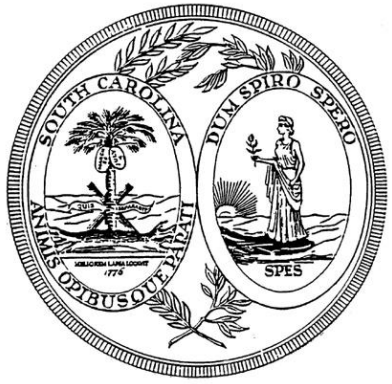
South Carolina Academic Standards and Performance Indicators for Science 2014



Instructional Units Resource

Chemistry

South Carolina Academic Standards and Performance Indicators for Science 2014
Chemistry Instructional Unit Resource

As support for implementing the *South Carolina Academic Standards and Performance Indicators for Science 2014*, the standards for Chemistry have been grouped into possible units. In the Overview of Units below, the titles for those possible units are listed in columns. Refer to the Overview document to note these unit titles and how Standards, Conceptual Understandings, Performance Indicators, Science and Engineering Practices, and Crosscutting Concepts align. Following the Overview of Units, an Instructional Unit document is provided that delivers guidance and possible resources in teaching our new *South Carolina Academic Standards and Performance Indicators for Science 2014*. The purpose of this document is to provide guidance as to how all the standards in this grade may be grouped into units and how those units might look. Since this document is merely guidance, districts should implement the standards in a manner that addresses the district curriculum and the needs of students. This document is a living document and instructional leaders from around the state will continuously update and expand these resource documents. These documents will be released throughout the 2016-2017 school year with the intentionality of staying ahead of instruction. Teachers should also note that links to the Standards document, A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, the SEP Support Document, and the Support Document 2.0 are embedded throughout the Instructional Unit format for reference.

Acknowledgments

Jean Baptiste Massieu, famous deaf educator, made a statement that is now considered a French proverb. “Gratitude is the memory of the heart. Indeed, appreciation comes when you feel grateful from the depths of your heart. The head keeps an account of all the benefits you received and gave. But the heart records the feelings of appreciation, humility, and generosity that one feels when someone showers you with kindness.” It is with sincere appreciation that we humbly acknowledge the dedication, hard work and generosity of time provided by teachers and instructional leaders across the state that have made and are continuing to make the Instructional Unit Resources possible.

Chemistry Overview of Units

Unit 1		Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
ATOMIC STRUCTURE AND NUCLEAR PROCESSES		BONDING AND CHEMICAL FORMULAS	STATES OF MATTER	SOLUTIONS, ACIDS, AND BASES	CHEMICAL REACTIONS	THERMOCHEMISTRY AND CHEMICAL KINETICS
Standard		**Standard**	**Standard**	**Standard**	**Standard**	**Standard**
H.C.2		H.C.3	H.C.4	H.C.5	H.C.6	H.C.7
Conceptual Understanding		**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**	**Conceptual Understanding**
H.C.2A	H.C.2B	H.C.3A	H.C.4A	H.C.5A	H.C.6A	H.C.7A
Performance Indicators		**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**	**Performance Indicators**
H.C.2A.1 H.C.2A.2 H.C.2A.3	H.C.2B.1 H.C.2B.2 H.C.2B.3 H.C.2B.4	H.C.3A.1 H.C.3A.2 H.C.3A.3 H.C.3A.4 H.C.3A.5 H.C.3A.6 H.C.3A.7	H.C.4A.1 H.C.4A.2 H.C.4A.3	H.C.5A.1 H.C.5A.2 H.C.5A.3 H.C.5A.4	H.C.6A.1 H.C.6A.2 H.C.6A.3 H.C.6A.4	H.C.7A.1 H.C.7A.2 H.C.7A.3 H.C.7A.4
***Science and Engineering Practices**		***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**	***Science and Engineering Practices**
S.1A.2 S.1A.6 S.1A.4 S.1A.8 S.1A.5		S.1A.2 S.1A.6 S.1A.3 S.1A.4	S.1A.2 S.1A.3 S.1A.4	S.1A.4 S.1A.5 S.1A.8	S.1A.2 S.1A.3 S.1A.5	S.1A.2 S.1A.5 S.1A.3 S.1A.4
***Crosscutting Concepts**		***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**	***Crosscutting Concepts**
1, 2, 3, 4, 5, 6, 7		1, 4, 6	2, 4, 5	2, 3, 6	1, 2, 3, 4, 7	2, 3, 4, 6, 7

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Unit Title
Chemical Reactions
Standard http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf
H.C.6 The student will demonstrate an understanding of the types, the causes, and the effects of chemical reactions.

