teacher tip: Use the acronym MINOH for ordering of balancing. Order: Metals, polyatomic Ions, Nonmetals, Oxygen, Hydrogen. Draw representations of chemical equations using shapes to map out the reactants and products. EX: $\underline{2}\ H_2 + O_2 \rightarrow \underline{2}\ H_2O$ □□ + □□ + ●● → □●□ + □●□ A chemical equation describes what happens in a chemical reaction. The equation identifies the reactants (starting materials) and products (resulting substance), the formulas of the participants, the phases of the participants (solid, liquid, gas), and the amount of each	Hands-on Activity: Balancing equations using manipulatives (see activity details below). Demonstration: It's Chemical (see demonstration details below) Daily Activity: Guided and Individual Practice: • Use shapes of circles, triangles, squares, etc. to represent atoms for reactants and products to illustrate physical change and chemical change. Hands-on objects can be used also,

• Daily Activities: Guided and individual Practice • Hands-on activity • Demonstration • Inquiry Experiment	substance. Balancing a chemical equation refers to establishing the mathematical relationship between the quantity of reactants and products. The quantities are expressed as grams or moles. It takes practice to be able to write balanced equations. There are essentially three steps to the process: **Write the unbalanced equation.** • Chemical formulas of reactants are listed on the left hand side of the equation. • Products are listed on the right hand side of the equation. • Reactants and products are separated by putting an arrow between them to show the direction of the reaction. Reactions at equilibrium will have arrows facing both directions. **Balance the equation.** • Apply the Law of Conservation of Mass to get the same number of atoms of every element on each side of the equation. Tip: Start by balancing an element that appears in only *one* reactant and product. • Once one element is balanced, proceed to balance another, and another, until all elements are balanced. • Balance chemical formulas by placing coefficients in front of them. Do not add subscripts, because this will change the formulas. **Indicate the states of matter of the reactants and products.** • Use (g) for gaseous substances. • Use (s) for solids. • Use (l) for liquids. • Use (aq) for species in solution in water. • Write the state of matter immediately following the formula of the substance it describes. **Worked Example Problem** • Tin oxide is heated with hydrogen gas to form tin metal and water vapor. Write the balanced equation	example: nuts and bolts. • Balancing Chemical Equations practice (find links under resources) • Physical vs Chemical Changes practice (find links under resources. Inquiry Experiment: Investigating Physical and Chemical Changes (see experiment details below)

	that describes this reaction. **Write the unbalanced equation.** • $SnO_2 + H_2 \rightarrow Sn + H_2O$ • Refer to Table of Common Polyatomic Ions and Formulas if you have trouble writing the chemical formulas of the products and reactants. **Balance the equation.** • Look at the equation and see which elements are not balanced. In this case, there are two oxygen atoms on the left hand side of the equation and only one on the right hand side. Correct this by putting a coefficient of 2 in front of water: • $SnO_2 + H_2 \rightarrow Sn + 2\ H_2O$ • This puts the hydrogen atoms out of balance. Now there are two hydrogen atoms on the left and four hydrogen atoms on the right. To get four hydrogen atoms on the right, add a coefficient of 2 for the hydrogen gas. Remember, coefficients are multipliers, so if we write 2 H_2O it denotes 2x2=4 hydrogen atoms and 2x1=2 oxygen atoms. • $SnO_2 + 2\ H_2 \rightarrow Sn + 2\ H_2O$ • The equation is now balanced. Be sure to double-check your math! Each side of the equation has 1 atom of Sn, 2 atoms of O, and 4 atoms of H. **Indicate the physical states of the reactants and products.** • To do this, you need to be familiar with the properties of various compounds or you need to be told what the phases are for the chemicals in the reaction. Oxides are solids, hydrogen forms a diatomic gas, tin is a solid, and the term 'water vapor' indicates that water is in the gas phase: • $SnO_2(s) + 2\ H_2(g) \rightarrow Sn(s) + 2\ H_2O(g)$ **Chemical change** is any change that results in the formation of new chemical substances. At the molecular level, chemical change involves making or breaking of bonds between atoms.	

These changes are chemical:

- iron rusting (iron oxide forms)
- gasoline burning (water vapor and carbon dioxide form)
- eggs cooking (fluid protein molecules uncoil and crosslink to form a network)
- bread rising (yeast converts carbohydrates into carbon dioxide gas)
- milk souring (sour-tasting lactic acid is produced)
- sun tanning (vitamin D and melanin is produced)

Physical change rearranges molecules but doesn't affect their internal structures. Some examples of physical change are:

- whipping egg whites (air is forced into the fluid, but no new substance is produced)
- Magnetizing a compass needle (there is realignment of groups ("domains") of iron atoms, but no real change within the iron atoms themselves).
- Boiling water (water molecules are forced away from each other when the liquid changes to vapor, but the molecules are still H_2O.)
- Dissolving sugar in water (sugar molecules are dispersed within the water, but the individual sugar molecules are unchanged.)
- Dicing potatoes (cutting usually separates molecules without changing them.)

Classification of real processes can be tricky. Complex changes can be broken down into many simpler steps. Some of the steps are chemical and others are physical, so the overall process can't cleanly be placed in either category. For example, boiling coffee involves chemical change (the delicate molecules that give coffee its flavor react with air and become new, bitter-tasting substances) and physical change (the water in the coffee is going from liquid to gaseous form).

RESOURCES:	VOCABULARY:

Daily Activities – Balancing Chemical Equations: • http://funbasedlearning.com/chemistry/chemBalancer/worksheet.htm • http://www.kentchemistry.com/Worksheets/Regents/Units/MathofChem/WSBalancing21.pdf • http://chemistry.about.com/od/chemicalequations/a/How-To-Balance-Equations.htm • http://www.gallantsbiocorner.com/uploads/9/1/3/5/9135671/balancing_chemical_equations_with_key.pdf • http://www.chemicalformula.org/chemistry-help/balancing-chemical-equations-worksheets Daily Activities – Physical vs Chemical Changes: • http://www.currituck.k12.nc.us/cms/lib4/NC01001303/Centricity/Domain/149/Unit%202%20Physical%20and%20Chemical%20Change%20Worksheet.pdf • http://www.chemteam.info/Matter/WS-Physical&Chem-Changes.html • http://www.viking.portage.k12.oh.us/Blizzard%20Bag/Day%203/Knepp7-3.pdf • http://www.mtlsd.org/teachers/smeer/stuff/physical%20vs.%20chemical%20properties%20and%20changes%20key.pdf • http://www.pinterest.com/gotoddgo/physical-chemical-changes/ Hands-on Activity: • http://www.middleschoolscience.com/balance.html Demonstration: • http://www.alkaseltzer.com/as/student_experiment6.html Inquiry Experiment: • http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/lab1.html	CHEMICAL CHANGES CHEMICAL EQUATION CHEMICAL PROPERTIES COEFFICIENTS HYDROGEN METAL NONMETALS OXYGEN PHYSICAL CHANGES PHYSICAL PROPERTIES POLYATOMIC IONS PRODUCTS REACTANTS
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• How do balance equations follow the law of conservation of matter?	Hands-on Activity: Balancing equations using manipulatives. Students learn to balance equations through this hands-on activity. Click on link below to get

• What are some physical and chemical changes that you come across in everyday life?	cut-outs and hand-outs. http://www.middleschoolscience.com/balance.html Demonstration: It's Chemical. When two substances react together, they can form new chemicals or products. In this chemical reaction, the vinegar and baking soda react and create carbon dioxide. It is these bubbles of gas that inflate the balloon. See the following link for procedure: http://www.alkaseltzer.com/as/student_experiment6.html Inquiry Experiment: Investigating Physical and Chemical Changes. Students compare and contrast between physical and chemical changes. See procedure details at this website: http://www2.ucdsb.on.ca/tiss/stretton/CHEM1/lab1.html

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C5.2x**	**Standard:** A balanced chemical equation will allow one to predict the amount of product formed. **Unpacked Standard:** **C5.2d** Calculate the mass of a particular compound formed from the masses of starting materials. **C5.2e** Identify the limiting reagent when given the masses of more than one reactant. **C5.2f** Predict volumes of product gases using initial volumes of gases at the same temperature and pressure. **C5.2g** Calculate the number of atoms present in a given mass of element. **Board Objective:** I can calculate the mass of a compound by using stoichiometry principles in order to determine the limiting and excess reagents. I can predict the volumes of gases by using stoichiometry principles in order to determine the proper measurements needed for experimentation. I can calculate the number of atoms of a compound by using stoichiometry principles t in order to determine the proper measurements needed for experimentation.		
NEXT GEN CODE: HS-PS1-6 HS-PS1-7	**Next Gen Standard:** 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. **ACT Alignment:** Interpretation of Data – Determine how the value of one variable changes as the value of another variable changes in a complex data presentation. Identify and/or use a complex mathematical relationship between data. Understand basic scientific terminology.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able: • Use stoichiometry principles to calculate the mass and number	Coefficients in a balanced equation represent moles of the substances. The ratios between coefficients (the molar ratios) can be used in calculations. If the amount of starting material	Guided/Individual Practice: S'more Stoichiometry. Students use the analogy of making s'mores to complete

