Subject	Chemistry
Unit	Unit 1: Matter
Est. Length	23 lessons (Aug - Oct)
Big Idea	Matter is composed of individual and combinations of elements from the Periodic Table.
Essential Questions	1. How can we use the Periodic Table to understand the properties of matter? 2. How can we use lab equipment and procedures to demonstrate the properties and conservation of matter?
MA State Standards *Power standards in bold	**HS-PS1-1. Use the periodic table as a model to predict the relative properties of main group elements, including ionization energy and relative sizes of atoms and ions, based on the patterns of electrons in the outermost energy level of each element. Use the patterns of valence electron configurations, core charge, and Coulomb's law to explain and predict general trends in ionization energies, relative sizes of atoms and ions, and reactivity of pure elements.** ● Clarification Statement: Size of ions should be relevant only for predicting strength of ionic bonding ● State Assessment Boundary: State assessment will be limited to main group (s and p block) elements HS-PS1- 3. Cite evidence to relate physical properties of substances at the bulk scale to spatial arrangements, movement, and strength of electrostatic forces among ions, small molecules, or regions of large molecules in the substances. Make arguments to account for how compositional and structural differences in molecules result in different types of intermolecular or intramolecular interactions. ● Clarification Statements: (1) Substances include both pure substances in solid, liquid, gas, and networked forms

	(such as graphite). (2) Examples of bulk properties of substances to compare include melting point and boiling point, density, and vapor pressure. (3) Types of intermolecular interactions include dipole-dipole (including hydrogen bonding), ion-dipole, and dispersion forces. ● State Assessment Boundary: Calculations of vapor pressure by Raoult's law, properties of heterogeneous mixtures, and names and bonding angles in molecular geometries are not expected in state assessment HS-PS1-11. Design strategies to identify and separate the components of a mixture based on relevant chemical and physical properties. ● Clarification Statements: (1) Emphasis is on compositional and structural features of components of the mixture. (2) Strategies can include chromatography, distillation, centrifuging, and precipitation reactions. (3) Relevant chemical and physical properties can include melting point, boiling point, conductivity, and density HS-PS2- 6. Communicate scientific and technical information about the molecular-level structures of polymers, ionic compounds, acids and bases, and metals to justify why these are useful in the functioning of designed materials ● Clarification Statement: Examples could include comparing molecules with simple molecular geometries; analyzing how pharmaceuticals are designed to interact with specific receptors; and considering why electrically conductive materials are often made of metal, household cleaning products often contain ionic compounds to make materials soluble in water, or materials that need to be flexible but durable are made up of polymers. ● State Assessment Boundary: State assessment will be limited to comparing substances of the same type with one compositional or structural feature different
Common Core State Standards (CCSS)	**Reading** RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. RST.9-10.2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

	RST.9-10.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. **Writing** WHST.9-10.1. Write arguments focused on *discipline-specific content*. WHST.9-10.1.A. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. WHST.9-10.1.B. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. WHST.9-10.1.C. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. WHST.9-10.1.D. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.1.E. Provide a concluding statement or section that follows from or supports the argument presented. WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

	WHST.9-10.2.A. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. WHST.9-10.2.B. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. WHST.9-10.2.C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. WHST.9-10.2.D. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. WHST.9-10.2.E. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.2.F. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

	WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research. WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Science Practices (SP)	**1. Asking scientific questions & defining engineering problems** 2. Developing & using models 3. Planning & carrying out investigations **4. Analyzing & interpreting data** 5. Using mathematics & computational thinking 6. Constructing scientific explanations & designing engineering solutions **7. Engaging in argument from evidence** 8. Obtaining, evaluating, and communicating information
Assessment Alignment	**Minor assessments** ● Sig Fig Quiz ● Lab Skills Quiz ● Matter Quiz **Major assessments** ● Matter Exam ● Copper Cycle Lab Report
Honors Assignments	1. Element Profile (see pg. 51 of Living by Chemistry) - explore an element and create a theoretical Facebook profile of an element, including its characteristics, images, and interactions with other elements 2. Unsung Scientists (options include: Marie Curie, James Andrew Harris, Faraday) 3. Academic Enrichment article - read an article about a chemical experiment and answer reflection questions about the article (to be done in AE only) 4. Scientist report - students research a scientist of color on the HHMI website and generate a report on this scientist's findings and important work
20 Key Vocabulary	Element, Periodic Table of the Elements, density, mass, volume, significant figure, phase of matter, chemical formula, compound, Law of Conservation of Matter, atomic mass, atomic number, alkali metals, alkaline