Conceptual Understanding
H.C.6A A chemical reaction occurs when elements and /or compounds interact, resulting in a rearrangement of the atoms of these elements and/or compounds to produce substance with unique properties. Mass is conserved in chemical reactions. Reactions tend to proceed in a direction that favors lower energies. Chemical reaction can be categorized using knowledge about the reactant to predict products. Chemical reactions are quantifiable. When stress is applied to a chemical system that is in equilibrium, the system will shift in a direction that reduces the stress.
New Academic Vocabulary **Some students may need extra support with the following academic vocabulary in order to understand what they are being asked to understand and do. Teaching these terms in an instructional context is recommended rather than teaching the words in isolation. A great time to deliver explicit instruction for the terms would be during the modeling process. Ultimately, the student should be able to use the academic vocabulary in conversation with peers and teachers. These terms are pulled from the essential knowledge portion of the Support Doc 2.0 (http://ed.sc.gov/instruction/standards-learning/science/support-documents-and-resources/) and further inquiry into the terms can be found there.**

Chemical Reactions	Elements	Compounds	Conservation of Matter	Reactants	Products
Mole	Avogadro's number	Atomic Mass	Molar Mass	Atomic Mass	Formula Mass
Molecular Mass	Stoichiometry	Limiting Reactants	Molar Ratio	Ions	Double Replacement Reactions
Precipitation	Metathesis	Neutralization Reactions	Decomposition	Oxidation	Reduction
Oxidizing Agent	Reducing Agent	Net Ionic Equation	Exothermic Reactions	Endothermic Reactions	Equilibrium

Phase Notations	Balanced Chemical Equation	Bronsted-Lowry Acids and Bases	Conjugate Acid-Base Pairs

Performance Indicators

Text highlighted below in *orange* and *italicized/underlined* shows connections to SEP's.

H.C.6A.1 *Develop and use models* to predict the products of chemical reactions (1) based upon movements of ions; (2) based upon movements of protons; and (3) based upon movements of electrons.

H.C.6A.2 *Use Le Châtelier's principle to predict* shifts in chemical equilibria resulting from changes in concentration, pressure, and temperature.

H.C.6A.3 *Plan and conduct controlled scientific investigations* to produce mathematical evidence that mass is conserved in chemical reactions

H.C.6A.4 *Use mathematical and computational thinking* to predict the amounts of reactants required and products produced in specific chemical reactions.

***Science and Engineering Practices**

Support for the guidance, overviews of grade level progressions, and explicit details of each SEP can be found in the Science and Engineering Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf). It is important that teachers realize that the nine science and engineering practices are not intended to be used in isolation. Even if a performance indicator for a given standard only lists one of the practices as a performance expectation, scientists and engineers do not use these practices in isolation, but rather as part of an overall sequence of practice. When educators design the learning for their students, it is important that they see how a given performance expectation fits into the broader context of the other science and engineering practices. This will allow teachers to provide comprehensive, authentic learning experiences through which students will develop and demonstrate a deep understanding of scientific concepts.

H.C.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

H.C.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses based on credible scientific information, (2) identify materials, procedures, and variables, (3) use appropriate laboratory equipment, technology, and techniques to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

H.C.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) express relationships between variables for models and investigations, and (3) use grade-level appropriate statistics to analyze data.

***Cross Cutting Concepts** (http://www.nap.edu/read/13165/chapter/8)

The link above provides support from the Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) The text in blue and *italicized/underlined* below provides a brief explanation of how the specific content ties to the CCC's.

1. Patterns: The National Research Council (2012) states that "Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them" (p. 84). *The products of chemical reactions can be predicted using*

patterns, i.e. A+B yields AB is a synthesis reaction.