of atoms of a compound, determine limiting and excess reagents, and predict the amount of product produced by a chemical reaction. Pre-assessment: • Re-visit the mole concept. Have students complete mole mathematics before introducing stoichiometry During: • Daily Activities: Guided and Independent practice • Cooperative Lesson • Inquiry Experiments Post-assessment: • Unit Test	used is known, the amount of product formed can then be calculated. Once the amount of product formed is known, the limiting and excess reactants can be determined. The limiting reactant (sometimes called the limiting reagent) is the substance that is completely consumed during the chemical reaction and thus stops the reaction. The excess reactant is the reactant that is not completely consumed during the reaction and thus has some left over after the reaction stops. **EX: The reaction between nitrogen monoxide (NO) and oxygen to from nitrogen dioxide (NO_2) is a key step in photochemical smog formation.** $2NO + O_2 \rightarrow 2NO_2$ 4) How many moles of NO_2 are formed by the complete reaction of 0.254 moles of O_2? $0.254\ \text{mol } NO_2 \times \frac{1\ \text{mol } O_2}{2\ \text{mol } NO_2} = 0.127\ \text{mol } O_2$ B) How many grams of NO_2 are formed by the reaction of 1.44 grams of NO with excess O_2? Step 1: Get to moles Step 2: Set up a mole-to-mole ratio from the balanced equation. Step 3: Get to units asked for in question $1.44\ \text{g NO} \times \frac{1\ \text{mol NO}}{30.0\ \text{g NO}} \times \frac{1\ \text{mol } NO_2}{1\ \text{mol NO}} \times \frac{46.0\ \text{g } NO_2}{1\ \text{mol } NO_2} = 2.21\ \text{g } NO_2$ Determining the limiting and excess reactants are as simple as the above examples with a few extra steps. **EX: The reaction between aluminum and iron (III) oxide generates high temperatures and is therefore used in the welding process.** $2\ Al + Fe_2O_3 \rightarrow 2\ Fe + Al_2O_3$ In one process 124 g of Al are reacted with 601 g of Fe_2O_3. Use	stoichiometry examples and decided what is a limiting reagent and excess reagent. See the following link for the student handout: http://www.nclark.net/Smore_Stoichiometry_Teacher_Notes.pdf Cooperative Lesson – Given routine activities write scenarios that will describe a limiting reagent in action. a) Making S'mores around a camp fire (grahams, marshmallows, chocolate, roasting sticks.) b) Building bicycles from parts in a factory (frames, tires, chains). c) Ordering at a fast food drive-thru window. d) Have students peer review the scenarios with a partner. Inquiry Experiment #1: Baking Soda and Vinegar (see experiment details below) Inquiry Experiment #2: Micro Rocket Lab (see experiment details below) Inquiry Experiment #3: Stoichiometry of cooking (see experiment details below)

the following:

A) Start with one reactant and turn it into the other reactant (either one is fine to start with). Compare the answer with the given amount in the problem to determine if you have more of less of what is given. From this information, the limiting and excess reactants can be determined.

B) Determine how many grams of the product can be formed, starting with the limiting reactant.

C) Determine how much of your excess reactant is left over.

Part A)

124 g Al	1 mol Al	1 mol Fe_2O_3	159.7 g Fe_2O_3	=	367 g Fe_2O_3
	27.0 g Al	2 mol Al	1 mol Fe_2O_3		

The amount of iron (III) oxide needed to react with all of that aluminum is less that what is stated in the problem (601 g in the problem is more than the 367 g determined to be needed using the stoichiometric ratios), therefore iron (III) oxide is the excess reactant and aluminum is the limiting reactant.

Part B)

124 g Al	1 mol Al	1 mol Al_2O_3	102 g Al_2O_3	=	234 g Al_2O_3
	27.0 g Al	2 mol Al	1 mol Fe_2O_3		

There are 234 grams of Al_2O_3 produced during this reaction.

Part C)

124 g Al	1 mol Al	1 mol Fe_2O_3	159.7 g Fe_2O_3	=	367 g Fe_2O_3
	27.0 g Al	2 mol Al	1 mol Fe_2O_3		

Al is the limiting reactant, so we do a stoichiometric conversion to determine how much Fe2O3 is consumed during the reaction. 367 grams are used, so we simply subtract to determine how much of the excess reactant is left over.

601g Fe2O3 – 367 g Fe2O3 = 234 g Fe2O3 left over

8

RESOURCES:

Daily activities:

- http://misterguch.brinkster.net/WKS001_026_234211.pdf
- http://misterguch.brinkster.net/mar2002.pdf

VOCABULARY:

CHEMICAL CHANGE
CHEMICAL PROPERTY
COMBUSTION REACTION
DELTA (MEANING CHANGE)

• http://misterguch.brinkster.net/WKS001_030_367307.pdf • http://www.nclark.net/Smore_Stoichiometry_Teacher_Notes.pdf Inquiry Experiments: • http://www.syvuhsd.org/cms/lib4/CA01001173/Centricity/Domain/118/VinegarandBakingSodaStoichiometryLab.pdf • https://www.flinnsci.com/media/621403/91612.pdf • http://www.learner.org/workshops/chemistry/support/act5_a2.pdf	DOUBLE REPLACEMENT REACTION EXCESS REAGENT LIMITING REAGENT MOLAR VOLUME OXIDATION-REDUCTION REACTION REACTANTS PRODUCTS PHYSICAL CHANGE PHYSICAL PROPERTY SINGLE REPLACEMENT REACTION SYNTHESIS REACTION VOLUME YIELD
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How are balanced chemical equations used in stoichiometric calculations? • How can you calculate amounts of reactants and products in a reaction?	Inquiry Experiment #1: Baking Soda and Vinegar Limiting Reactant Lab. Students predict the amount of Carbon Dioxide gas that should be produced in a chemical reaction; then calculate the amount of CO_2 released, the percent yield. See link for full procedure: http://www.syvuhsd.org/cms/lib4/CA01001173/Centricity/Domain/118/VinegarandBakingSodaStoichiometryLab.pdf Inquiry Experiment #2: Micro Rocket Lab. The purpose of this microscale experiment is to generate hydrogen and oxygen and determine the optimum ratio for their combustion reaction to give water. The optimum ratio will be used to calculate the mole ratio for the reaction of hydrogen and oxygen in a balanced chemical equation. The concept of limiting reactants will be used to explain the results obtained with various hydrogen/oxygen gas mixtures. See link for procedure details: https://www.flinnsci.com/media/621403/91612.pdf Inquiry Experiment #3: Stoichiometry of Cooking. Students conduct this hands-on experiment to understand the meaning of stoichiometry and to relate to chemistry via everyday phenomena so that new concepts are better internalized. For full procedure, see the following link: http://www.learner.org/workshops/chemistry/support/act5_a2.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE:	**Standard:** Most chemical reactions reach a state of dynamic equilibrium where the rates of the forward and reverse reactions are equal.		

HS.Chemistry.TRG.1.1

C5.3x	**Unpacked Standard:** **C5.3a** Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle). **C5.3b** Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle). **C5.3c** Predict the extent reactants are converted to products using the value of the equilibrium constant.
	Board Objective: I can describe shifts in a chemical system by using Le Chatelier's Principle in order to predict the extent that reactants are converted to products.
NEXT GEN CODE: HS-PS1-6	**Next Gen Standard:** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium
	ACT Alignment: Interpretation of Data – Identify and/or use a complex mathematical relationship between data. Evaluation of Models, Inferences, and Experimental Results – Determine whether given information supports or contradicts a simple hypothesis or conclusion. Scientific Investigation – Predict results of an additional trial or measurement in an experiment.

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Describe equilibrium • Predict shifts in a chemical system • Predict the extent of reactants that are converted into products <u>Pre-assessment:</u> • Chemical equations – have students label the reactants, products, coefficients, and yield sign. <u>During:</u> • Daily Activities: Guided and Independent practice, cold call, show mes, exit slip, and verbal quizzes • Cooperative Learning Activity • Inquiry Experiment <u>Post-assessment</u> • Unit Test	**Le Chatelier's principle** allows us to predict the effects of changes in temperature, pressure, and concentration on a system at equilibrium. It states that if a system at equilibrium experiences a change, the system will shift its equilibrium to try to compensate for the change. • Changing the concentration (only with gases or aqueous solutions): If you lower the concentration or remove some of a species, the system will shift to produce more of that species. On the other hand, if you increase the concentration or add some of a species, the system will shift to produce less of that species. For example, in the equation: $H_2 + I_2 \rightleftharpoons 2HI$ If we remove some of the H_2, the system will shift towards the left (the reverse reaction will happen the most) to produce more H_2. • Changing the volume/pressure (only gases): When you increase the pressure (by decreasing the volume), the system will shift so the least number of gas molecules are formed because the more gas molecules there are, the more collisions there are. These collisions and the presence of gas molecules are what cause the pressure to increase. Likewise, when you decrease the pressure, the system will shift so the highest number of gas molecules is produced. For example, in the equation:	Real World Context: • Unprotected iron on automobiles or other steel structures will rust. • Batteries are electrochemical cells. • Hydrogen fuel cells produce water and energy using hydrogen and oxygen. • Outdoor grilling uses combustion, a redox reaction. • Commercially available hot and cold packs. • Electroplating • Sacrificial anodes (made of magnesium or zinc generally) are used on ships, in water heaters, and on the Alaskan pipeline to prevent corrosion of the primary metal. Guided Practice: Have students predict the effect of the reaction if the following conditions are met using Le

	$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ If the pressure is increased, the system will shift to the right because fewer gas molecules are produced in the forward reaction than in the reverse reaction. • Changing temperature: For every reaction which can go forwards and backwards, one direction is endothermic and the other is exothermic. A reaction is endothermic if it takes heat from its surroundings. On the other hand, a reaction is exothermic if it releases heat to the surroundings. If you increase the temperature, then the endothermic reaction will be favored because that will take in some of the excess heat. If you decrease the temperature, the exothermic reaction will be favored because it will produce the heat that was lost. For example, in the equation: $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$ + energy If the temperature was increased, the system would shift to the left and the reverse reaction would happen more because that would use some of the extra energy. • Using a catalyst: A catalyst increases the speed in which a reaction takes place, however it never has any effect on the equilibrium. When a chemical reaction is carried out in a closed container, the reaction eventually comes to "equilibrium." Equilibrium occurs when there is a constant ratio between the concentration of the reactants and the products. Different reactions have different equilibriums. Some may appear to be completely products; however, all reactions have some reactants present. A reaction may look "finished" when equilibrium is reached, but actually the forward and reverse reactions continue to happen at the same rate. A reverse reaction is when the written reaction goes from right to left instead of the forward reaction which proceeds from left to right. It is possible to write an equilibrium expression for a reaction. This can be expressed by concentrations of the products	Chatelier's Principle. Given the following equilibrium reaction: $2SO_3 (g) \rightarrow 2SO_2 (g) + O_2 (g)$ $\Delta H = 197$ kJ What effect will each of the following have on the amount of SO_3 in equilibrium? A. Oxygen gas is added. B. The pressure is increased by decreasing the volume. C. The temperature is decreased. D. Gaseous sulfur dioxide is removed. Cooperative Learning Activity: Equilibrium (see activity details below) Inquiry Experiment: Stress on Equilibrium (see experiment details below)

	divided by the concentration of the reactants with the coefficients of each equation acting as exponents. It is important to remember that only species in either the gas or aqueous phases are included in this expression because the concentrations for liquids and solids cannot change. For the reaction: aA + bB → cC + dD, the equilibrium expression (Keq) is: $$K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$ Where: K is the equilibrium constant. [A], [B], etc. are the molar concentrations of A, B, etc. a, b, etc. are the coefficients of the balanced reaction For every reaction at a specific temperature, there is only one value for K. A large value of K (greater than one) implies that there are more products than reactants. A small K value (less than one) implies there are more reactants than products. It is critical to remember that the only thing that changes K is changing temperature.	

