Colorado Teacher-Authored Instructional Unit Sample

Science

High School - Chemistry

Unit Title: Chemical Reactions

Colorado's District Sample Curriculum Project

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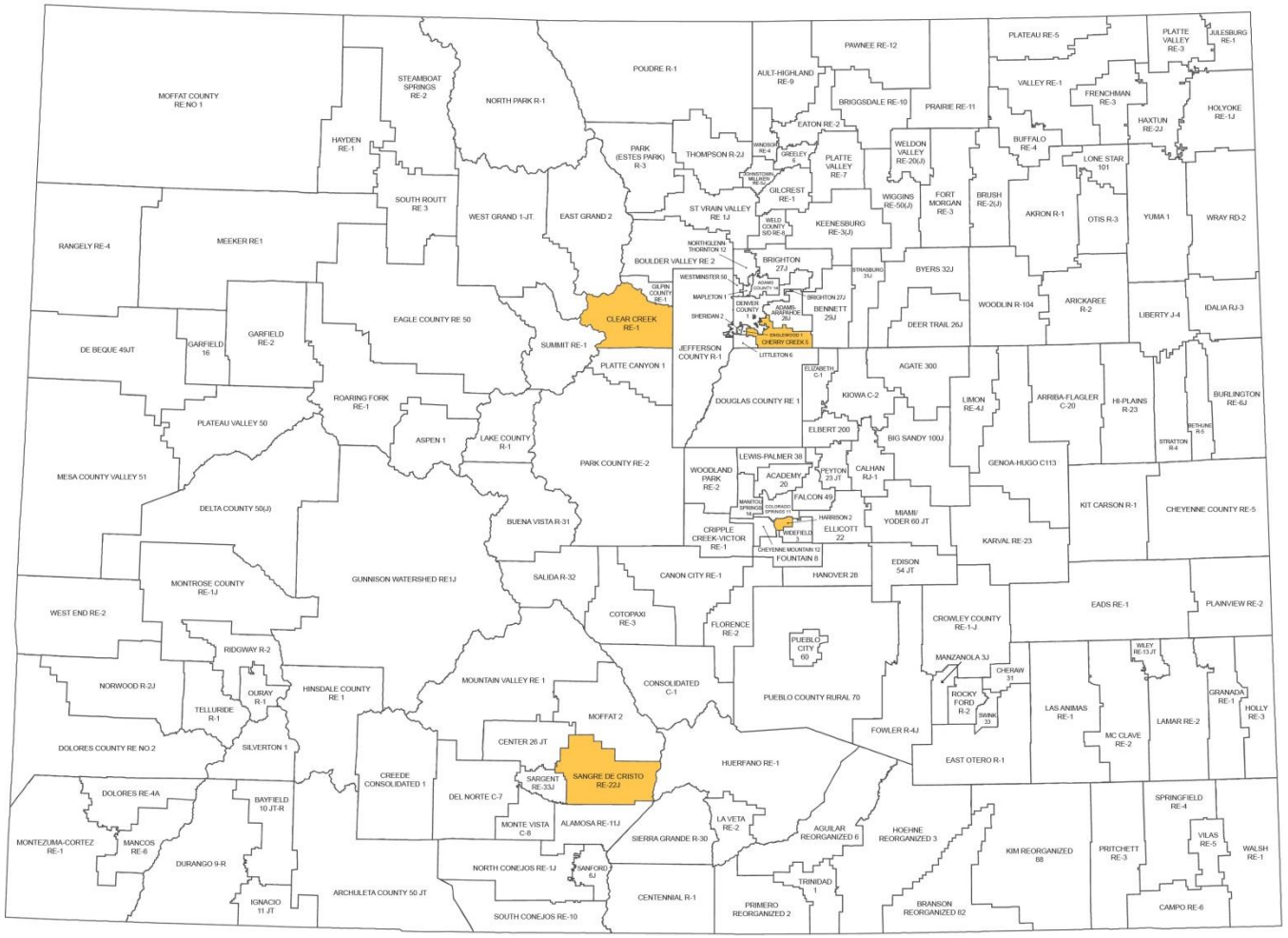

This unit was authored by a team of Colorado educators. The template provided one example of unit design that enabled teacher-authors to organize possible learning experiences, resources, differentiation, and assessments. The unit is intended to support teachers, schools, and districts as they make their own local decisions around the best instructional plans and practices for all students.

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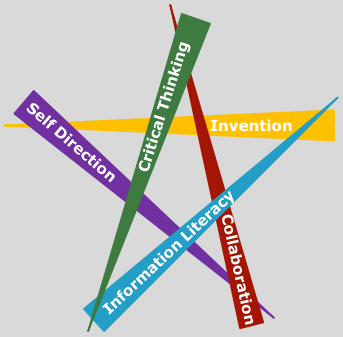
Colorado Teacher-Authored Sample Instructional Unit

Content Area	Science	**Grade Level**	High School
Course Name/Course Code	Chemistry		

Standard	**Grade Level Expectations (GLE)**	**GLE Code**
1. Physical Science	1. Newton's laws of motion and gravitation describe the relationships among forces acting on and between objects, their masses, and changes in their motion – but have limitations	SC09-GR.HS-S.1-GLE.1
	2. Matter has definite structure that determines characteristic physical and chemical properties	SC09-GR.HS-S.1-GLE.2
	3. Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy	SC09-GR.HS-S.1-GLE.3
	4. Atoms bond in different ways to form molecules and compounds that have definite properties	SC09-GR.HS-S.1-GLE.4
	5. Energy exists in many forms such as mechanical, chemical, electrical, radiant, thermal, and nuclear, that can be quantified and experimentally determined	SC09-GR.HS-S.1-GLE.5
	6. When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases	SC09-GR.HS-S.1-GLE.6
2. Life Science	1. Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem	SC09-GR.HS-S.2-GLE.1
	2. The size and persistence of populations depend on their interactions with each other and on the abiotic factors in an ecosystem	SC09-GR.HS-S.2-GLE.2
	3. Cellular metabolic activities are carried out by biomolecules produced by organisms	SC09-GR.HS-S.2-GLE.3
	4. The energy for life primarily derives from the interrelated processes of photosynthesis and cellular respiration. Photosynthesis transforms the sun's light energy into the chemical energy of molecular bonds. Cellular respiration allows cells to utilize chemical energy when these bonds are broken.	SC09-GR.HS-S.2-GLE.4
	5. Cells use the passive and active transport of substances across membranes to maintain relatively stable intracellular environments	SC09-GR.HS-S.2-GLE.5
	6. Cells, tissues, organs, and organ systems maintain relatively stable internal environments, even in the face of changing external environments	SC09-GR.HS-S.2-GLE.6
	7. Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins	SC09-GR.HS-S.2-GLE.7
	8. Multicellularity makes possible a division of labor at the cellular level through the expression of select genes, but not the entire genome	SC09-GR.HS-S.2-GLE.8
	9. Evolution occurs as the heritable characteristics of populations change across generations and can lead populations to become better adapted to their environment	SC09-GR.HS-S.2-GLE.9