Words	earth metals, halogens, noble gases, group, period, metal, nonmetal

Prior knowledge that students have entering this unit
1. Phases of matter (solid, liquid, gas) 2. Algebraic calculations and magic triangles 3. Measurements (weighing, using a ruler) 4. Reading a flow chart 5. Metallic characteristics of solids (shiny, malleable, good conductors)

Where this knowledge goes next
1. Combining elements into a variety of molecules and compounds 2. Using charges and element properties to determine the formulas for chemical compounds 3. Converting mL to L for calculations 4. Determining the significant figures in any given number 5. Any future laboratory procedures 6. Using the periodic table to explore element interactions 7. Using the textbook to preview and review topics learned in class 8. Writing future lab reports 9. Reading chemical symbols to interpret compounds involved in reactions

Descriptive outline narrative of unit
The first topic in the unit is an introduction to Chemistry through discussion of the classroom policies and laboratory safety. The textbook will then be explored through a scavenger hunt in the Fire unit. Prior to digging into matter, a foundational knowledge of significant figures is required, so students will learn to identify and manipulate significant figures for any number or set of numbers. The rule of leading zeros (never count) and trailing zeros (only count in the presence of a decimal) will be utilized to distinguish

between significant zeros present in a number. Laboratory safety and proper use of lab equipment will then be learned and utilized to measure a variety of objects. Students will be quizzed to demonstrate their mastery of basic chemistry skills such as sig figs and use of lab materials. Matter will then be defined and students will classify matter and non-matter entities. After learning about matter, students will measure mass and volume using laboratory techniques. Matter and volume will then be combined into an equation and density will be defined. Phases of matter and elements will then be identified based on chemical symbols and the Periodic Table. From there, matter and elements will be combined into chemical reactions where the conservation of matter will be observed. Students will then demonstrate their knowledge of matter, mass, and volume on a quiz. The conservation of matter will then be observed and demonstrated through a series of reactions that transform copper into different forms and phases in the Copper Cycle Lab. After performing the lab, students will complete a lab report analyzing and reporting the observed transformations of copper. The trends and organization of the periodic table will then be explored and explained, and students will use these trends to describe the effects of atomic number, mass, and reactivity on elements in given periods and groups of the periodic table. Concepts of matter and laboratory skills will then be reviewed and students will demonstrate their knowledge on the matter exam.

Day	Lesson #/name	MA	CCSS	Content Objective	Language Objective	Science practice(s)
1	I1	N/A	RST9-10.2	SWBAT explain policies and routines in Chemistry.	(S) orally describe expectations in Chemistry to a partner during turn and talks	SP8: Obtaining, evaluating, and communicating information
2	I2	N/A	RST9-10.3	SWBAT identify and explain the use of safety equipment in the laboratory.	(S) orally explain to a partner the use of lab safety equipment	SP8: Obtaining, evaluating, and communicating information
3	I3	N/A	RST9-10.2	SWBAT use the textbook to identify definitions and central ideas from a toxins lesson.	(R) read the TOC to determine where Toxins Lesson 3 is located in the Chemistry textbook	SP3: Planning & carrying out investigations
4	I4	N/A	WHST 9-10.1	SWBAT report the correct number of sig figs for any number.	(W) identify in a number how many zeros are	SP5: Using mathematics & computational thinking

			D		after a decimal point to determine the correct number of sig figs	
5	I5	N/A	RST9-10.8	SWBAT manipulate sig figs by addition, subtraction, multiplication, and division.	(W) correctly execute a mathematical function using the multiplying sig figs rule	SP5: Using mathematics & computational thinking
6	I6	N/A	RST9-10.8	SWBAT follow a procedure correctly to learn how to use a variety of lab equipment	(R) read the lines on a graduated cylinder to determine the measurement scale	SP3: Planning & carrying out investigations
7	I7	N/A	RST9-10.3	SWBAT demonstrate the proper use of lab equipment and significant figures on a quiz.	(R) read a diagram of lab equipment to accurately determine the volume of a liquid	SP6: Constructing scientific explanations & designing engineering solutions
8	A2/3	HS-PS 1-3	WHST 9-10.2 D	SWBAT define and classify matter as anything that has mass and volume.	(S) use the words “matter, mass, volume” to orally determine whether or not an item is classified as matter with a partner	**SP7: Engaging in argument from evidence**
9	A4	HS-PS 1-3	RST9-10.3	SWBAT measure mass using a balance AND measure volume using water displacement or geometric formulas.	(R) read the lines on a graduated cylinder to determine the volume of water	**SP1: Asking scientific questions & defining engineering problems**
10	A5	HS-PS 1-3	RST9-10.7	SWBAT define density as the mass per unit volume, and solve problems using the equation D = m/V.	(W) extract information from a word problem to properly determine the given, unknown, and equation for a density problem	SP5: Using mathematics & computational thinking