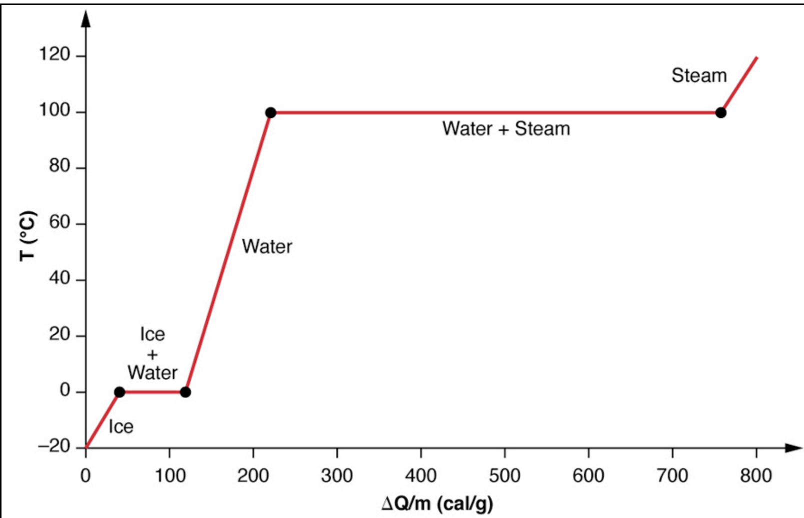
RESOURCES:	VOCABULARY:
Daily Activities: • http://mmsphyschem.com/lechatP.pdf • https://whsmorrisonchemistry.wikispaces.com/file/view/worskeet_lechateliers.pdf/506835032/worskeet_lechateliers.pdf • http://www.lmghs.org/ourpages/auto/2014/4/4/40545113/le%20chatelier%20ws%20keys.pdf • http://www.whitehall.k12.mi.us/SrHigh/Lessons/Cullen/equilibriumws.pdf • http://cms.cerritos.edu/uploads/Chemistry/Chem_111/111%20worksheets/Worksheet%20Equilibrium.pdf • http://web.gccaz.edu/~lisys52871/equilibriumkey.pdf Cooperative Learning Activity:	ANODE CATHODE ELECTROCHEMICAL CELL EQUILIBRIUM K_{EQ} LE CHATELIER OXIDATION OXIDATION-REDUCTION REACTION REDUCTION

• http://mypages.iit.edu/~smile/ch9116.html Inquiry Experiment: • http://www.foothill.edu/attach/psme/sinha.LeChatelierPrin.pdf	
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• What chemical reactions are reversible? • How can you identify when a chemical reaction has reached equilibrium? • What is Le Chatelier's Principle and how does it apply to chemical reactions?	Cooperative Learning Activity: Equilibrium. The student will distinguish between reactions that go to completion and those that are reversible, explain the concept of chemical equilibrium, and understand how Le Chatelier's Principle works on a chemical reaction at equilibrium. For complete procedure see: http://mypages.iit.edu/~smile/ch9116.html Inquiry Experiment: Stress on Equilibrium. Students will investigate Le Chatelier's Principle in several systems by shifting the equilibrium concentrations of reactants and products by applying a "stress" to the equilibrium. This experiment will demonstrate some observable equilibrium concentration shifts and give you a chance to relearn the technique of writing net-ionic equations. The stress that will be applied in the investigation will be either the addition of more reactant or product to the equilibrium mixture, increasing their concentration. Also, students will investigate the addition of a species that chemically reacts with either a reactant or product in the equilibrium mixture, lowering their concentration. For complete procedure see: http://www.foothill.edu/attach/psme/sinha.LeChatelierPrin.pdf

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C5.4**	**Standard:** Changes of state require a transfer of energy. Water has unusually high-energy changes associated with its changes of state.		
	Unpacked Standard: **C5.4A** Compare the energy required to raise the temperature of one gram of aluminum and one gram of water the same number of degrees. **C5.4B** Measure, plot, and interpret the graph of the temperature versus time of an ice-water mixture, under slow heating, through melting and boiling.		
	Board Objective: I can calculate the specific heat of a compound by using the appropriate mathematic formula in order to determine the amount of energy in the compound. I can determine the amount of energy converted in an ice-water mixture by graphing temperature vs. time in order to understand the that changes of states require a transfer of energy.		
NEXT GEN	**Next Gen Standard:** 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		

CODE: HS-PS1-4 HS-PS1-5	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. **ACT Alignment:** Scientific Investigation – Predict the results of an additional trial or measurement in an experiment	

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Calculate specific heat of a compound • Graph a temperature vs time of an ice-water mixture Pre-assessment: • KWL – state of mater and energy During: • Daily activities: guided and individual practice • Animations • Inquiry Experiments Post-assessment: • Unit Test	Heat released or absorbed in chemical reactions is proportional to the amounts of reactants consumed. When a reversible process occurs, the same amount of energy is involved no matter which way the reaction proceeds. The difference will be if the energy is released or absorbed. Why does water have such a high specific heat capacity? Hydrogen bonds cause water to have a greater specific heat (thermal inertia) than many other substances. When heat is applied to water, much of the heat is consumed in breaking hydrogen bonds. Broken hydrogen bonds are a form of potential energy. Much of the heat added to water is therefore stored as potential energy. Consequently, less heat is available to increase the kinetic energy of the water molecules. Since temperature is a measure of the kinetic energy, we find that as water is heated, its temperature rises slowly. By the same token, when water is cooled, its temperature drops slowly-as the kinetic energy decreases, molecules slow down and more hydrogen bonds are able to reform. This releases heat that helps to maintain the temperature. Phase changes can be diagramed to show temperature-time relationship and pressure-temperature relationships. Each compound has a different phase change diagram based on its molecular make up. Melting point and boiling point are indices used on these diagrams.	Animation: http://www.northland.cc.mn.us/biology/Biology1111/animations/hydrogenbonds.html Students can calculate specific heat of a compound. Use the following worksheets to assess understanding of material: • http://www.isd622.org/cms/lib07/MN01001375/Centricity/Domain/166/specific%20heat%20problems%20answer%20key.pdf • http://winterschemistry.com/wp-content/uploads/2012/03/Specific-Heat-Answers-2013.pdf • http://twcp.conroeisd.net/Teachers/tdelong/Chemistry%20Resources/FOV1-00100772/Specific%20Heat%20Worksheet%20Key.pdf?plugin=RWD&templates=RWD& • http://www.mrschamberlain.com/PHYS/ENERGY/Wksht_Intro_Specific_Heat&Calcs-1.pdf • http://www.muhsd.k12.ca.us/cms/lib5/CA01001051/Centricity/Domain/198/Specific%20Heat%20Calculations%202.pdf Inquiry Experiment #1 : Racing



Temperature (see experiment details below)

Phase Changes and Diagrams: Individual Practice:

- http://www.mayfield.k12.oh.us/userfiles/1250/Classes/10325/phase%20change%20worksheet%20and%20key-0.pdf
- http://misterguch.brinkster.net/PRA032.pdf
- http://www.sciencegeek.net/Chemistry/chempdfs/phasediagrams.pdf
- http://teacherweb.com/MA/CentralTreeMiddleSchool/Schmohl/phase_change_diagram_wsv1031.pdf

Inquiry Experiment #2: Temperature-Time Graph (see experiment details below)

RESOURCES:

Animation:

- http://www.northland.cc.mn.us/biology/Biology1111/animations/hydrogenbonds.html

Daily Activities:

- http://www.isd622.org/cms/lib07/MN01001375/Centricity/Domain/166/specific%20heat%20problems%20answer%20key.pdf
- http://winterschemistry.com/wp-content/uploads/2012/03/Specific-Heat-Answers-2013.pdf
- http://twcp.conroeisd.net/Teachers/tdelong/Chemistry%20Resources/FOV1-00100772/Specific%20Heat%20Worksheet%20Key.pdf?plugin=RWD&templates=RWD&

VOCABULARY:

BOILING
CHANGE OF STATE
ENERGY
GAS
LIQUID
MELTING
MOLECULE
PHASE CHANGE DIAGRAM
SOLID
SPECIFIC HEAT
STATE OF MATTER
TEMPERATURE

• http://www.mrschamberlain.com/PHYS/ENERGY/Wksht_Intro_Specific_Heat&Calcs-1.pdf • http://www.muhsd.k12.ca.us/cms/lib5/CA01001051/Centricity/Domain/198/Specific%20Heat%20Calculations%202.pdf • http://www.mayfield.k12.oh.us/userfiles/1250/Classes/10325/phase%20change%20worksheet%20and%20key-0.pdf • http://misterguch.brinkster.net/PRA032.pdf • http://www.sciencegeek.net/Chemistry/chempdfs/phasediagrams.pdf • http://teacherweb.com/MA/CentralTreeMiddleSchool/Schmohl/phase_change_diagram_wsv1031.pdf Inquiry Experiment: • http://www.chemteam.info/Thermochem/Time-Temperature-Graph.html	
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• Why is it necessary to find the specific heat of a compound? • How does temperature relate to the energy of atoms in a compound?	Inquiry Experiment #1: Racing Temperatures. Students will determine which substance has a higher specific heat. This example does not involve water, but it could be modified to add a test of the specific heat of water. Materials: Uncooked rice, table salt, 1-cup measuring cup, aluminum foil, baking sheet, two identical ceramic coffee mugs, thermometer. Procedure: 1.) Tear off two pieces of foil, each about half the size of the baking sheet. Place them side-by-side on the baking sheet. 2.) Measure out one sup of rice and pour onto one of the foil sheets. Measure out one cup of salt and pour onto the other foil sheet. 3.) Heat the rice and salt for 10 minutes in an oven preheated to 250C, and then pour the rice into one of the coffee mugs and the salt into the other. 4.) Use a thermometer to note which comes out of the oven at the higher temperature and which cools down faster. If you don't have a thermometer, leave the heated rice and salt on the aluminum foil and judge their cooling rates by cautious touch. Which has the higher specific heat?