3. Earth Systems Science	1. The history of the universe, solar system and Earth can be inferred from evidence left from past events	SC09-GR.HS-S.3-GLE.1
	2. As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet's geosphere, atmosphere, and biosphere in a variety of ways	SC09-GR.HS-S.3-GLE.2
	3. The theory of plate tectonics helps to explain geological, physical, and geographical features of Earth	SC09-GR.HS-S.3-GLE.3
	4. Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere	SC09-GR.HS-S.3-GLE.4
	5. There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources	SC09-GR.HS-S.3-GLE.5
	6. The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes	SC09-GR.HS-S.3-GLE.6
	7. Natural hazards have local, national and global impacts such as volcanoes, earthquakes, tsunamis, hurricanes, and thunderstorms	SC09-GR.HS-S.3-GLE.7

Colorado 21st Century Skills



Critical Thinking and Reasoning: *Thinking Deeply, Thinking Differently*

Information Literacy: *Untangling the Web*

Collaboration: *Working Together, Learning Together*

Self-Direction: *Own Your Learning*

Invention: *Creating Solutions*

Reading & Writing Standards for Literacy in Science and Technical Subjects 6 - 12

Reading Standards

- Key Ideas & Details
- Craft And Structure
- Integration of Knowledge and Ideas
- Range of Reading and Levels of Text Complexity

Writing Standards

- Text Types & Purposes
- Production and Distribution of Writing
- Research to Construct and Present Knowledge
- Range of Writing

Unit Titles	Length of Unit/Contact Hours	Unit Number/Sequence
Chemical Reactions	Teacher's discretion	3

Unit Title	Chemical Reactions			**Length of Unit**	Teacher's discretion
Focusing Lens(es)	Transformation Patterns	**Standards and Grade Level Expectations Addressed in this Unit**	SC09-GR.HS-S.1-GLE.3		
Inquiry Questions (Engaging-Debatable):	• If matter can't be created or destroyed, why are we running out of resources? (SC09-GR.HS-S.1-GLE.3-EO.d) • Why are compounds limited in living systems? (SC09-GR.HS-S.1-GLE.3-EO.c,d) • How are medicines related to chemical reactions? (SC09-GR.HS-S.1-GLE.3-EO.a,b,c) • What are positive and negative effects of chemical reactions? (SC09-GR.HS-S.1-GLE.3;RA.1,2)				
Unit Strands	Physical Science				
Concepts	Reactions, Equations, Quantities, Mass, Conservation, Classification, Prediction				

Generalizations **My students will Understand that…**	**Guiding Questions** **Factual**	**Conceptual**
Chemical reactions conserve mass as matter is neither created nor destroyed. (SC09-GR.HS-S.1-GLE.3-EO.d)	How is the law of conservation of mass/matter related to chemical reactions?	Why is the mass of products equal to the mass of reactants?
Products of chemical reactions follow predictable patterns based on classification (reaction type). (SC09-GR.HS-S.1-GLE.3-EO.a,b)	What are the differences among various reaction types? (SC09-GR.HS-S.1-GLE.3-EO.a)	What patterns of chemical reactions exist?
Balanced chemical equations illustrate the relationships between quantities of products and reactants. (SC09-GR.HS-S.1-GLE.3-EO.a,c,d)	How are amounts of products and/or reactants calculated from a balanced chemical equation? (SC09-GR.HS-S.1-GLE.3-EO.a,c)	How are chemical reactions used to maximize production in manufacturing? (SC09-GR.HS-S.1-GLE.3-EO.c)

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
• Why mass/matter is neither created nor destroyed in chemical reactions(SC09-GR.HS-S.1-GLE.3-EO.d) • Law of conservation of mass/matter)) (SC09-GR.HS-S.1-GLE.3-EO.c,d) • The difference between reactants and products in a chemical reaction (SC09-GR.HS-S.1-GLE.3-EO.a) • Characteristics of the main types of chemical reactions, including synthesis, decomposition, single-replacement, double-replacement, and combustion reactions (SC09-GR.HS-S.1-GLE.3-EO.a) • How reactants and products can be predicted based on the type of reaction (SC09-GR.HS-S.1-GLE.3-EO.b) • The connections between the amount(s) of product(s) produced and the amount(s) of reactant(s) involved in the reaction (SC09-GR.HS-S.1-GLE.3-EO.c) • Mole as a unit in chemistry that represents the amount of matter (SC09-GR.HS-S.1-GLE.3-EO.c) • The mole is equal to 6.02×10^{23} representative particles of matter (atoms, molecules, formula units, ions, etc.) (SC09-GR.HS-S.1-GLE.3-EO.c) • The role/effects of the limiting reactant in a chemical equation (SC09-GR.HS-S.1-GLE.3-EO.c)	• Calculate the amount(s) of reactant(s) and product(s) based on information given, using the law of conservation of mass (SC09-GR.HS-S.1-GLE.3-EO.c,d) • Write and balance a chemical equation to illustrate the law of conservation of mass / matter (SC09-GR.HS-S.1-GLE.3-EO.c,d) • Identify the reactant(s) and product(s) in a given chemical reaction (SC09-GR.HS-S.1-GLE.3-EO.a) • Identify reaction type based upon the reactant(s) given (SC09-GR.HS-S.1-GLE.3-EO.a,b) • Predict reactant(s) and product(s) for different types of chemical reactions (SC09-GR.HS-S.1-GLE.3-EO.b) • Analyze a balanced chemical equation and use the information to write mole ratios from the equation (SC09-GR.HS-S.1-GLE.3-EO.a) • Use mole ratios to determine relationships between substances in a chemical equation (SC09-GR.HS-S.1-GLE.3-EO.a) • Use the various stoichiometric calculations (mole-mole, mole-mass, mass-mole, mass-mass) to determine amounts of reactants and products in ideal stoichiometric calculations (SC09-GR.HS-S.1-GLE.3-EO.c) • Determine the limiting reactant of a chemical reaction, given appropriate data (SC09-GR.HS-S.1-GLE.3-EO.c) • Use an inquiry approach to test predictions about chemical reactions (i.e. titrations, activity series of metals and halogens, neutralization reactions, etc.) (SC09-GR.HS-S.1-GLE.3;N.3)