2. Cause and effect: Mechanism and explanation: The National Research Council states "Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts" (p. 84). *If there is an increase in the reactants of a system, then there will be a shift towards the products of a system to re-establish equilibrium.*

3. Scale, proportion, and quantity: The National Research Council states "In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance" (p. 84). *Based on the Law of Conservation of Matter, the number of atoms of each element in the reactants must be the same as the number of atoms of each element in the products.*

4. Systems and system models: The National Research Council states "Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering" (p. 84). *A chemical reaction and all of the potential stresses is a system.*

7. Stability and change: The National Research Council states "For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study"(p. 84). *Le Châtelier's principle provides stability to a system in that equilibrium can be reestablished when stress has been imposed on a system.*

**Teachers have the discretion to enhance the selected SEP's and CCC's.*

Prior Knowledge
• 7.P.2B.4 Physical and Chemical Properties and Changes • 7.P.2B.5 Law of Conservation of Matter
Subsequent Knowledge
• N/A

Possible Instructional Strategies/Lessons
Strategies and lessons that will enable students to master the standard and/or indicator.

- H.C.6A.1
  - Types of Chemical Reactions and Predicting the Products: In this activity, students will use picture cards, reaction cards, and product cards to model the prediction of the products in each reaction. This activity can be found at http://alex.state.al.us/lesson_view.php?id=26220

  - Predicting Products: These practice exercises provide multiple-choice equations from which students will predict the products. Students can use the Types of Chemical Reactions and Predicting Products cards as models to assist them in this activity. These exercises can be found at http://www.sciencegeek.net/APchemistry/APtaters/ReactionProducts.htm

  - Oxidation Number Rules Gridlocks: Students can use the oxidation rules and problem-solving skills to predict products of chemical equations. This activity can be found at http://www.rsc.org/learn-chemistry/resources/gridlocks/puzzles/level-3/OxidationNumberRules.html

  - Oxidation Numbers Activity: Students are provided with chemical symbols, molecular compounds, etc. and are required to determine the oxidation numbers. This activity is beneficial for them because it will assist them in using as a model for predicting products. This activity can be found be at http://www.learningliftoff.com/high-school-science-activity-oxidation-numbers/#.V-LYq_ArK00

  - Sweetly Balanced Equations: Students will use edible manipulatives (candy) to create models of chemical reactions. Using their models, students will balance equations to demonstrate the law of conservation of mass. This activity uses the SEP of systems modeling for balancing equations. This activity can be found at https://www.howtosmile.org/resource/smile-000-000-001-782

  - Oxidation-Reduction Reactions (Redox) Using a Film Clips from *Daylight* and Youtube: Students will be able to use models to explain how the oxidation-reduction reactions occur during the movie *Daylight*. This activity can be found at http://www.teachwithmovies.org/snippets/sn-sci-chem-redox-daylight.html

- H.C.6A.2
    - All Things Being Equal: This is a three-part activity in which the concept of equilibrium is introduced and modeled to the students, followed by an equilibrium/Le Chatelier lab where students can see a color change as stresses are applied to the system and equilibrium is re-established. In the final stage of the activity, students deconstruct equilibrium on a molecular and particulate level using bingo chips as a manipulative to model relative concentrations of reactants and products. This activity can be found at http://ngss.nsta.org/Resource.aspx?ResourceID=225
    - Equilibrium/Le Chatelier's Principle: There are three activities that use Le Chatelier's principle to predict shifts in the chemical equilibrium of reactions. There is a student sheet; however, teachers could provide students with guided inquiry practice if they chose not to give the Student Sheet. This activity can be found at http://www.dec.ny.gov/docs/materials_minerals_pdf/lechatelier12.pdf
    - Using Le Chatelier's Principle: In this activity, silver nitrate and cobalt chloride are used to help predict the shifts in chemical equilibria. This activity can be found using the following link https://www.google.com/#q=how+does+le+chatelier%27s+principle+predict+equilibrium+shifts+activities
- H.C.6A.3
    - LEGO Atoms and Molecules: Chemical Reactions: Students will complete a wet lab to visualize reactants and products of a chemical reaction. Subsequently, students will deconstruct the reactants and products of the wet lab chemical reaction to demonstrate the law of conservation of matter. Students will use LEGOs as a manipulative to build molecules and compounds from atoms. The different combinations of elements and compounds can be used to write formulas and chemical equations. Students can visualize how to balance chemical equations based on the proportion of LEGOs used in the reaction. This resource can be found at http://edgerton.mit.edu/chemical-reactions
    - Law of Conservation of Matter: This activity provides a chemical reaction for which students are able to determine mathematically if mass has been conserved. The teacher should be a facilitator for this performance indicator assisting students in planning and conducting an investigation to determine if mass has been conserved. This activity can be found at http://www.nclark.net/conservation_of_matter_lab.pdf