	Inquiry Experiment #2: Temperature-Time Graph. Students investigate the temperature of an ice-water mixture through time. Have students measure the temperature of an ice-water mixture every 30 seconds. With the collected data students will graph the Temperature vs. Time of the ice-water mixture. For some guidance, see the following link: http://www.chemteam.info/Thermochem/Time-Temperature-Graph.html

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C5.4x**	**Standard:** All changes of state require energy. Changes in state that require energy involve breaking forces holding the particles together. The amount of energy will depend on the type of forces.		
	Unpacked Standard: **C5.4c** Explain why both the melting point and boiling points for water are significantly higher than other small molecules of comparable mass (e.g., ammonia and methane). **C5.4d** Explain why freezing is an exothermic change of state. **C5.4e** Compare the melting point of covalent compounds based on the strength of IMFs (intermolecular forces).		
	Board Objective: I can compare melting and boiling points of compounds by identifying the intermolecular forces of the compounds in order to explain the physical and chemical properties. I can explain freezing by illustrating the energy of the molecules in order to identify energy changes in a system.		
NEXT GEN CODE: HS-PS1-4 HS-PS1-5	**Next Gen Standard:** 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.		
	ACT Alignment: Interpretation of Data – Understand basic scientific terminology. Identify and/or use a simple mathematical relationship between data. Analyze given information when presented with new, simple information.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Identify intermolecular forces that affect melting and boiling points • Explain freezing at the molecular level Pre-assessment:	Within a family or a group of compounds with similar formulas, the dispersion forces increase as molecular mass increases. The larger the molecule, the greater the number of electrons available to create a temporary dipole are, and thus results in a stronger force of attraction. **Effects of Intermolecular Forces:** The strength of intermolecular forces present in a substance is related to the	Animation: Freezing. Students get to see the molecules in action as they freeze in this animation. Have students recreate these animations with a different substance. http://www.chem.purdue.edu/gchelp/liquids/freeze2.html

• KWL – Intermolecular forces and states of matter. During: • Animation Recreation • Intermolecular Forces and Phase Change Activity. • Cooperative Learning Activity • Inquiry Experiment Post-Assessment: • Unit Test	boiling point and melting point of the substance. Stronger intermolecular forces cause higher melting and boiling points. Examples: • CH_4 - Methane: Have only very weak London dispersion forces (lowest b.p. & m.p.) • $CHCl_3$ - Chloroform: has dipole-dipole interaction (moderate b.p. & m.p.) • NH_3 - Ammonia: has hydrogen bonding and dipole-dipole interaction (high b.p. & m.p.)	Intermolecular Forces and Phase Change Activities. In this document there are a number of great activities for students to explore intermolecular forces and phase changes. https://staff.rockwood.k12.mo.us/grayted/apchemistry/Documents/U7%20Intermolecular%20Forces/NOTES%201%20Intermolecular%20Bonding%20and%20Phases%20T.pdf Cooperative learning activity: Kinetic Cards (see activity details below) Inquiry Experiment: Kinetic Molecular Activity in Popcorn (see experiment details below)

RESOURCES:	VOCABULARY:
Animation: • http://www.chem.purdue.edu/gchelp/liquids/freeze2.html Content Information: • http://www.chem.ufl.edu/~itl/2045/lectures/lec_g.html Intermolecular Forces and Phase Change Activities: • https://staff.rockwood.k12.mo.us/grayted/apchemistry/Documents/U7%20Intermolecular%20Forces/NOTES%201%20Intermolecular%20Bonding%20and%20Phases%20T.pdf • Inquiry Experiment: http://teachers.net/lessons/posts/91.html	BOILING BOILING POINT CHEMICAL CHANGE CONDENSATION DEPOSITION FREEZING GASES ENDOTHERMIC EVAPORATION EXOTHERMIC INTERMOLECULAR FORCES LIQUIDS MELTING MELTING POINT PHASE CHANGE PHYSICAL CHANGE SOLIDS SUBLIMATION
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)

• How are solids, liquids, and gases different? How are they similar? • How are intermolecular forces and boiling points related? • How are intermolecular forces and melting points related?	Cooperative Learning activity: Kinetic Cards. The purpose of this activity is to allow students the opportunity to review new concepts and terminology related to states of matter. This would be a great way for students to vocabulary. Have students: • Generate words, phrases, or drawings that come to mind when they think of: States of Matter and Temperature • Work in small groups to share ideas and group them into categories. • Observe and analyze the work of other groups. One student stays behind at the table to answer questions and to note which cards are clear to the other students and which ones need further clarification. • Discuss what they observed and to revise or add new ideas/categories based on class feedback. • Create a class set of the cards. Students can keep their cards in an index box for further study. Inquiry Experiment: Kinetic Molecular Activity in Popcorn. The object of the activity is to use popcorn kernels as molecules and the margarine as the bonding forces between them. Heating produces physical changes in the popcorn-margarine mixture which are analogous to melting and boiling points of matter. See the following link for full procedure: http://teachers.net/lessons/posts/91.html

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C5.5**	**Standard:** An atom's electron configuration, particularly of the outermost electrons, determines how the atom can interact with other atoms. The interactions between atoms that hold them together in molecules or between oppositely charged ions are called chemical bonds.		
	Unpacked Standard: **C5.5A** Predict if the bonding between two atoms of different elements will be primarily ionic or covalent. **C5.5B** Predict the formula for binary compounds of main group elements.		
	Board Objective: I can illustrate the bonding between atoms by using the periodic table in order to predict if the bonding will be primarily ionic or covalent. I can predict the formula for binary compounds by using the periodic table in order to determine the electron placement.		
NEXT GEN CODE:	**Next Gen Standard:** 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-PS1-2	**ACT Alignment:** Interpretation of Data – Translate information into a table, graph, or diagram. Understand basic scientific terminology

Assessments:	Concept Notes:	Lesson Strategies:
Students should be able to: • Use periodic table to predict ion or covalent bonding between two or more elements. • Illustrate bonding between elements • Predict formulas for binary compounds Pre-assessment: • Periodic Table – Label periodic table by metals, nonmetals, and metalloids • KWL During: • Animation • Daily Assignments: Guided and Individual practice worksheets, cold call, show me • Inquiry experiment • Quizzes Post-assessment • Unit Test	The periodic table organizes the known elements into periods and families with similar properties. The periodic table is organized to display trends in the characteristics of elements. The type of chemical bonding determines some characteristic properties of materials. Bonds can be differentiated by looking at physical properties of the compound and/or by looking at whether the atoms are metallic or nonmetallic on the periodic table. Ionic compounds consist of a metal and a nonmetal, they are brittle, will conduct electricity if melted or dissolved in water, and they have high melting points. Ionic bonds will be favored when atoms from groups 1 and 2 in the periodic table, bond with atoms from groups 16 and 17. Ionic bonding can also be expected if a compound consists of a metal atom and ions containing hydroxide, sulfate, sulfite, nitrate, nitrite, carbonate and ammonium. Covalent bonding can be predicted when two nonmetal atoms bond or when a metalloid atom bonds with a nonmetal atom. Physical properties can also be used to predict covalent bonding. If physical properties do not indicate ionic bonding then the bond should be assumed to be covalent. The main group elements are found in columns 1, 2, and 13-18 on modern periodic tables. Column 18 does not react under normal conditions and will not be used here.	Animation: Ionic and Covalent Bonding. This animation allows students to visually see the difference between ionic and covalent bonding at the molecular level. http://www.mhhe.com/physsci/chemistry/animations/chang_7e_esp/bom1s2_11.swf. To integrate the animation into the lesson, have student illustrate the compounds in the animation or test for understanding by having students illustrate compounds similar to those that were animated. Bonding Basics: Worksheets for students where they are able to predict ionic and covalent bonds using the periodic table. • http://www.oakland.k12.mi.us/Portals/0/Learning/bonding.pdf • http://www.sciencespot.net/Media/chbondionic.pdf Inquiry Experiment: Comparing Ionic and Covalent Bonds (see experiment details below).

Resources:	Vocabulary:
Animation: • http://www.mhhe.com/physsci/chemistry/animations/chang_7e_esp/bom1s2_11.swf Daily Assignments: • http://www.oakland.k12.mi.us/Portals/0/Learning/bonding.pdf • http://www.sciencespot.net/Media/chbondionic.pdf	Anion Atomic Mass Atomic Number Cation Covalent bond Group ion Ionic Bond

Inquiry Experiment: • http://www.nclark.net/Compounds	METAL METALLOID NEUTRAL ATOM NONMETAL PERIOD PERIODIC TABLE
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• What determines if elements bond ionicly or covalently? • How are formulas for ionicly and covalently bonded compounds determined?	Inquiry Activity: Comparing Ionic and Covalent Bonds. Find Details under Labs: Use common substance and determine if they are ionic or covalent. Visit the following website to get Word Doc version of experiment: http://www.nclark.net/Compounds