Critical Language: includes the Academic and Technical vocabulary, semantics, and discourse which are particular to and necessary for accessing a given discipline.
EXAMPLE: A student in Language Arts can demonstrate the ability to apply and comprehend critical language through the following statement: *"Mark Twain exposes the hypocrisy of slavery through the use of satire."*

A student in _____ can demonstrate the ability to apply and comprehend critical language through the following statement(s):	*A balanced chemical equation can be used to determine the amount(s) of reactant(s) and product(s).* *The limiting reactant of a chemical equation determines how much product is formed.* *Identifying the type of reaction can be determined by analysis of the reactant(s) and/or product(s).*
Academic Vocabulary:	inquiry, predict, develop, justify, communicate, analyze, gather, interpret, model, recognize, balance, calculate
Technical Vocabulary:	law of conservation of mass / matter, reactant, product, synthesis, decomposition, single-replacement, double-replacement, mole, activity series, neutralization, percent yield, theoretical yield, actual yield, limiting reactant, mole ratio, stoichiometry, balanced chemical equation, chemical equation, chemical reaction, combustion

Unit Description:	This unit focuses on chemical changes. The unit begins by differentiating between physical and chemical changes and then focuses on chemical equations as a means to represent, identify, and quantify a chemical reaction. The unit culminates in a performance assessment that asks students to investigate a reaction between zinc metal and HCl in order to identify the useful product, state the reaction type, and determine how much zinc would be required to make enough of this product.
Considerations:	Teachers need to consider timing for this unit based on district scheduling of Chemistry courses (i.e., semester or year-long course). It is important that the units around the periodic table, atomic structure, compounds, elements, symbols, nomenclature, molar mass, diatomic, and bonding precede this unit. The suggested sequence within the unit overview places this unit third and energy (which includes reaction rates and catalysts) fourth. Teachers need to consider if they want to include reaction rates and catalysts within this unit or leave them for the last unit. **Possible misconception:** Mass is not conserved when a gas is produced. Phase changes are chemical reactions.
Unit Generalizations	
Key Generalization:	Chemical reactions follow predictable patterns based on classification (reaction type)
Supporting Generalizations:	Chemical reactions conserve mass as matter is neither created nor destroyed
	Balanced chemical equations illustrate the relationships between quantities of products and reactants

Performance Assessment: *The capstone/summative assessment for this unit.*	
Claims: (Key generalization(s) to be mastered and demonstrated through the capstone assessment.)	Chemical reactions follow predictable patterns based on classification (reaction type)
Stimulus Material: (Engaging scenario that includes role, audience, goal/outcome and explicitly connects the key generalization)	A local battery company found using the product from the reaction of zinc metal and HCl increases battery life by 50%. The company has hired you to conduct an experiment to determine the (a) reaction type, (b) identity of the useful product, and (c) how much zinc is required to make the 4.83 g of product needed per battery. Other information: There are two products in the reaction. One is not useful and will bubble away during the reaction. Your task: Generate a report for the company in which you answer the three (a-c) requirements given in the introduction. Your report must include the products of this reaction, a balanced equation, the type of reaction, and the use of stoichiometry to determine the amount of product necessary for one battery.

Product/Evidence: (Expected product from students)	Students must predict the products of this reaction, write a balanced equation, identify the type of reaction, and use stoichiometry. Students will provide a written answer showing all work and justification. They must ascertain that $ZnCl_2$ is the useful product that increases the battery life. http://www.ohschools.k12.oh.us/userfiles/330/Classes/63/0Zinc%20and%20Acid%20Lab%20Instructions-0.doc (A procedure for Zn and HCl)
Differentiation: (Multiple modes for student expression)	• The teacher may provide students with a sentence stem for each step in the process • The teacher may provide students with a skeletal template for the process • The teacher may provide students with the identity of the gas To extend this work, teachers may have students: • determine the cost of the zinc required for each battery given zinc's current price, • perform the lab and test for hydrogen gas with a burning splint to support their product predictions, or • write half reactions for the oxidation and reduction processes (if redox has been introduced), or • determine reaction rate based on different concentrations of HCl (if rates have been introduced) http://www.infomine.com/investment/metal-prices/zinc/ (Prices for zinc metal)

Texts for independent reading or for class read aloud to support the content

Informational/Non-Fiction	Fiction
Chemical Reactions – Richard Spilsbury [lexile level 1100] *Chemistry: The Molecular Nature of Matter* – Martin Silberberg [lexile level 1270] *Chemistry* – Ann Newmark [lexile level 1040] *Chemical Reactions* – The Perfection Corporation [lexile level 980] *States of Matter* – Kristen Weir [lexile level 810] *The Periodic Table* –Sharon Cooper [lexile level 1080]	*Adventures of the Elements* – Richard E. James, III [lexile level 810] *Catalyst* –Laurie Anderson [lexile level 580]

Ongoing Discipline-Specific Learning Experiences

1.	Description:	Working like a scientist: Using mathematics to solve problems	Teacher Resources:	http://www.chem.tamu.edu/class/fyp/mathrev/mr-da.html (Website for dimensional analysis) http://www.endmemo.com/chem/mmass.php (Site with moles to mass calculator) http://education.jlab.org/elementbalancing/ (Game about balancing chemical equations) http://funbasedlearning.com/chemistry/chemBalancer/ (Game to practice balancing equations) https://phet.colorado.edu/en/simulation/balancing-chemical-equations (PhET simulation about balancing chemical equations) http://sciencespot.net/Pages/kdzchem.html (Science Spot-Chemistry) https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiometry/e/balancing_chemical_equations (Khan Academy-balancing chemical equations)