11	A6	HS-PS 1-3	WHST 9-10.D	SWBAT identify elements and phases of matter based on chemical symbols.	(W) write (s), (l), (g), or (aq) as the phase of matter for a substance based on visual examples	SP2: Developing & using models
12	A7	HS-PS 1-7	RST9-10.7	SWBAT explain how matter is conserved in chemical equations.	(R) identify each element on the left side of a chemical equation and then match it with the element on the right side of the equation	**SP1: Asking scientific questions & defining engineering problems**
13	A7a	HS-PS 1-7	WHST 9-10.1 C	SWBAT apply knowledge of matter to complex chemical examples SWBAT demonstrate knowledge of matter on Matter Quiz.	(W) solve a density problem on the quiz using the density formula and the given information in the problem	SP5: Using mathematics & computational thinking
14	A7b	HS-PS 1-7	RST9-10.3	SWBAT demonstrate conservation of matter by transforming copper into copper oxide.	(R) read the symbols in a chemical equation to identify the phase of matter for copper	SP3: Planning & carrying out investigations
15	A7b	HS-PS 1-7	RST.9-10.3	SWBAT complete the copper cycle by transforming copper oxide into solid copper.	(W) write how copper was conserved in the second step of the Cu cycle lab as it was transformed from liquid $Cu(NO_3)_2$ to solid $Cu(OH)_2$	SP3: Planning & carrying out investigations
16	A7c	HS-PS 1-7	WHST 9-10.2 A	SWBAT write the heading, title, question, and hypothesis for the copper cycle lab.	(W) correctly write the question and hypothesis for the copper cycle lab in their lab report using a	SP8: Obtaining, evaluating, and communicating information

					model	
17	A7d	HS-PS 1-7	WHST 9-10.1 B	SWBAT write the results and start the analysis section of the copper cycle lab report.	(W) create and fill a data table in their lab report with results and observations from the lab	**SP4: Analyzing & interpreting data**
18	A7e	HS-PS 1-7	WHST 9-10.1 0	SWBAT finish their analysis section of the copper cycle lab report.	(W) put step 3 of the Cu cycle lab into words to describe how copper transformed from solid $Cu(OH)_2$ to solid CuO	**SP4: Analyzing & interpreting data**
19	A7f	HS-PS 1-7	WHST 9-10.1 0	SWBAT revise their analysis and write the argument to finalize the copper cycle lab report.	(W) describe how copper is conserved throughout the copper cycle lab using evidence that copper was the end product	**SP7: Engaging in argument from evidence**
20	A9	HS-PS 1-1, 11	WHST 9-10.9	SWBAT explain how elements are organized on the Periodic Table and predict the characteristics of a missing element based on its position in the table.	(R) read a chart of element characteristics to identify which elements are most related	**SP1: Asking scientific questions & defining engineering problems**
21	A10	HS-PS 1-1, 11	RST9-10.7	SWBAT describe how atomic number, mass, and reactivity change in periods and groups on the Periodic Table .	(R) read the periodic table to identify the atomic mass and number of Cu and Au	SP8: Obtaining, evaluating, and communicating information
22	A10a	HS-PS 1-1, 11	RST9-10.7	SWBAT analyze trends in the Periodic Table to make arguments about the relative reactivities and sizes of elements	(S) use the periodic table trends to make an argument about the relative reactivity of C and S	**SP4: Analyzing & interpreting data**

23	Review	HS-PS 1-1,3,7	WHST 9-10.1 E	SWBAT review matter concepts and skills in preparation for Exam M1.	(W) solve matter problems with a partner using the reference sheet and notes	SP5: Using mathematics & computational thinking
24	Exam	HS-PS 1-1,3,7	WHST 9-10.1 E	SWBAT demonstrate knowledge of matter concepts on Exam M1.	(W) independently solve matter problems using a reference sheet	SP8: Obtaining, evaluating, and communicating information