- Conservation of Mass Gum Lab: Students will plan and conduct an investigation to determine the mass of sugar gum and sugar-free gum that is swallowed while chewing. This activity can be found at http://serc.carleton.edu/sp/mnstep/activities/26992.html

- H.C.6A.4
  - Mole Lab: Introduction to the Mole Concept: This lab practical includes 12 variations of counting by weighing in which students are tasked to mass out specified amount of moles, molecules, and formula units of compounds. Students will use dimensional analysis to convert between grams, moles, and particles. Assessment is based on accuracy of conversions to gram quantities. A scoring guide is included for each variation. This resource can be found at http://www.flinnsci.com/teacher-resources/teacher-resource-videos/best-practices-for-teaching-chemistry/mole-concept-and-stoichiometry/mole-lab/
  - Decomposition of Baking Soda: In this lab investigation, students will analyze mass data and use stoichiometry to predict the identity of product(s) following the decomposition of sodium bicarbonate. This activity addresses reaction stoichiometry and types of chemical equations. This activity can be found at https://www.flinnsci.com/teacher-resources/teacher-resource-videos/best-practices-for-teaching-chemistry/mole-concept-and-stoichiometry/decomposition-of-baking-soda/
  - S'more Stoichiometry: Students are given the ingredients to make S'mores and are required to predict the number of sweet treats they can make. Students will write a chemical equation for the reaction as well as calculate the molecular mass for the S'mores. This is a free resource; however, it does require you to create an account. This activity can be found at https://phet.colorado.edu/services/download-servlet?filename=%2Factivities%2F3436%2Fphet-contribution-3436-5810.pdf
  - Limiting Reactants Activity Lab: In this activity, students will use candy manipulatives to model equations with correct mole ratios. Students will use their models to determine the limiting reactant and extend their learning to calculate the mass of excess. As an assessment to this activity, students could construct their own candy equations and write stoichiometry problems with limiting and excess reactants for other groups to solve. If candy/edibles are not an option, this activity can be completed using other manipulatives with different colors, sizes, and shapes. This activity can be found at http://www.gpb.org/chemistry-study-of-matter/episodes/803

Resources

- Types of Reactants and Predicting the Products: This 30-minute video provides a discussion on what students should look for as they begin the process of predicting the products. Students are walked through states of matter of reactants, classifying equations, etc. This video can be found at http://scetv.pbslearningmedia.org/resource/2a263167-efb4-47b0-98bd-38535347e5b6/chemistry-605-types-of-reactions-and-predicting-products/

- Le Chatelier's Principle Website: This website is a resource that provides sample generic equations illustrating what happens with changes in concentration, pressure, and temperature. This website can be found at http://www.chemguide.co.uk/physical/equilibria/lechatelier.html

- Law of Conservation of Mass: This video provides an explanation of the Law of Conservation of Mass with a demonstration reaction. This video can be found at http://scetv.pbslearningmedia.org/resource/rr10.sci.chem.matt.lawconmas/law-of-conservation-of-mass/

- How to Determine Amounts of Reactants and Products in Chemical Reactions: This video walks teachers and students through working out a problem specifying the amount of reactants and inquiring about the quantity of products. https://www.youtube.com/watch?v=4cZLjcNvJbU

- The Sweet Science of Candy Making: This article shows the application of Le Chatelier's principle in the preparation of rock candy. Changes in temperature are specifically discussed in relation to crystallization. This article can be found at https://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/archive/chemmatters-oct2014-candy-chem.pdf?_ga=1.149039539.426777755.1438970662

- Beautiful Chemical Reactions: This website contains a collection of videos that visually depict chemical reactions, specifically single and double replacement reactions. Students are able to see the formation of a precipitate in magnified detail. This website can be found at https://www.youtube.com/watch?v=dQGreQyoXxI

- Reactants, Products, and Leftovers: This PhET simulation provides students the opportunity to predict the products in real life situations, i.e. building a sandwich. They receive content-specific practice predicting the amount of products given the amount of reactants. This simulation can be found at https://phet.colorado.edu/en/simulation/reactants-products-and-leftovers

Sample Formative Assessment Tasks/Questions

Additional sample formative assessment tasks/questions for grade bands are located at the end of each of the SEP Support Doc (http://ed.sc.gov/scdoe/assets/File/instruction/standards/Science/Support%20Documents/Complete_2014SEPsGuide_SupportDoc2_0.pdf)

- Teacher can provide students with chemical reactions typed out on slips of paper. Students must classify the reaction under the Synthesis, Decomposition, Single Replacement, Double Replacement, Combustion, and Oxidation Reduction headings.