			Student Resources:	http://www.endmemo.com/chem/mmass.php (Site with moles to mass calculator) http://www.graphpad.com/quickcalcs/moleform.cfm (Graph pad for calculations of moles) http://www.youtube.com/watch?v=rwhJklbK8R0 (You tube-How to find mole ratio and molar mass) http://www.youtube.com/watch?v=S6UQX7ZdkTg (You tube-mole ration practice problems) http://education.jlab.org/elementbalancing/ (Game about balancing chemical equations) http://funbasedlearning.com/chemistry/chemBalancer/ (Game to practice balancing equations) https://phet.colorado.edu/en/simulation/balancing-chemical-equations (PhET simulation about balancing chemical equations) http://sciencespot.net/Pages/kdzchem.html (Science Spot-Chemistry) https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiometry/e/balancing_chemical_equations (Khan Academy-balancing chemical equations)
	Skills:	Write and balance equations Reinforce conservation in equations Understand moles Determine molar mass Convert mass to moles Conduct dimensional analysis	Assessment:	The student will be assessed within the learning experience
2.	Description:	Thinking like a scientist: Using systems of organization	Teacher Resources:	http://misterguch.brinkster.net/6typesofchemicalrxn.html (Different types of chemic al reactions) http://www.sparknotes.com/testprep/books/sat2/chemistry/chapter6section2.rhtml (Spark Notes-chemical reactions)
			Student Resources:	http://misterguch.brinkster.net/6typesofchemicalrxn.html (Different types of chemic al reactions) http://www.sparknotes.com/testprep/books/sat2/chemistry/chapter6section2.rhtml (Spark Notes-chemical reactions) https://phet.colorado.edu/en/simulations/category/chemistry (PhET Simulations- chemistry) http://www.science.uwaterloo.ca/~cchieh/cact/trios/simulation.html#reaction (Chemical reaction simulation)
	Skills:	Classify reactions Predict and identify patterns	Assessment:	The student will be assessed within the learning experiences
3.	Description:	Working like a scientist: Using models	Teacher Resources:	https://www.google.com/search?q=models+%2B+chemistry&tbm=isch&tbo=u&source=univ&sa=X&ei=FBErU7_6B8aaqwGCsoCACA&ved=0CDAQsAQ&biw=1024&bih=648 (Images of models in chemistry)

			Student Resources:	http://www.creative-chemistry.org.uk/molecules/ (Creative chemical molecular models)
	Skills	Create models Interpret models Writing chemical equations	Assessment	The student will be assessed within the learning experience
4.	Description:	Communicating like a scientist: Using chemistry terminology	Teacher Resources:	http://www.emsb.qc.ca/laurenhill/science/name.html (Site for practicing naming compounds) http://bowvalleycollege.ca/Documents/Learning%20Resource%20Services/Library%20Learning%20Commons/E-Resources/Study%20guides%202/chemistry%20rules_for_naming.pdf (Rules for naming compounds)
			Student Resources:	http://www.youtube.com/watch?v=7Lfc6jjp1WQ (You tube for naming ionic compounds) http://www.elementalmatter.info/types-of-compounds.htm (Types of chemical compounds)
	Skills:	Name compounds and elements from symbols Balance charge in ionic compounds Write compounds Identify types of compounds or elements (ionic, covalent, diatomic, hydrocarbon)	Assessment:	The student will be assessed within the learning experience

Prior Knowledge and Experiences

Students must have an understanding of electron configuration, atomic structure, metric system (including units), patterns, composition, CER writing, lab skills, conservation laws, classification, mass, matter, organization of the periodic table, moles, molar mass, powers of 10, number sense, cross multiplication, basic algebra, and ratios.

Vertical Articulation: Students have last seen concepts within this unit in 8^{th}, 7^{th}, 6^{th}, 5^{th}, 3^{rd}, 1^{st}, K and PK.

Learning Experiences # 1 – 2
Instructional Timeframe: Week 1

Learning Experience # 1

The teacher may provide concrete interactive experiences (e.g., labs, card sort, demonstrations) so students can explore the differences between chemical and physical changes.

Generalization Connection(s):	Chemical reactions conserve mass as matter is neither created nor destroyed

<table>
<tr><td>Teacher Resources:</td><td colspan="2">http://antoine.frostburg.edu/chem/senese/101/matter/faq/physical-chemical.shtml (Chemical and physical change)
https://www.google.com/search?q=physical+and+chemical+change&tbm=isch&tbo=u&source=univ&sa=X&ei=XQYrU8CTLcn0qAHYzIH4DA&ved=0CD4QsAQ&biw=1024&bih=648 (Images for chemical and physical change)
https://sites.jmu.edu/chemdemo/category/demo-database/physical-change/ (Demonstration of physical and chemical change)
http://www.teacherspayteachers.com/Product/Physical-and-Chemical-Changes-Sort-Cards-Matter-Changes-743882 (Card sort activity)</td></tr>
<tr><td>Student Resources:</td><td colspan="2">http://vital.cs.ohiou.edu/steamwebsite/downloads/ChangeLab.swf (Chemical and physical change animation lab)
http://www.glencoe.com/sites/common_assets/science/virtual_labs/E03/E03.html (Virtual lab for physical and chemical change)</td></tr>
<tr><td>Assessment:</td><td colspan="2">The student will generate a compare and contrast graphic organizer (e.g., double bubble, etc.) for chemical and physical changes.

http://www.eisd.net/cms/lib04/TX01001208/Centricity/Domain/599/DoubleBubbleMap.pdf (Thinking map for comparing and contrasting)</td></tr>
<tr><td rowspan="2">Differentiation:
(Multiple means for students to access content and multiple modes for student to express understanding.)</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>The teacher may assist students to organize their observations
The teacher may provide students with a word bank
The teacher may allow for partner work

http://www.eisd.net/cms/lib04/TX01001208/Centricity/Domain/599/FlowMap.pdf (Flow chart thinking map)</td><td>The student may compare and contrast chemical and physical changes verbally</td></tr>
<tr><td rowspan="2">Extensions for depth and complexity:</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>The teacher may allow students to provide unique examples of chemical and physical changes

http://www.edutopia.org/blog/science-inquiry-claim-evidence-reasoning-eric-brunsell (CER site)
https://docs.google.com/presentation/d/1sw6uY-Lpm_162rUwaSDFqG1PL7za0_c93szqZ0msodY/edit?pli=1#slide=id.p (CER presentation)
https://www.google.com/search?q=claim+evidence+reasoning&tbm=isch&tbo=u&source=univ&sa=X&ei=fQkrU7KmKtLhqAGt2YGgBQ&sqi=2&ved=0CCQQsAQ&biw=1024&bih=648 (Images of CER)</td><td>The student may use Claim, Evidence, Reasoning (CER) writing to demonstrate their understanding</td></tr>
<tr><td>Critical Content:</td><td colspan="2">• Chemical change
• Physical change</td></tr>
<tr><td>Key Skills:</td><td colspan="2">• Compare and contrast the chemical and physical change
• Use a graphic organizer</td></tr>
<tr><td>Critical Language:</td><td colspan="2">Chemical change, physical change, compare and contrast, graphic organizer</td></tr>
</table>