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C5.5x**	**Standard:** Chemical bonds can be classified as ionic, covalent, and metallic. The properties of a compound depend on the types of bonds holding the atoms together. **Unpacked Standard:** **C5.5c** Draw Lewis structures for simple compounds. **C5.5d** Compare the relative melting point, electrical and thermal conductivity, and hardness for ionic, metallic, and covalent compounds. **C5.5e** Relate the melting point, hardness, and electrical and thermal conductivity of a substance to its structure. **Board Objective:** I can illustrate covalent bonds and ionic bonds by drawing the Lewis structure for atoms in order to model bonding energy and properties of the compound.		
NEXT GEN CODE: HS-PS1-4	**Next Gen Standard:** 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. **ACT Alignment:** Evaluation of Models, Inferences, and Experimental Results – Identify similarities and differences between models.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Illustrate covalent and ionic bonds using Lewis dot structures • Compare and contrast properties of ionic, metallic, and covalent compounds. Pre-assessment: • Bonding Quiz - Predict if	Lewis structures can be drawn for covalent and ionic compounds. Examples should be limited to nonmetal binary compounds with single center atoms, for example: H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2, H_2O, H_2S, HCl, HBr, HI, SF_2, SCl_2, SBr_2, SI_2, NCl_3, NBr_3, NI_3, PCl_3, PBr_3, PI_3, CH_4. Exclusion: Resonance structures and expanded octets. Among the many covalently bonded compounds are: plastics ceramics/glasses, waxes, and common room temperature liquids and gases. Ionic bonds form very strong bonds. They form salts like table	Hands-on Activity: Build-A-Molecule (see activity details below) Bonding Basics: Students draw Lewis dot structures for covalent and ionic bonds: • http://www.sciencespot.net/Media/chbondionic.pdf Inquiry Experiment: Ionic, Covalent,

compounds are covalent, ionic or metallic based on their position in the periodic table <u>During</u>: • Daily Assignments: Guided and Individual practice worksheets, cold call, show me • Inquiry experiment • Hand-on Activity <u>Post-assessment</u> Unit Test	salt, NaCl. They are brittle, and while they dissolve easily in water they have high melting points, they are nonconductors as solids and don't readily corrode (react with gases in the air). Comparing properties should lead to understanding trends. Examples: Ionic, NaCl; metallic, Na; covalent, paraffin. Physical properties of a substance depend on the strength and types of bonding holding it together. Use examples: common covalent network (diamond or silicon dioxide), a metal (copper or gold), and ionic substance (sodium chloride).	and Metallic Bonding Lab (see experiment details below).

RESOURCES:	VOCABULARY:
Daily Assignments: • http://www.sciencespot.net/Media/chbondionic.pdf • http://www.acschools.org/cms/lib07/PA01916405/Centricity/Domain/362/Chemical%20Bonds%20and%20Lewis%20Dot%20Structures%20Worksheet.pdf • http://misterguch.brinkster.net/PRA017.pdf • http://myweb.astate.edu/mdraganj/LewisDotanswers.html Hands-on Activity: • Activity #2 from: http://www.oakland.k12.mi.us/Portals/0/Learning/bonding.pdf Inquiry Experiment: • Activity #3 from: http://www.oakland.k12.mi.us/Portals/0/Learning/bonding.pdf	ATOMIC BONDING PRINCIPLES AVOGADRO'S HYPOTHESIS BINARY COMPOUND CHEMICAL BOND CHEMICAL PROPERTIES OF ELEMENTS COVALENT BOND EARTH'S ELEMENTS ELECTRICAL CONDUCTIVITY ELECTRONEGATIVITY ELECTRON SHARING ELECTRON TRANSFER ELEMENT FAMILY ELEMENTS OF MATTER ENERGY SUBLEVELS PERIODIC TABLE OF THE ELEMENTS IONIC BOND IONIZATION ENERGY LEWIS STRUCTURES MAIN ENERGY LEVEL MAIN GROUP ELEMENTS METALLOIDS METALLIC BOND ORBITAL SHAPE OUTER ELECTRON

	THERMAL CONDUCTIVITY
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• What are the differences between ionic, covalent, and metallic compounds? The similarities? • How can I illustrate ionic and covalent bonds?	Hands-on Activity: Build-A-Molecule. Students investigate Lewis dot structure through the use of gumdrops and toothpicks. Choose Activity #2 from http://www.oakland.k12.mi.us/Portals/0/Learning/bonding.pdf Inquiry Experiment: Ionic, Covalent, and Metallic Bonding Lab. Students investigate properties of ionic, covalent, and metallic bonding. See Activity #3 from http://www.oakland.k12.mi.us/Portals/0/Learning/bonding.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C5.6x**	**Standard:** Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve electron transfer are known as oxidation/reduction (or "redox").		
	Unpacked Standard: **C5.6a** Balance half-reactions and describe them as oxidations or reductions. **C5.6b** Predict single replacement reactions. **C5.6c** Explain oxidation occurring when two different metals are in contact. **C5.6d** Calculate the voltage for spontaneous redox reactions from the standard reduction potentials. **C5.6e** Identify the reactions occurring at the anode and cathode in an electrochemical cell.		
	Board Objective: I can balance half-reactions by describing them as oxidation and reductions in order to describe how batteries work. I can create a battery by using a lemon in order to apply redox reaction rules to the real world. I can predict products or single replacement reactions by using the appropriate rules in order to identify real world examples of the reactions. I can balance redox reactions and single replacement reaction by using the appropriate tools in order to create chemical reactions. I can compare and contrast dry cell and wet cell batteries by conducting research in order to apply chemistry concepts to the real world.		
NEXT GEN CODE: HS-PS1-2	**Next Gen Standard:** 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.		
	ACT Alignment: Evaluation of Models, Inferences, and Experimental Results – Use new information to make a prediction based on a model. Identify similarities and differences between models. Scientific Investigation – Predict the results of an additional trial or measurement in an experiment Interpretation of Data – Compare or combine data from a complex data presentation. Analyze given information when presented with new, complex information.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Identify redox reactions • Identify oxidations and	**Redox:** Redox is an abbreviation that combines the concepts of "Reduction" and "Oxidation." Redox reactions result from the competition for electrons between atoms. This is indicated	Show me or Exit Slips Example: Give students a reaction and have them identify and balance the reduction half

reductions of redox reactions • Balance redox reactions and single replacement reactions • Predict products of single replacement reactions • Explain how batteries work • Create a lemon battery • Compare and contrast between dry cell and wet cell batteries <u>Pre-assessment:</u> • Review of oxidation states based on electronegativity <u>During:</u> • Daily activities: show me and exit slips, guided and individual practice, quizzes to check for understanding • Inquiry Experiment #1 • Inquiry Experiment #2 • Cooperative Learning Activity <u>Post-assessment</u> • Unit Test	by a change in the expected oxidation numbers of atoms as they progress from reactants to products. Oxidation and reduction occur SIMULTANEOUSLY and cannot occur without the other [conservation of mass and conservation of charge] **Oxidation State:** Oxidation number is the charge an atom possesses, or appears to possess, when electrons are counted according to certain arbitrary rules. Electrons shared between 2 unlike atoms are counted as belonging to the more electronegative atom Electrons shared between 2 like atoms are counted being shared equally between the sharing atoms. Oxidation occurs at the anode and reduction occurs at the cathode. Limit these reactions to balancing electrons on reactant or product side of the equation. Example: $Mg \rightarrow Mg^{2+} + 2e^-$ $Cl_2 + 2e^- \rightarrow 2Cl^-$ Single Replacement Reactions: A single-displacement reaction, also called single-replacement reaction, is a type of oxidation-reduction chemical reaction when an element or ion moves out of one compound and into another. (One element is replaced by another in a compound.) This is usually written as $A + BC \rightarrow AC + B$ This will occur if A is more reactive than B. You can refer to the reactivity series to be sure of this. A single displacement reaction example. A and B must be either: different metals (hydrogen's behavior as a cation renders it as a metal here), in which case X represents an anion; or halogens, in which case X represents a cation. For example the reaction between silver nitrate, $AgNO_3$, and zinc, Zn, forms silver, Ag, and zinc nitrate, $Zn(NO_3)_2$.	reaction, and identify and balance the oxidation half reaction: $3\ Cu\ (s) + 8\ HNO_3\ (aq) \rightarrow 3\ Cu(NO_3)_2\ (aq) + 2\ NO + 4\ H_2O\ (s)$ Oxidation ½ reaction: $3\ (\ Cu\ (s) \rightarrow Cu^{2+}\ (aq) + 2\ e^-\ )$ Reduction ½ reaction: $2\ (\ N^{+5}\ (aq) + 3\ e^- \rightarrow N^{+2}\ (s)\ )$ Have students predict the products of a single replacement reactions and balance the equation by giving them just the reactants: Ex: HCl + Mg Answer: $2\ HCl + Mg \rightarrow H_2 + MgCl_2$ Inquiry Experiment #1: The Lemon Battery (see activity details below) Inquiry Experiment #2: Single Replacement Reaction (see experiment details below) Cooperative learning: Split students into groups of two. Have 1 student from each group conduct research on dry cell batteries. Have the other students conduct research on wet cell batteries. Students write individual summary papers. Students go into their groups and share research summaries. As a group, students will complete a research essay that explains how the batteries are similar and different. Why is one used over the other for specific applications? Students should provide sources in MLA format.

<table>
<tr><td></td><td>$2AgNO_3(aq) + Zn(s) \rightarrow 2Ag(s) + Zn(NO_3)_2(aq)$

Students should learn to predict hypothetical products from single replacement reactions and then predict if the reaction will actually form products indicated using the appropriate activity series table.
$3CuCl_2\ (aq) + 2Al\ (s) \dashrightarrow 3Cu\ (s) + 2AlCl_3\ (aq)$</td><td></td></tr>
</table>

<table>
<tr><th>RESOURCES:</th><th>VOCABULARY:</th></tr>
<tr><td>Daily Assignments:
• http://www.sciencegeek.net/Chemistry/chempdfs/EquationsWorksheet4.pdf
• http://bhhs.bhusd.org/ourpages/auto/2010/6/28/55919701/Chapter%2020%20Worksheet%20Redox.pdf
• http://www.lmghs.org/ourpages/auto/2013/5/8/52952826/2-5%20Redox%20reactions%20practice%20worksheet%20with%20answers.pdf
• http://www.ahsd.org/science/siwak/chem1H/chapter4/11-12/Single%20Replacement%20Reactiosn%20WS%20ANSWERS.pdf
• http://www.chemistryconnections.com/Chemical%20Reaction%20Types/single%20replacement%20WS.pdf

Inquiry Experiment #1:
• http://www.carolina.com/teacher-resources/Interactive/creating-a-battery-with-lemons/tr10901.tr
• http://pbskids.org/zoom/activities/sci/lemonbattery.html