- Practice Problems - Predicting Reaction Products: Students will work to determine the products of each reaction and determine how many atoms/molecules are required by the reactants. This resource can be found at http://scienceatcchs.weebly.com/documents2.html

- Human Reactivity Series Card Game: Students will receive card(s) with either an element or a compound. Students will then walk around the room to find a matching partner to form a single replacement/oxidation-reduction reaction that will work. The partners will predict the products and write a balanced equation for the reaction. Students will need to assign oxidation numbers to each species in the reaction to illustrate what is oxidized and what is reduced. If students encounter a pair in which products will not form, students can explain why that reaction will not work, based on the activity series and reduction potentials.

- Whiteboard races: Students can race other students in teams to solve stoichiometry problems. This can be completed using a variety of materials (individual whiteboards, chart paper on the wall, sidewalk chalk, etc.) This activity can also be completed as a team relay where each student completes a specific part of the problem (listing givens, calculating molar mass, listing conversion factors, solving with correct significant figures).

- "Sturkey-o-metry": The objective of this formative assessment is for students to feather a paper turkey by solving stoichiometry problems. Problems can be printed directly on paper feathers or the teacher can provide students with faux feathers. This assessment can be altered depending seasonal holidays.

- Stoichiometry Lab Practical: The objective of this formative assessment is two-fold. First, given reactants and respective amounts, students predict the products, write an equation, and balance the equation. Second, students will use stoichiometry conversions to predict the

amount of product that should be made. This step can involve limiting reactants. Students can then mass the products and calculate percent yield.

- One-minute response: Students are given two compounds with which to create a reaction. They are required to classify the equation, predict the products, and determine how many products are produced by the given number of reactants. They must also write an explanation of how mass has been conserved.

- Experiencing real-life Le Chatelier's: Provide students with a prompt requiring them to explain a dilemma: 1) between spending time on school (homework, projects, extracurricular) and time with friends, 2) the amount of food mom makes for dinner when only a few family members are home/then when more people arrive, or 3) student-made prompt. Ask them how they would compensate to create equilibrium. Then, have students apply this to Le Chatelier's principle. Idea obtained from http://systemsandequilibrium.weebly.com/qualitative-changes-in-equilibrium-le-chateliers-principle.html

References

Allan, A. (n.d.). Predicting Products. *ScienceGeek.Net.* Retrieved September 21, 2016 from http://www.sciencegeek.net/APchemistry/APtaters/ReactionProducts.htm

Beauty of Science. (2016, August 15). Beautiful chemical reactions [Video file]. Retrieved October 12, 2016, from https://www.youtube.com/watch?v=dQGreQyoXxI

Carpenter, Y. (2016). Reactants, Products, and Leftovers. *PhET Interactive Simulations.* Retrieved October 1, 2016 from https://phet.colorado.edu/en/simulation/reactants-products-and-leftovers

Clark, J. (2013). Le Chatelier's Principle. Retrieved September 30, 2016 from http://www.chemguide.co.uk/physical/equilibria/lechatelier.html

Decomposition of Baking Soda. (2009). *Flinn Scientific, Inc.* Retrieved October 3, 2016 from https://www.flinnsci.com/teacher-resources/teacher-resource-videos/best-practices-for-teaching-chemistry/mole-concept-and-stoichiometry/decomposition-of-baking-soda/

Equilibrium/Le Chatelier's Principle [PDF document]. (n.d.). *Beyond Benign*. Retrieved September 30, 2016 from http://www.dec.ny.gov/docs/materials_minerals_pdf/lechatelier12.pdf

Henry, C. (2011). S'more Stoichiometry. Retrieved October 1, 2016 from https://phet.colorado.edu/services/download-servlet?filename=%2Factivities%2F3436%2Fphet-contribution-3436-5810.pdf

High School Science Activity: Oxidation Numbers. (2016). *Learning Liftoff.* Retrieved from http://www.learningliftoff.com/high-school-science-activity-oxidation-numbers/#.V-LYq_ArK00