Learning Experience # 2		
The teacher may engage the students in using models (e.g., 3-D, digital, particulate diagram, ball and stick) to explain conservation of mass so students can begin discerning relationships between reactants and products.		
Generalization Connection(s):	Balanced chemical equations illustrate the relationships between quantities of products and reactants Chemical reactions conserve mass as matter is neither created nor destroyed	
Teacher Resources:	http://www.rosslattner.ca/pdf-9-lit-chemistry6.pdf (Pdf file of particle diagrams for chemical equations) http://www.kentchemistry.com/links/Matter/EndoExo.htm (Images of reactants and products) http://phet.colorado.edu/en/simulation/reactants-products-and-leftovers (PhET reactants and products simulation) http://www.bbc.co.uk/learningzone/clips/reactants-and-products/1852.html (BBC learning zone class clips-reactants and products) http://www.chem4kids.com/files/react_equilib.html (Chem 4 kids-reactants and products) http://www.engineeringtoolbox.com/conservation-mass-d_182.html (Engineering toolbox-conservation of mass) http://bit.ly/1gGJxFC (Images of conservation of mass) http://www.harmsy.freeuk.com/jig/index.html (Puzzle piece models of elements) http://en.wikipedia.org/wiki/Chemical_reaction (Includes pictorial and symbolic representations of reactions types) http://misterguch.brinkster.net/pra_equationworksheets.html (Example worksheets on chemical equations)	
Student Resources:	http://www.rosslattner.ca/pdf-9-lit-chemistry6.pdf (Pdf file of particle diagrams for chemical equations) http://phet.colorado.edu/en/simulation/reactants-products-and-leftovers (PhET reactants and products simulation) http://www.chem4kids.com/files/react_stoichio.html (Chem 4 kids- Stoichiometry background and rationale) http://www.nature.com/scitable/search-scitable?criteria=conservation%20of%20mass (Nature education-The law of conservation of mass, connection to carbon cycle and circle of life) http://www.chem.wisc.edu/deptfiles/genchem/sstutorial/Text1/Tx14/tx14.html (Conservation of mass tutorial) http://www.brainpop.com/science/matterandchemistry/conservationofmass/preview.weml (Brainpop-conservation of mass animation) https://drive.google.com/file/d/0B52Bg4Uj1RDOQzZla051YjQ0VE0/edit?usp=sharing (Particle diagram examples) https://www.google.com/search?q=conservation+of+mass&espv=210&es_sm=93&source=lnms&tbm=isch&sa=X&ei=vlojU-P2GYXe2AWOnYH4DQ&sqi=2&ved=0CAcQ_AUoAQ&biw=1093&bih=534 (Images of conservation of mass) http://www.youtube.com/watch?v=dExpJAECSL8 (You tube videos-conservation of mass)	
Assessment:	The students will draw particle diagrams demonstrating the relationship between reactants and products. https://www.google.com/search?q=particle+diagrams&tbm=isch&tbo=u&source=univ&sa=X&ei=j0MwU-7TGMiWyAHF6oDQDw&ved=0CCQQsAQ&biw=1680&bih=930 (Images of particle diagrams)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide an example of a diagram https://www.google.com/search?q=particle+diagram&tbm=isch&tbo=u&source=univ&sa=X&ei=lFcrU_myCI_9qAH-mYCIDQ&ved=0CCUQsAQ&biw=1366&bih=648 (Images for a particle diagram)	The student may demonstrate the change with a 3-D model

Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may allow students to research unique chemical reactions	The student may construct a 3-D models for their unique chemical reaction using other materials (e.g., toothpicks and gum drops)
Critical Content:	• Reactants and products • Rearrangement of atoms • Conservation of mass	
Key Skills:	• Modeling chemical reactions • Drawing diagrams • Interpreting models and diagrams	
Critical Language:	Reactants, products, conservation, mass, matter, model, diagram, draw, construct, interpret, rearrange, atoms, demonstrate, particle	

Learning Experiences # 3
Instructional Timeframe: Week 2

Learning Experience # 3		
The teacher may provide a variety of opportunities (e.g., reaction demonstrations, word equations, discussions) so students can begin to recognize the significance of using correct symbols (naming and subscripts) in relation to writing and balancing chemical equations representing reactions.		
Generalization Connection(s):	Balanced chemical equations illustrate the relationships between quantities of products and reactants Chemical reactions conserve mass as matter is neither created nor destroyed	
Teacher Resources:	https://www.khanacademy.org/science/mcat/physical-processes/stoichiometry/v/balancing-chemical-equations (Khan academy explanation of balancing chemical equations)	
Student Resources:	https://www.khanacademy.org/science/mcat/physical-processes/stoichiometry/v/balancing-chemical-equations (Khan academy explanation of balancing chemical equations)	
Assessment:	The students will write (e.g., white boards, worksheets, etc.) balanced equations using appropriate symbols. *Teacher Note*: At this stage of general chemistry, the equations are basic.	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide formulas and symbols The teacher may allow students to work cooperatively	N/A
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide opportunities to write and balance more complex equations	N/A

Critical Content:	• Coefficients • Formulas • Symbols • Equation format
Key Skills:	• Balancing equations • Writing equations
Critical Language:	Coefficients, balancing, equation, formulas, symbols, moles

Learning Experiences # 4 – 6
Instructional Timeframe: Week 1

Learning Experience # 4	
The teacher may present examples (e.g., variable equations, analogies) demonstrating patterns that chemical reactions follow so students can use the patterns to classify chemical reactions.	
Generalization Connection(s):	Chemical reactions follow predictable patterns based on classification (reaction type)
Teacher Resources:	Examples of classifying chemical reactions: Generic versions using letters $A + B \rightarrow AB$ (synthesis/combination), $AB \rightarrow A + B$ (decomposition), $A + BY \rightarrow B + AY$ or $Z + AY \rightarrow Y + AZ$ (single replacement/single displacement), $AX + BY \rightarrow AY + BX$ (double replacement), and Hydrocarbon + $O_2 \rightarrow H_2O + CO_2$ (combustion) "Dance" analogy provides a TPR to get students to recognize the different types of reactions (doesn't work for combustion) Single replacement is someone stealing another person's partner Double replacement is switching partners http://honorsph.startlogic.com/honorsphysicalscience/chemical_reaction_types.htm (Chemical reactions as a Dance and examples of writing and predicting reactions and determining if single and double replacement reactions occur) http://www.pogil.org/uploads/media_items/classifying-types-of-chemical-reactions.original.pdf (Chemical reactions as a Dance with examples) http://misterguch.brinkster.net/6typesofchemicalrxn.html (Different types of chemic al reactions) http://www.sparknotes.com/testprep/books/sat2/chemistry/chapter6section2.rhtml (Spark Notes-chemical reactions)
Student Resources:	http://honorsph.startlogic.com/honorsphysicalscience/chemical_reaction_types.htm (Written and graphical descriptions of dance analogy) https://phet.colorado.edu/en/simulations/category/chemistry (PhET Simulations- chemistry) http://www.science.uwaterloo.ca/~cchieh/cact/trios/simulation.html#reaction (Chemical reaction simulation)