Inquiry Experiment #2:
• http://erika01pd2013.wikispaces.com/file/view/Single+Displacement+Lab.pdf</td><td>ANODE
CATHODE
ELECTROCHEMICAL CELL
OXIDATION
OXIDATION-REDUCTION REACTIONS
PRESSURE
PRODUCT
PROPERTIES OF REACTANTS
REACTANT
REAGENT
REDUCTION
RELEASE OF ENERGY
SINGLE REPLACEMENT REACTION</td></tr>
<tr><th>ESSENTIAL QUESTIONS:</th><th>EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)</th></tr>
<tr><td>• What kind of chemistry exists in batteries?
• What will the products be of a chemical reaction given the reactants?
• What household items can be used to make a battery?</td><td>Inquiry Experiment #1: The Lemon Battery. Students create a battery out of a lemon, copper wires, and pennies. Students will investigate redox reactions in this lab. See the following websites for experiment details.
• http://www.carolina.com/teacher-resources/Interactive/creating-a-</td></tr>
</table>

• How are redox reactions similar to single replacement reactions? • What kinds of reactions power our lives?	battery-with-lemons/tr10901.tr • http://pbskids.org/zoom/activities/sci/lemonbattery.html Inquiry Experiment #2: Single Replacement Reaction. Students create a single replacement reaction by using metals and an acid. See link below for full procedure: http://erika01pd2013.wikispaces.com/file/view/Single+Displacement+Lab.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C5.7**	**Standard:** Acids and bases are important classes of chemicals that are recognized by easily observed properties in the laboratory. Acids and bases will neutralize each other. Acid formulas usually begin with hydrogen, and base formulas are a metal with a hydroxide ion. As the pH decreases, a solution becomes more acidic. A difference of one pH unit is a factor of 10 in hydrogen ion concentration.		
	Unpacked Standard: **C5.7A** Recognize formulas for common inorganic acids, carboxylic acids, and bases formed from families I and II. **C5.7B** Predict products of an acid-base neutralization. **C5.7C** Describe tests that can be used to distinguish an acid from a base. **C5.7D** Classify various solutions as acidic or basic, given their pH. **C5.7E** Explain why lakes with limestone or calcium carbonate experience less adverse effects from acid rain than lakes with granite beds.		
	Board Objective: I can identify common acids and bases by calculating their pH in order to design an acid/base indicator. I can predict products of an acid-base neutralization by conducting a virtual lab in order to better understand the interactions between acids and bases. I can describe how acid rain affects the environment by explaining how the acid interacts with naturally occurring substances in order to understand how our actions affect the world around us.		
NEXT GEN CODE: HS-PS1-6	**Next Gen Standard:** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.		
	ACT Alignment: Scientific Investigation – Determine the experimental conditions that would produce specified results. Understand methods and tools used in a moderately complex experiment. Interpretation of Data – Determine how the value of one variable changes as the value of another variable changes in a complex data presentation. Evaluation of Models, Inferences, and Experiment Results – Use new information to make a prediction based on a model		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to: • Identify common household products and foods as acids or bases • Compare and contrast between	Many household cleaners are acidic or basic. Examples of these are soaps, shampoos, window and toilet bowl cleaners, vinegar and drain cleaners. Foods such as soda, antacids, vinegar, and salad dressings are acidic or basic and many food processing techniques adhere to strict pH ranges. Indicators	Real World Connections: Introduce acids and bases by displaying common household and food items. Have students deduce which products are neutral, acidic, or basic and create a list

acids and bases • Identify acids or bases by using an indicator • Understand acid-base neutralizations • Explain how acid rain affects the environment <u>Pre-assessment:</u> • KWL chart <u>During:</u> • Introduction activity • Guided Practice • Daily work – worksheets, text rendering, article annotations, guided and individual practice • Inquiry lab • Virtual lab • Cooperative Learning activity <u>Post-assessment</u> • Unit Test	can be used to test swimming pools, and some fruits and vegetables may be used as indicators. Plants such as hydrangeas bloom blue in acidic soil and pink in alkaline soil. Limit examples of inorganic acids to: HCl, HBr, and HI Limit common oxy-acids to: H_2SO_4 and HNO_3 Limit carboxylic acids to: H_2CO_3 and $HC_2H_3O_2$. Limit bases to: hydroxides of alkali and alkaline earth metals. Use examples to illustrate that a salt and water are products of the reaction. Example: $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$ Limit indicators to litmus, phenolphthalein and universal indicator both in the aqueous form and treated paper form. For universal indicator, color changes or a color chart will be given. Other properties could also be used such as acidic foods taste sour and bases taste bitter and feel slippery. Acids react with most metals to produce hydrogen gas. Ph<7 acidic PH= 7 neutral PH > 7 basic Focus on the neutralization reaction. $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O$ Granite + $H_2SO_4 \rightarrow$ No Reaction Acid precipitation is defined to have a pH lower than 5.6. Freshwater lakes commonly are slightly basic. pH in the range of 6.5 to 8.2 is optimal for most organisms, and below 5.0 is lethal to many fish species. The susceptibility of lakes to changes in pH varies depending on how well buffered they are. Measured as alkalinity, the buffering capacity of water is a function primarily of the concentration of carbonate (CO_3^{-2}) and bicarbonate (HCO_3^{-1}) ions. In areas with limestone ($CaCO_3$) bedrock, surface waters have	of properties that can help identify each. Students should be able to identify some of the following properties. <u>Acids:</u> • Sour taste • Change color of indicators • React w/ metals to produce hydrogen • Conduct electricity • React w/ carbonates to produce CO_2 <u>Bases:</u> • Bitter taste • Feel slippery • Conduct electricity • Change color of indicators For mathematical formulas, provide guided practice and individual practice. Inquiry activity: Red Cabbage pH indicator lab (see activity details below) Virtual Lab: Acid-Base Titration virtual lab (see experiment details below) Cooperative Learning Activity: Acid Rain Activity(see activity details below)

	high concentrations of carbonate and bicarbonate and therefore are able to resist change in pH. The pH of a well-buffered lake does not change dramatically following a storm or snowmelt period because the acidity becomes neutralized by these ions. In regions where the bedrock is granite, the soils and surface waters are naturally low in alkalinity. One such region is the Adirondack Mountains, where approximately 20% of the lakes are too acidic to support fish life.	

RESOURCES:	VOCABULARY:
Daily Work: • http://www.unit5.org/Page/4037 • http://www.skanschools.org/webpages/rallen/five.cfm?subpage=194654 • http://whs.woodridge.k12.oh.us/apps/pages/index.jsp?uREC_ID=62809&type=u&termREC_ID=&pREC_ID=117370 Inquiry Experiment: • http://chemistry.about.com/od/acidsbase1/a/red-cabbage-ph-indicator.htm • http://www.stevespanglerscience.com/lab/experiments/red-cabbage-chemistry Virtual Lab: • http://chemcollective.org/acid-base • http://ir.chem.cmu.edu/vlab/vlab.php • http://phet.colorado.edu/en/simulation/acid-base-solutions Cooperative Learning: • http://www.dnrec.state.de.us/DNREC2000/Divisions/AWM/aqm/education/airqualityLesson6.pdf	ACID RAIN ACID/BASE REACTION ACIDIC ALKALINE BASIC BRONSTED-LOWRY CARBOXYL GROUP HYDROGEN ION HYDRONIUM ION HYDROXIDE ION K_a K_w NEUTRAL NEUTRALIZE pH TITRATION

ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• What are strong acids and weak acids? • What are strong bases and weak bases? • How do pH indicators predict acids and bases? • What are the products of acid-base neutralizations?	Inquiry Lesson: Can we make our own pH indicator? Using red cabbage; design an experiment to extract the juice from the cabbage. Make a table showing the color changes associated with red cabbage juice. Extension: Grape juice can also be used.

• How does acid rain affect our environment?	Virtual Lab: Have students complete an acid-base neutralization titration lab virtually. See the following websites for simulations: • http://chemcollective.org/acid-base • http://ir.chem.cmu.edu/vlab/vlab.php • http://phet.colorado.edu/en/simulation/acid-base-solutions Cooperative Learning Activity: Choose from a variety of acid rain activities in which students work in groups to better understand how acid rain affects the environment. http://www.dnrec.state.de.us/DNREC2000/Divisions/AWM/aqm/education/airqualityLesson6.pdf

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C5.7x**	**Standard:** Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve proton transfer are known as acid/base reactions.		
	Unpacked Standard: **C5.7f** Write balanced chemical equations for reactions between acids and bases and perform calculations with balanced equations. **C5.7g** Calculate the pH from the hydronium ion or hydroxide ion concentration. **C5.7h** Explain why sulfur oxides and nitrogen oxides contribute to acid rain. **C5.r7i** Identify the Brønsted-Lowry conjugate acid-base pairs in an equation. *(recommended)*		
	Board Objective: I can write a balance chemical equation by using reactions between acids and bases in order to understand real world applications of acid and base reactions. I can calculate the pH for acids and bases by using the concentration of hydronium or hydroxide ions in order to track the proton transfer. I can describe how sulfur oxides and nitrogen oxides contribute to acid rain by explaining how the acids interact with naturally occurring substances in order to understand how our actions affect the world around us. I can identify Bronsted-Lowry acid/base reactions by identifying conjugate acid-base pairs in an equation in order to understand how acids and bases interact with each other.		
NEXT GEN CODE: HS-PS1-6	**Next Gen Standard:** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*		
	ACT Alignment: Scientific Investigation – Determine the experimental conditions that would produce specified results. Understand methods and tools used in a moderately complex experiment. Interpretation of Data – Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Students should be able to:	When calculating the pH of a solution given the hydrogen ion	Students must understand how to