How To Determine Amounts of Reactants and Products In Chemical Reactions. (2012, October 15). *StraighterLine* [Video File]. Retrieved October 1, 2016 from https://www.youtube.com/watch?v=4cZLjcNvJbU

Husband, T. (2014) The Sweet Science of Candymaking. *ChemMatters.* Retrieved October 2, 2016 from https://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/archive/chemmatters-oct2014-candy-chem.pdf?_ga=1.149039539.426777755.1438970662

Jolliff, T. (n.d.). Oxidation Number Rules. *RSC.* Retrieved September 21, 2016 from http://www.rsc.org/learn-chemistry/resources/gridlocks/puzzles/level-3/OxidationNumberRules.html

Law of Conservation of Mass. (2016). *PBS LearningMedia.* Retrieved October 1, 2016 from http://scetv.pbslearningmedia.org/resource/rr10.sci.chem.matt.lawconmas/law-of-conservation-of-mass/

Law of Conservation of Matter. (2005). *Science Course Module: Integrated Physics and Chemistry (IPC).* Retrieved September 30, 2016 from http://www.nclark.net/conservation_of_matter_lab.pdf

Limiting Reactants Activity Lab. (2004) *GPB Media*. Retrieved October 14, 2016 from http://www.gpb.org/chemistry-study-of-matter/episodes/803

Lorenz, S. (n.d.). Le Chatelier's Thought Experiment. *Grade 12U Chemistry-Systems and Equilibrium.* Retrieved October 8, 2016 from http://systemsandequilibrium.weebly.com/qualitative-changes-in-equilibrium-le-chateliers-principle.html

Mole Lab. (2012). *Flinn Scientific, Inc.* Retrieved September 21, 2016 from http://www.flinnsci.com/teacher-resources/teacher-resource-videos/best-practices-for-teaching-chemistry/mole-concept-and-stoichiometry/mole-lab/

National Research Council. A Framework for k-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press, 2012. doi: 10.17226/13165.

Predicting Reaction Products [Word document]. (2001). *Cavalcade Publishing.* Retrieved October 1, 2016 from http://scienceatcchs.weebly.com/documents2.html

Putti, A. (2010). All Things Being Equal. *National Science Teachers Association.* Retrieved September 21, 2016 from http://ngss.nsta.org/Resource.aspx?ResourceID=225

Rathjen, D. (2003). Sweetly Balanced Equations. *Exploratorium.* Retrieved October 12, 2016 from https://www.howtosmile.org/resource/smile-000-000-001-782

Reilly, N. (2013). Conservation of Mass Gum Lab. *Minnesota Science Teachers Education Project*. Retrieved September 30, 2016 from http://serc.carleton.edu/sp/mnstep/activities/26992.html

Rinehart, B. (2014). Types of Chemical Reactions and Predicting Products. *Alabama Learning Exchange.* Retrieved September 21, 2016 from http://alex.state.al.us/lesson_view.php?id=26220

South Carolina Department of Education. (2014). South Carolina Academic Standards and Performance Indicators for Science 2014. [PDF document]. Retrieved July 13, 2016, from http://ed.sc.gov/scdoe/assets/file/agency/ccr/Standards-Learning/documents/South_Carolina_Academic_Standards_and_Performance_Indicators_for_Science_2014.pdf

Stengler, E. and Frieden, J. (2012). Oxidation-Reduction Reactions (Redox) Using a Film Clip from *Daylight* and Youtube. *Teaching with Movies.* Retrieved October 14, 2016 from http://www.teachwithmovies.org/snippets/sn-sci-chem-redox-daylight.html

Types of Reactions and Predicting Products. (2016). *PBS LearningMedia.* Retrieved October 1, 2016 from http://scetv.pbslearningmedia.org/resource/2a263167-efb4-47b0-98bd-38535347e5b6/chemistry-605-types-of-reactions-and-predicting-products/

Using Le Chatelier's Principle [Word document]. (2001). *Chemistry: A Modern Course.* Retrieved September 30, 2016 from https://www.google.com/#q=how+does+le+chatelier%27s+principle+predict+equilibrium+shifts+activities

Vandiver, K. (2012). LEGO Atoms and Molecules: Chemical Reactions. *MIT Edgerton Center*. Retrieved September 21, 2016 from http://edgerton.mit.edu/chemical-reactions