<table>
<tr><td>Assessment:</td><td colspan="2">The student will identify reaction type when given an equation (e.g., paper/pencil exit pass).

http://www.readwritethink.org/files/resources/printouts/Exit%20Slips.pdf (Scaffolded exit tickets)</td></tr>
<tr><td rowspan="2">Differentiation:
(Multiple means for students to access content and multiple modes for student to express understanding.)</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>The teacher may provide manipulatives for students to physically rearrange the parts of each reaction type (i.e., cards labeled “A,” “B,” “X,” and “Y”)

The teacher may provide an activity where students become the different parts of reactions through physical motion</td><td>The student may demonstrate understanding by making a poster by sticking the manipulatives correctly for each reaction type

The student may be the “director” for the physical activity, naming the type of chemical reaction that is occurring</td></tr>
<tr><td rowspan="2">Extensions for depth and complexity:</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>The teacher may provide the opportunity for students to search online for additional examples of reaction types and accompanying media (e.g., pictures, videos)
[Recommendation: Use Google Images and Google Video search features.]

The teacher may include incomplete combustion and/or redox reactions, as appropriate for the students</td><td>The student may produce a digital presentation (e.g., Prezi, PowerPoint) using the media they found online

The student may demonstrate proficiency of identifying incomplete combustion and/or redox as part of the assessment</td></tr>
<tr><td>Critical Content:</td><td colspan="2">• Patterns
• Types of reactions (single replacement, double replacement, synthesis, decomposition, combustion)
• Activity series
• Solubility table or rules
• Conservation of mass
• Balancing equations
• Predictions</td></tr>
<tr><td>Key Skills:</td><td colspan="2">• Predict products
• Critical writing (i.e., Claim, Evidence, Reasoning {CER})
• Balance equations
• Recognize patterns
• Arrange elements and compounds within an equation
• Model chemical reactions
• Use context cues
• Compare products to reactants
• Use periodic table to determine charge and nature (metal vs. nonmetal)
• Recognize diatomic molecules (i.e., N_2, O_2, F_2, Cl_2, Br_2, I_2, and H_2)</td></tr>
<tr><td>Critical Language:</td><td colspan="2">Reactants, products, single replacement, double replacement, synthesis, decomposition, combustion, hydrocarbon, metal, nonmetal, periodic table, diatomic molecules, classify, organize, predict, patterns, activity series, solubility chart, precipitate</td></tr>
</table>

Learning Experience # 5		
The teacher may model demonstrations of reaction types so students can experience, observe, and begin to analyze chemical reactions.		
Generalization Connection(s):	Chemical reactions follow predictable patterns based on classification (reaction type)	
Teacher Resources:	The teacher may provide materials to create an activity series (metal strips and metal nitrates). The teacher may provide chemicals for a small-scale double-replacement and solubility lab. The teacher my demonstrate combustion using hydrocarbons (e.g., methane bubbles, whoosh bottle). http://www.youtube.com/watch?v=nsEkKIiOz7Q (Video of reaction type demos being performed) http://serc.carleton.edu/sp/mnstep/activities/27596.html (laboratory activity requiring students to identify reaction types)	
Student Resources:	http://www.youtube.com/watch?v=nsEkKIiOz7Q (Video of reaction type demos being performed) http://misterguch.brinkster.net/6typesofchemicalrxn.html (Different types of chemic al reactions) http://www.sparknotes.com/testprep/books/sat2/chemistry/chapter6section2.rhtml (Spark Notes-chemical reactions) http://www.chem.wisc.edu/deptfiles/genchem/demonstrations/Gen_Chem_Pages/04chemrxnpage/chemicalreactions.htm (Demo of single replacement reaction that makes a Christmas tree)	
Assessment:	The student will use the CER approach to explain why a particular example fits a specific reaction type. https://docs.google.com/presentation/d/1sw6uY-Lpm_162rUwaSDFqG1PL7za0_c93szqZ0msodY/edit?pli=1#slide=id.p (CER presentation)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide a detailed (written or verbal) explanation for each laboratory and demonstration example The teacher may allow the use of manipulatives (e.g., "puzzle pieces") during the laboratory and demonstration examples	The student may use the provided explanation to construct a symbolic or graphical representation of each example
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may give students the opportunity to design, predict, and perform original examples (preapproved for safety considerations) The teacher may include a discussion and demonstration of chemical complexes (e.g., acid + carbonate $\rightarrow$ salt + carbonic acid; carbonic acid $\rightarrow$ water + carbon dioxide) and provide the resources for students to create these complexes in a laboratory	The student may design, predict, and perform original examples (preapproved for safety considerations) The student may perform experiments in which chemical complexes are a product

Critical Content:	• Patterns • Types of reactions (single replacement, double replacement, synthesis, decomposition, combustion) • Activity series • Solubility table or rules • Conservation of mass • Balancing equations
Key Skills:	• Critical writing (i.e., Claim, Evidence , Reasoning [CER}) • Perform experiments • Observe chemical reactions • Predict products from patterns • Balance equations • Recognize patterns • Arrange elements and compounds within a chemical equation • Model a balanced chemical equation • Use context cues • Use periodic table to determine charge and nature (metal vs. nonmetal) • Recognize diatomic molecules (i.e., N_2, O_2, F_2, Cl_2, Br_2, I_2, and H_2) • Formulate examples (for extension) • Draw conclusions • Design experiment (extension) • Recognize chemical complexes
Critical Language:	Reactants, products, single replacement, double replacement, synthesis, decomposition, combustion, hydrocarbon, metal, nonmetal, periodic table, diatomic molecules, classify, organize, observe, predict, patterns, activity series, solubility chart, precipitate, carbonates, carbonic acid, chemical complexes, aqueous, ionic compounds, salt