• Write a balanced chemical equation using acid and base reactions • Calculate pH by using mathematical equation • Explain how acid rain affects the environment • Identify Bronsted-Lowry conjugate acid-base pairs <u>Pre-assessment</u>: • Vocabulary assessment • pH Scale quiz • KWL (in conjunction with standard 5.7) <u>During:</u> • Daily Assignments: Show Me, Guided Practice, Example Problems, and Individual Practice Worksheets • Interactive Game • Cooperative Learning Activity <u>Post-assessment</u> Unit Test	concentration [H+] (otherwise called hydronium ion concentration), or the hydroxide ion concentration of a strong acid or base, the following may be used in a conceptual course: pH – A measure of acidity (derived to make a number scale consisting of numbers between zero and 14) • pH = -log[H+] • pH $<$ 7 acidic • pH $>$ 7 basic • pH = 7 neutral The ion product constant of water may be used to find the pH of a solution. The value of the hydrogen ion concentration indicates the acidity and basicity of the solution. Kw (the ion product constant for water) is used to calculate either [H+] or [OH-] when the other is known. The pH can then be calculated using the [H+]. Kw = [H+] [OH-]. In pure water at 25ºC [H+] & [OH-] are equal to each other (1.0 x 10-7 M) so Kw = 1.0 x 10-14 M "Acid rain" is a broad term referring to a mixture of wet and dry deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids. The precursors, or chemical forerunners, of acid rain formation result from both natural sources, such as volcanoes and decaying vegetation, and man-made sources, primarily emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx) resulting from fossil fuel combustion. In the United States, roughly 2/3 of all SO2 and 1/4 of all NOx come from electric power generation that relies on burning fossil fuels, like coal. Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. The result is a mild solution of sulfuric acid and nitric acid. When sulfur dioxide and nitrogen oxides are released from power plants and other sources, prevailing winds blow these compounds across state and national borders, sometimes over hundreds of miles.	calculate pH and pOH of acids and bases. During lecture and lessons, be sure to have all students perform a “Show me”. Each student should practice a problem displayed on the board and show all work required to complete it. Students will then hold up their paper to show what their answer is. This allows you the opportunity to check for understanding quickly. Examples of a “Show Me” Problem”: <u>EX:</u> Calculate the pH of a HNO_3 solution whose H+ conc. is 0.76 M pH = -log [H+] pH = -log[0.76] pH = 0.12 <u>EX:</u> The pH of a juice is 3.33, calculate the H+ concentration. pH = -log[H+] 3.33 = -log[H+] 10-3.33 = [H+] 4.68 x 10-4 M = [H+] pOH = -log[OH-] 4 = pOH + pH 14 - pOH = pH <u>EX:</u> Calculate the H+ conc. in a solution whose OH- conc. is 1.3 M Kw = [H+][OH-] [H+] = <u>Kw</u> [OH-] = <u>1.0 x 10-14</u> 1.3 M = 7.7 x 10-15 pH = -log[7.7 x 10-15] pH = 14

	A Bronsted acid can donate a proton and a Bronsted base can accept a proton. For every Bronsted acid there is a conjugate base and vice versa. Ex: $NH_3 + HF \leftrightarrow NH_4^+ + F^-$ **Base + acid → conjugate acid + conjugate base**	Interactive game: pH vs. pOH (see activity details below) Be sure to assign individual practice work for students to practice at home. See resources section for a list of individual practice activities. Cooperative Learning Activity: Acid Rain Activity (see activity details below)

RESOURCES:	VOCABULARY:
Balancing Acid/Base Reactions: • www.msdiehl.com/resources/Equation+WS+5.doc pH and pOH calculations: • http://misterguch.brinkster.net/pra_solutionworksheets.html • http://che1.lf1.cuni.cz/html/Calculations1112_II_handout.pdf • http://www2.stetson.edu/~wgrubbs/datadriven/activitieswtg/activitieshydrogenwtg.html Bronsted-Lowry Acids and Bases: • http://hs.pequannock.org/ourpages/auto/2013/6/5/44856967/bronsted_lowry_acids_bases_KEY.pdf • http://coffman.dublin.k12.oh.us/teachers/teacherpages/Brown/Mr._Browns_Chemistry_Pages/Unit_14_Acids_&_Bases_files/Bronsted-LowryKEY.pdf • http://www.ylhs.org/apps/download/2/2EtWc72labYZ2gKVd7DsBghqtTnrajyLCLvsKLdLCNjHmrdi.pdf/Worksheet%20-%20Bronsted-Lowry%20Acids%20and%20Bases.pdf Interactive Game: • http://www.quia.com/rr/4051.html Cooperative Learning Activity:	ACID RAIN ACID/BASE REACTION ACIDIC ALKALINE BASIC BRONSTED-LOWRY CARBOXYL GROUP HYDROGEN ION HYDRONIUM ION HYDROXIDE ION K_a K_w NEUTRAL NEUTRALIZE pH TITRATION

• http://www.dnrec.state.de.us/DNREC2000/Divisions/AWM/aqm/education/airqualityLesson6.pdf	
ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• How can I determine the pH and/or pOH of acids and bases? • What are Bronsted-Lewis acids and bases? • How does acid rain affect our environment?	Interactive game: Have students complete this interactive game to ensure they understand the difference between pH and pOH. http://www.quia.com/rr/4051.html Cooperative Learning Activity: Choose from a variety of acid rain activities in which students work in groups to better understand how acid rain affects the environment. http://www.dnrec.state.de.us/DNREC2000/Divisions/AWM/aqm/education/airqualityLesson6.pdf

GRADE: 10th	**SUBJECT: Chemistry**	**STRAND:**	**TRG Pacing Summary:**
CODE: **C5.8**	**Standard:** The chemistry of carbon is important. Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.		
	Unpacked Standard: **C5.8A** Draw structural formulas for up to ten carbon chains of simple hydrocarbons. **C5.8B** Draw isomers for simple hydrocarbons. **C5.8C** Recognize that proteins, starches, and other large biological molecules are polymers.		
	Board Objective: I can identify all the isomers for a simple hydrocarbon by drawing the structural formula in order to understand how hydrocarbons affect our lives.		
NEXT GEN CODE: HS-PS1-2	**Next Gen Standard:** 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.		
	ACT Alignment: Interpretation of Data – Understand basic scientific terminology		

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
Student should be able to: • Identify and draw hydrocarbons based on their chemical formulas • Draw isomers for simple hydrocarbons <u>Pre-assessment:</u>	**Hydrocarbons:** Hydrocarbons are molecules composed exclusively of carbon and hydrogen which can be arranged in simple or complex chains, rings, and with single (alkane), double (alkene), or triple (alkyne) bonds.	Real World Connections: Almost all useable supplies of hydrocarbons are obtained from fossil fuels--coal, petroleum, and natural gas. Through distillation, crude oil is boiled and condensed over several fractions to give the desired mixture of compounds. Gasoline, for example, is a fraction boiling roughly between 40 and 200°C.

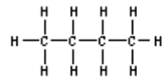
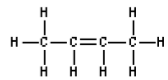
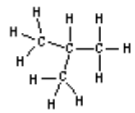
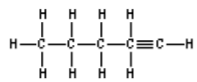
- Review of Covalent bonds.
- Quiz students on single, double and triple bonds

<u>During:</u>

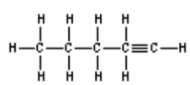
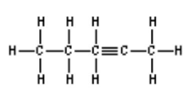
- Daily activities: video activities, guide and individual practice
- Hands-on activity
- Inquiry Experiment

<u>Post-assessment:</u>

- Unit Test

Lewis Structure	Organic Shorthand	Name
		Butane
		But-2-ene
		2-methyl propane
		Pent-1-yne

Isomer: Molecules with the same chemical formula but different structural connectivity are called isomers. Each isomer has a unique Lewis structure which allows for easy naming. Naming is based on the presence of double or triple bonds, the length of the longest carbon chain, and the lengths, numbers, and locations of any side chains.

Lewis Structure	Organic Shorthand	Name
		Pent-1-yne
		Pent-2-yne

Polymer: Large molecule composed of repeating smaller units. Examples include: proteins, starches, nucleic acids and cellulose.

The great number of carbon compounds is possible because of

The vapors that are condensed in this fraction are mostly alkanes and have between 5 to 10 carbon atoms.

Students will need much practice with the skills associated with naming and drawing hydrocarbons. During the lesson, provide a variety of guided practice problems and have students practice individually. Check for understanding often.

Video: Show students video animations. Pick from the list below:

- http://www.youtube.com/watch?v=R1B_UzZQAug
- http://www.youtube.com/watch?v=8EpaTZVHJYA

Hands-on activity: Build models and draw structural representations for the following substances: HCN, O_2, CO_2, $CHCl_3$, PH_3, and H_2S. (If isomers also exist, construct them as well.) After the model is built, then pretend to place it in an electric field and decide if the molecule will be polar or nonpolar. Identify the bonds in the molecule as being polar or nonpolar covalent.

Hands-on Activity: Organic Molecule name Game! (see activity details below)

Inquiry Experiment: Chemistry Hydrocarbon (see experiment details below)

	the ability of carbon to form strong covalent bonds to each other while also holding the atoms of other nonmetals strongly. Chains of carbon atoms can be thousands of atoms long, as in polyethylene.	

RESOURCES:	VOCABULARY:
Daily Activities: • https://chemistry58.wikispaces.com/file/view/hydrocarbon-naming-questions.pdf/202499144/hydrocarbon-naming-questions.pdf • https://chemistry58.wikispaces.com/Handouts+and+Answer+Keys • http://legacy.jefferson.kctcs.edu/users/kaya.muller/CHE120/Supplements/orgnomenclature/worksheets/ • http://www.ugdsb.on.ca/uploadedFiles/odss/science/chemistry/4U/unit2/Naming%20and%20Drawing%20Hydrocarbons.pdf • http://www.esrl.noaa.gov/gmd/infodata/lesson_plans/Naming%20and%20Creating%20Hydrocarbons.pdf • http://missballinger.com/vce-chemistry/unit-1-2/chapter-8-hydrocarbons/ Video: • http://www.youtube.com/watch?v=R1B_UzZQAug • http://www.youtube.com/watch?v=8EpaTZVHJYA Hands-on Activity: • http://www.ellenjmchenry.com/homeschool-freedownloads/chemistry-games/documents/OrganicMoleculesCardGame.pdf Inquiry Experiment: • http://chemtech.org/cn/cn1105/experiments/hydrocarbons.pdf	ALCOHOL ALKANE ALKENE ALKYNE BOILING POINT DOUBLE BOND ESTER FUNCTIONAL GROUP ISOMER HYDROCARBON LEWIS STRUCTURE PETROLEUM SINGLE BOND TRIPLE BOND

ESSENTIAL QUESTIONS:	EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)
• Can the properties of hydrocarbons be predicted by their formulas?	Hands-on Activity: Organic Molecule Name Game. Students create organic molecules from flash cards. For full procedure, see the following link: http://www.ellenjmchenry.com/homeschool-freedownloads/chemistry-

	games/documents/OrganicMoleculesCardGame.pdf Inquiry Experiment: Chemistry of Hydrocarbons. Students perform this experiment to distinguish the difference between various types of hydrocarbons by performing simple tests and reactions involving hydrocarbons. For full procedure, see the following link: http://chemtech.org/cn/cn1105/experiments/hydrocarbons.pdf

GRADE: 10th	SUBJECT: Chemistry	STRAND:	TRG Pacing Summary:
CODE: **C1.1** **C1.2**	**Standard:** Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process. **Standard:** The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.		
	Unpacked Standard: **C1.1A** Generate new questions that can be investigated in the laboratory or field. **C1.1B** Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions. **C1.1C** Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision). **C1.1D** Identify patterns in data and relate them to theoretical models. **C1.1E** Describe a reason for a given conclusion using evidence from an investigation. **C1.1f** Predict what would happen if the variables, methods, or timing of an investigation were changed. **C1.1g** Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation. **C1.1h** Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables. **C1.1i** Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate. **C1.2A** Critique whether or not specific questions can be answered through scientific investigations. **C1.2B** Identify and critique arguments about personal or societal issues based on scientific evidence.		