Learning Experience # 6	
The teacher may provide simulations around single replacement, double replacement, synthesis, decomposition, and combustion so students can predict products from patterns and write balanced chemical equations.	
Generalization Connection(s):	Chemical reactions follow predictable patterns based on classification (reaction type) Balanced chemical equations illustrate the relationships between quantities of products and reactants
Teacher Resources:	Puzzle pieces for writing formulas Worksheets for practicing predicting, writing, and balancing equations based on reaction type (single replacement, double replacement, synthesis, decomposition, combustion https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiometry/e/balancing_chemical_equations (Khan Academy-balancing chemical equations) http://www.harmsy.freeuk.com/jig/index.html (Puzzle piece models of elements)

<table>
<tr><td></td><td colspan="2">http://honorsph.startlogic.com/honorsphysicalscience/chemical_reaction_types.htm (Chemical reactions as a Dance and examples of writing and predicting reactions and determining if single and double replacement reactions occur)

https://jeopardylabs.com/play/balancing-chemical-equations2 (Balanced chemical reactions Jeopardy)</td></tr>
<tr><td>Student Resources:</td><td colspan="2">http://education.jlab.org/elementbalancing/ (Game about balancing chemical equations)
http://funbasedlearning.com/chemistry/chemBalancer/ (Game to practice balancing equations)
https://phet.colorado.edu/en/simulation/balancing-chemical-equations (PhET simulation about balancing chemical equations)
http://sciencespot.net/Pages/kdzchem.html (Science Spot-Chemistry)
http://bit.ly/1gGIN3d (Khan Academy-balancing chemical equations)</td></tr>
<tr><td>Assessment:</td><td colspan="2">The student will demonstrate mastery of identifying types, predicting products, and balancing chemical equations by writing complete balanced equations.

https://jeopardylabs.com/play/balancing-chemical-equations2 (Balanced chemical reactions Jeopardy)</td></tr>
<tr><td rowspan="2">Differentiation:
(Multiple means for students to access content and multiple modes for student to express understanding.)</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>The teacher may scaffold practice to facilitate student learning to an appropriate level

The teacher may allow students to work in small groups or partners</td><td>The student may demonstrate understanding to the designated learning target using any method desired (e.g., using manipulatives, whiteboard, worksheet, verbally, etc.)</td></tr>
<tr><td rowspan="2">Extensions for depth and complexity:</td><td>Access (Resources and/or Process)</td><td>Expression (Products and/or Performance)</td></tr>
<tr><td>The teacher may include a discussion and demonstration of chemical complexes (e.g., acid + carbonate → salt + carbonic acid; carbonic acid → water + carbon dioxide)</td><td>The student may identify chemical complexes as a possible product of chemical reactions during written assessment</td></tr>
<tr><td>Critical Content:</td><td colspan="2">• Word equations
• Reaction types (single replacement, double replacement, synthesis, decomposition, combustion)
• Patterns</td></tr>
<tr><td>Key Skills:</td><td colspan="2">• Identify reaction types
• Predict products
• Balance chemical equations</td></tr>
<tr><td>Critical Language:</td><td colspan="2">Word equations, single replacement, double replacement, synthesis, decomposition, combustion</td></tr>
</table>

Learning Experiences # 7 - 9
Instructional Timeframe: Weeks 5-6

Learning Experience # 7		
The teacher may introduce the topic of mole ratios so students can begin to recognize that the determination of mole ratios can only be made once a chemical equation is balanced.		
Generalization Connection(s):	Balanced chemical equations illustrate the relationships between quantities of products and reactants Chemical reactions conserve mass as matter is neither created nor destroyed	
Teacher Resources:	http://www.occc.edu/kmbailey/Chem1115Tutorials/Molar_Ratios.htm (Stoichiometry tutorial-finding and calculating mole ratios) http://www.youtube.com/watch?v=rwhJklbK8R0 (You tube-How to find mole ratio and molar mass) http://www.youtube.com/watch?v=S6UQX7ZdkTg (You tube-mole ratio practice problems)	
Student Resources:	http://m.learning.hccs.edu/faculty/mounia.elamrani/chem1405/lecture-powerpoints-notes/chapter-10-chemical-equation-calculations/stoichiometry.swf (Interactive tutorial that covers step-by-step mole ratios using real-life examples. Also advances to more advanced stoichiometric calculations.) http://www.occc.edu/kmbailey/Chem1115Tutorials/Molar_Ratios.htm (Stoichiometry tutorial-finding and calculating mole ratios) http://youtu.be/UL1jmJaUkaQ (Crash Course - Covers AMU, Moles, Molar Mass, Equation balancing, and molar ratios)	
Assessment:	The students will write mole ratios from a balanced equation (e.g., whiteboard checks, exit ticket, etc.). http://www.readwritethink.org/files/resources/printouts/Exit%20Slips.pdf (Scaffolded exit tickets)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide a mole map http://www.youtube.com/watch?v=QqwrNJ8e9WQ (You tube video explaining a mole map) The teacher may provide manipulatives	The students may use diagrams to illustrate mole ratios
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide opportunities to use dimensional analysis to solve problems using other conversion factors (e.g., nonsense units, time, distance, word problems) http://www.youtube.com/watch?v=aZ3J60GYo6U (You tube video on dimensional analysis) http://www.chem.tamu.edu/class/fyp/mathrev/mr-da.html (site for assistance with dimensional analysis)	The student may perform conversions using dimensional analysis

Critical Content:	• Dimensional analysis • Conversion factors • Mole ratios
Key Skills:	• Dimensional analysis • Calculations
Critical Language:	Ratios, moles, dimensional analysis, units, conversion factors

Learning Experience # 8	
The teacher may lead activities that apply stoichiometry so students can understand the quantities of reactant and products necessary to achieve a balanced chemical equation.	
Generalization Connection(s):	Balanced chemical equations illustrate the relationships between quantities of products and reactants Chemical reactions conserve mass as matter is neither created nor destroyed
Teacher Resources:	http://group.chem.iastate.edu/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/stoic_select_both.swf (Simulation of combustion. Includes balancing equation and product quantities. Shows how data from combustion are collected.) http://wings.buffalo.edu/research/ConnectedChemistry/Stoichiometry/stoichiometry.swf (Simulation to react substances including visual of how the atoms rearrange.) http://www.sciencegeek.net/Chemistry/taters/Unit4Stoichiometry.htm (Online stoichiometry practice and review) http://www.lessonplanet.com/lesson-plans/stoichiometry (Stoichiometry lesson plans and worksheets) http://group.chem.iastate.edu/Greenbowe/sections/projectfolder/flashfiles/stoichiometry/solid_atoms.html (Simulation for stoichiometry practice) http://kisdwebs.katyisd.org/campuses/CRHS/teacherweb/driverl/Documents/Stoichiometry%20packet.pdf (Stoichiomentry packet) http://mysite.cherokee.k12.ga.us/personal/laura_lamar/site/Honors%20Chemistry%20Syllabus/1/8-36a%20Limiting%20Reactants%20wkst-Key.pdf (Example limiting reactants worksheet) http://freevideolectures.com/Course/2550/Chemistry/17 (Khan Academy Limiting Reactants video)
Student Resources:	http://www.sciencegeek.net/Chemistry/taters/Unit4Stoichiometry.htm (Online stoichiometry practice and review) http://m.learning.hccs.edu/faculty/mounia.elamrani/chem1405/lecture-powerpoints-notes/chapter-10-chemical-equation-calculations/stoichiometry.swf (Interactive tutorial that covers step-by-step mole ratios using real-life examples. Also advances to more advanced stoichiometric calculations.) https://www.khanacademy.org/science/mcat/physical-processes/stoichiometry/v/stoichiometry (Khan academy - lecture on stoichiometry - a continuation of the balancing Khan link.) http://kisdwebs.katyisd.org/campuses/CRHS/teacherweb/driverl/Documents/Stoichiometry%20packet.pdf (Stoichiomentry packet) http://freevideolectures.com/Course/2550/Chemistry/17 (Khan Academy Limiting Reactants video)
Assessment:	The students will perform stoichiometry calculations using dimensional analysis (e.g., white board, worksheets, simulations, etc.)

Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may review the concept of molar masses The teacher may provide a mole map http://www.youtube.com/watch?v=QqwrNJ8e9WQ (You tube video explaining a mole map) The teacher may provide a flow map to show order of steps in the calculation http://creately.com/diagram-type/templates/flowchart (Flow map examples) The teacher may teach the GUESS method http://www.youtube.com/watch?v=dLx5fynBPRs (You tube video explaining the GUESS method)	N/A
Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may introduce (e.g., demonstrations, lecture) the concept of limiting reactants and how to determine limiting reactants The teacher may introduce the idea of "percent yield"	The student may perform calculations that involve limiting reactants The student may calculate theoretical yield and use to determine percent yield
Critical Content:	• Reaction • Stoichiometry	
Key Skills:	• Dimensional analysis calculations	
Critical Language:	Stoichiometry, molar mass, mole ratio, dimensional analysis, units	

Learning Experience # 9	
The teacher may facilitate laboratory investigations so students can gain practical experience with chemical reactions in order to collect and analyze data to determine mole ratios (stoichiometric relationships).	
Generalization Connection(s):	Balanced chemical equations illustrate the relationships between quantities of products and reactants Chemical reactions conserve mass as matter is neither created nor destroyed
Teacher Resources:	http://misterguch.brinkster.net/MLX039.doc (Stoichiometry lab) http://misterguch.brinkster.net/pra_equationworksheets.html (Chemical equation worksheets) http://www.youtube.com/watch?v=qLUJdF_l8LA (You tube-Limiting and excess reactant)

	http://www.chem.tamu.edu/class/majors/tutorialnotefiles/limiting.htm (Limiting reactants notes page) http://mmsphyschem.com/stoichiometry.htm (Stoichiometry calculator) http://www.youtube.com/watch?v=krioEzlRegc (You tube-limiting reactants/reagents) http://onlinesciencetools.com/tools/stoichiometrycalculator (On-line science tools- stoichiometry calculator) https://www.khanacademy.org/science/mcat/physical-processes/stoichiometry/v/stoichiometry--limiting-reagent (Khan Academy-Limiting Reagents) http://phet.colorado.edu/en/contributions/view/3276 (PhET-limiting reactants activities) http://www.science.uwaterloo.ca/~cchieh/cact/c120/stoichio.html (Examples of problems to use for stoichiometry and questions to ask) https://jeopardylabs.com/play/balancing-chemical-equations2 (Stoichiometry Jeopardy)	
Student Resources:	http://m.learning.hccs.edu/faculty/mounia.elamrani/chem1405/lecture-powerpoints-notes/chapter-10-chemical-equation-calculations/stoichiometry.swf (Interactive tutorial that covers step-by-step mole ratios using real-life examples. Also advances to more advanced stoichiometric calculations.) http://youtu.be/LQq203gyftA (This is a good resource for students requiring extensions. In this video Paul Andersen explains how stoichiometry can be used to quantify differences in chemical reactions. The coefficients in a balanced chemical equation express the mole proportions in that reaction. These values can be used to predict the expected values, determine the limiting reactant, predict the molar mass of gases, determine the percent yield and interpret results from a titration.)	
Assessment:	The student will collect and analyze data from experiments involving chemical reactions to discover or confirm stoichiometric relationships. http://www.science.uwaterloo.ca/~cchieh/cact/c120/stoichio.html (Examples of problems to use for stoichiometry and questions to ask)	
Differentiation: (Multiple means for students to access content and multiple modes for student to express understanding.)	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may provide prefabricated data for student use during the analysis of stoichiometric relationships because real data is often difficult to decipher (in terms of whole-number stoichiometric ratio) http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Stoichiometry.html (Site with explanations of stoichiometry relationships) http://www.science.uwaterloo.ca/~cchieh/cact/c120/stoichio.html (Examples of problems to use for stoichiometry and questions to ask)	The student may use given data to determine or confirm stoichiometric relationships in a laboratory report

Extensions for depth and complexity:	**Access** (Resources and/or Process)	**Expression** (Products and/or Performance)
	The teacher may include limiting reactants and percent yield calculations in current experiments or provide additional experiments to investigate these concepts http://www.youtube.com/watch?v=qLUJdF_l8LA (You tube- Limiting and excess reactant) http://www.chem.tamu.edu/class/majors/tutorialnotefiles/limiting.htm (limiting reactants notes page) http://www.youtube.com/watch?v=krioEzlRegc (You tube- limiting reactants/reagents) https://www.khanacademy.org/science/mcat/physical-processes/stoichiometry/v/stoichiometry--limiting-reagent (Khan Academy- Limiting Reagents) http://phet.colorado.edu/en/contributions/view/3276 (PhET- limiting reactants activities) https://jeopardylabs.com/play/balancing-chemical-equations2 (Stoichiometry Jeopardy)	The student may include calculations involving limiting reactants and percent yield in a laboratory report
Critical Content:	• Chemical reaction • Stoichiometry • Dimensional analysis • Conversion factors • Mole ratios	
Key Skills:	• Dimensional analysis calculations • Collect and analyze data • Confirm stoichiometric relationships	
Critical Language:	Stoichiometry, molar mass, mole ratio, dimensional analysis, conversion factors	