	C1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information. **C1.2D** Evaluate scientific explanations in a peer review process or discussion format. **C1.2E** Evaluate the future career and occupational prospects of science fields. **C1.2f** Critique solutions to problems, given criteria and scientific constraints. **C1.2g** Identify scientific tradeoffs in design decisions and choose among alternative solutions. **C1.2h** Describe the distinctions between scientific theories, laws, hypotheses, and observations. **C1.2i** Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge. **C1.2j** Apply science principles or scientific data to anticipate effects of technological design decisions. **C1.2k** Analyze how science and society interact from a historical, political, economic, or social perspective.
	Board Objective: I can design an experiment by using appropriate tools and techniques in order to investigate controlling variable, measurement error and validity. I can identify patterns in data by investigation evidence in order to critique a scientific conclusion.
NEXT GEN CODE: HS-PS1-1 HS-PS1-3 HS-PS1-8 HS-PS2-6 HS-PS1-2 HS-PS1-4 HS-PS1-6 HS-PS1-7 HS-PS3-1 HS-PS3-2 HS-PS3-4 HS-PS3-5	**Next Gen Standard:** 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-PS1-3 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-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-PS1-4 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-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects). 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 the components in the system (second law of thermodynamics). 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.

	ACT Alignment: Interpretation of Data – Compare or combine data from two or more data presentations. Identify and/or use complex mathematical relationships between data. Analyze given information when presented with new complex information. Scientific Investigation – Understand the methods and tools used in a complex experiment. Understand a complex experimental design. Predict the results of an additional trial or measurement in an experiment. Determine the experimental conditions that would produce specified results. Evaluation of Models, Inferences, and Experimental Results – Select a complex hypothesis, prediction or conclusion that is supported by a data presentation or model. Determine whether new information supports or weakens a model and why. Use new information to make a prediction based on a model.

ASSESSMENTS:	CONCEPT NOTES:	LESSON STRATEGIES:
	For this standard students will investigate the scientific method and the nature of science. Many of the principles that are discussed here will be applied through the year. In addition, ACT practice principles can be discussed during this standard. The Scientific Method is an organized way of figuring something out. There are usually six parts to it. **Purpose/Question**- What do you want to learn? An example would be, "What doorknob in school has the most germs?" or "Do girls have faster reflexes than boys?" or "Does the color of a light bulb affect the growth of grass seeds?" **Research**- Find out as much as you can. Look for information in books, on the internet, and by talking with teachers to get the most information you can before you start experimenting. **Hypothesis**- After doing your research, try to predict the answer to the problem. Another term for hypothesis is 'educated guess'. This is usually stated like " If I...(do something) then...(this will occur)" An example would be, "If I grow grass seeds under green light bulbs, then they will grow faster than plants growing under red light bulbs." **Experiment**- The fun part! Design a test or procedure to find out if your hypothesis is correct. In our example, you would set up grass seeds under a green light bulb and seeds under a red light and observe each for a couple of weeks. You would also set up grass seeds under regular white light so that you can compare it with the others. If you are doing this for a science fair, you will probably have to write down exactly what	For this standard, ACT example passages should be given as Do Nows. This is continued throughout the year. There are many resources for ACT practice and guidance. The best is to purchase an ACT book with practice ACT tests and give these passages and questions to the students. There are some resources online. You can see these in the Resource section. Ted-Ed lesson: How simple ideas lead to scientific discoveries. http://ed.ted.com/lessons/how-simple-ideas-lead-to-scientific-discoveries Demonstration: Case of the sunken ice cube. (see demonstration details below) Inquiry Experiment #1: Egg in a bottle (see experiment details below) Inquiry Experiment #2: Candle Observation (see experiment details below) Throughout Chemistry, students will be conducting, designing, and analyzing experiments. In addition, they will be

	you did for your experiment step by step. **<u>Analysis</u>**- Record what happened during the experiment. Also known as 'data'. **<u>Conclusion</u>**- Review the data and check to see if your hypothesis was correct. If the grass under the green light bulb grew faster, then you proved your hypothesis, if not, your hypothesis was wrong. It is not "bad" if your hypothesis was wrong, because you still discovered something! A few other terms you may need to know: Independent Variable - This is the part of your experiment that you will test (vary) to answer your hypothesis. In the example above, the independent variable would be the different colors of the light bulbs. Dependent Variable - This is what occurs in response to the changing independent variable. In our example the Dependent Variable is how much the grass seeds grow. Control - The control should be the part of the experiment where you do not include the Independent Variable. In our example, grass seed that is growing under the white (uncolored) bulb would be your control. The control lets you compare your results in the experiment. Some teachers have asked how “The Nature of Science” differs from “The Scientific Method.” There is a common myth that there is only one way to do science: The Scientific Method. However, in spite of its persistence in science textbooks and science standards, there actually is no one “scientific method." In addition, we find there is much more to science than its special ways of solving problems by testing proposed solutions. The “Nature of Science” (NoS), on the other hand, consists of those seldom-taught but very important features of working science, e.g., its realm and limits, its levels of uncertainty, its biases, its social aspects, and the reasons for its reliability. Popular ignorance of these features of science has led to many misuses, misrepresentations and abuses of science. **Science has its limits**; it cannot be used to solve any kind of	performing many hands-on activities to investigate various chemistry concepts. Make sure students are applying the principles of science throughout the year. See other standards for more investigations and experiments.

	problem. Science can only address *natural* phenomena (not supernatural phenomena, as such), and only *natural* explanations can be used in science. Supernatural or magical explanations cannot be definitively or reliably tested - they cannot be disproved, since any result of any test could be attributed to some supernatural or mysterious influence. Natural explanations are testable (open to being disproved) by being shown *not* to consistently follow the rules of nature. The fact that the most highly credible concepts in science today have survived such critical testing attests to the practical reliability of scientific knowledge and the processes of science that created that knowledge. Scientific solutions tend to work! In addition, scientific knowledge accumulates over time to give us an increasingly better understanding of the natural world. Questions that require subjective, political, religious, ethical or esthetic judgment are generally beyond the power of science. Science can be used to shed light on such issues, but it seldom provides any final answers. **Scientific knowledge is inherently uncertain.** What we know in science is only with a relative level of confidence - a particular degree of probability. Many ideas (understandings) in science have been extensively tested and found to be highly reliable, as close to a fact as an idea can be. Others are merely speculative hunches, awaiting suitable testing to measure their respective probabilities. And there is every level in between. **Science can be done poorly, and it can be misused.** There are many variations of medical quackery, false advertising and other forms of "pseudoscience," where unconfirmed claims are presented as "scientific fact" to "prove" a flood of discredited assertions about a whole range of seemingly mysterious phenomena. Students must learn (and practice) the critical strategies for recognizing such claims. **Science is a very social process.** It is done by people working together collaboratively. Its procedures, results and analyses must be shared with the scientific community, and the public,	

	through conferences and peer-reviewed publications. These communications are critically assessed by the science community, where errors, oversights and fraud can be exposed, while confirmation and consilience (agreement from different lines of evidence) can be achieved to strengthen its findings. Being done by people, science is also subject to any of the biases that its workers have, but its openness to critical science community oversight tends to expose those biases when they have been allowed to creep in.	

RESOURCES:	VOCABULARY:
Content Resources and Activities: • http://www.nap.edu/openbook.php?record_id=5787 • http://scienceonline.tki.org.nz/Nature-of-science/Nature-of-Science-Teaching-Activities ACT: • http://www.actstudent.org/sampletest/science/sci_01.html • http://www.act.org/caap/sampletest/pdf/Science.pdf • http://www.varsitytutors.com/act_science-practice-tests • http://www.mhpracticeplus.com/act.php Ted-Ed Lesson: • http://ed.ted.com/lessons/how-simple-ideas-lead-to-scientific-discoveries Demonstration: • http://www.nclark.net/CaseofSunkenIceCube.pdf Inquiry Experiments: • http://www.scs.sk.ca/cyber/elem/learningcommunity/sciences/science9/curr_content/science9/chemistry/lesson2t.html • http://www.nclark.net/CandleObservation	CONTROL HYPOTHESIS DEPENDENT VARIABLE EXPERIMENT INDEPENDENT VARIABLE MODELS OBSERVATIONS INQUIRY NATURE OF SCIENCE SCIENTIFIC METHOD
ESSENTIAL QUESTIONS:	**EXPERIMENT/DEMONSTRATION/ACTIVITY: (SCIENCE PROCESSES/ENG. DESIGN)**
• How do scientific principles affect our lives? • How can we use the nature of science to solve everyday problems?	Demonstration: The case of the sunken Ice Cube. Students investigate hypothesis and observations in this fun demonstration. See demo procedure in the following link: http://www.nclark.net/CaseofSunkenIceCube.pdf

	Inquiry Experiment: Egg in a bottle. Students use the scientific method in this inquiry experiment. See link for full details: http://www.scs.sk.ca/cyber/elem/learningcommunity/sciences/science9/curr_content/science9/chemistry/lesson2t.html Inquiry Experiment #2: Candle Observation: Students investigate what the requirements for and characteristics of a candle flame and what are the products of the combustion of a candle. See the link : http://www.nclark.net/CandleObservation