Subject	Chemistry
Unit	Unit 2: Bonding
Est. Length	20 lessons (Oct - Dec)
Big Idea	Chemical bonds and their characteristics determine molecule interactions.
Essential Questions	1. How can we use element properties to understand chemical bonds? 2. How can the interactions between elements determine the composition of molecules and compounds?
MA State Standards *Power standards in bold	**HS-PS1- 1: Use the periodic table as a model to predict the relative properties of main group elements, including ionization energy and relative sizes of atoms and ions, based on the patterns of electrons in the outermost energy level of each element. Use the patterns of valence electron configurations, core charge, and Coulomb's law to explain and predict general trends in ionization energies, relative sizes of atoms and ions, and reactivity of pure elements.** ● **Clarification Statement: Size of ions should be relevant only for predicting strength of ionic bonding.** ● **State Assessment Boundary: State assessment will be limited to main group (s and p block) elements** HS-PS1- 2. Use the periodic table model to predict and design simple reactions that result in two main classes of binary compounds, ionic and molecular. Develop an explanation based on given observational data and the electronegativity model about the relative strengths of ionic or covalent bonds ● Clarification Statements: ○ Simple reactions include synthesis (combination), decomposition, single displacement, double displacement, and combustion. ○ Predictions of reactants and products can be represented using Lewis dot structures, chemical formulas, or physical models. ○ Observational data include that binary ionic substances (i.e., substances that have ionic bonds), when pure, are crystalline salts at room temperature (common examples include NaCl, KI, Fe_2O_3); and substances that are liquids and gases at room temperature are usually made of molecules that have covalent bonds (common examples include CO_2, N_2, CH_4, H_2O, C_8H_{18}). HS-PS1- 3. Cite evidence to relate physical properties of substances at the bulk scale to spatial arrangements, movement, and strength of electrostatic forces among ions, small molecules, or regions of large molecules in the substances. Make arguments to account for how compositional and structural differences in molecules result in different types of intermolecular

	or intramolecular interactions
	• Clarification Statements:
	  ○ Substances include both pure substances in solid, liquid, gas, and networked forms (such as graphite).
	  ○ Examples of bulk properties of substances to compare include melting point and boiling point, density, and vapor pressure.
	  ○ Types of intermolecular interactions include dipole-dipole (including hydrogen bonding), ion-dipole, and dispersion forces.
	• State Assessment Boundary: Calculations of vapor pressure by Raoult's law, properties of heterogeneous mixtures, and names and bonding angles in molecular geometries are not expected in state assessment
	
	HS-PS2- 6. Design ways to control the extent of a reaction at equilibrium (relative amount of products to reactants) by altering various conditions using Le Chatelier's principle. Make arguments based on kinetic molecular theory to account for how altering conditions would affect the forward and reverse rates of the reaction until a new equilibrium is established
	• Clarification Statements:
	  ○ Conditions that can be altered to affect the extent of a reaction include temperature, pressure, and concentrations of reactants.
	  ○ Conditions that can be altered to affect the rates of a reaction include temperature, pressure, concentrations of reactants, agitation, particle size, surface area, and addition of a catalyst.
	• State Assessment Boundaries:
	  ○ Calculations of equilibrium constants or concentrations are not expected in state assessment.
	  ○ State assessment will be limited to simple reactions in which there are only two reactants and to specifying the change in only one variable at a time

Common Core State Standards (CCSS)	**Reading** RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. RST.9-10.2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms

	(e.g., *force, friction, reaction force, energy*). RST.9-10.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. **Writing** WHST.9-10.1. Write arguments focused on *discipline-specific content*. WHST.9-10.1.A. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. WHST.9-10.1.B. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. WHST.9-10.1.C. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. WHST.9-10.1.D. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.1.E. Provide a concluding statement or section that follows from or supports the argument presented.

	WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-10.2.A. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. WHST.9-10.2.B. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. WHST.9-10.2.C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. WHST.9-10.2.D. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. WHST.9-10.2.E. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.2.F. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject,

	demonstrating understanding of the subject under investigation. WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research. WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Science Practices (SP)	**1. Asking scientific questions & defining engineering problems** 2. Developing & using models 3. Planning & carrying out investigations **4. Analyzing & interpreting data** 5. Using mathematics & computational thinking 6. Constructing scientific explanations & designing engineering solutions **7. Engaging in argument from evidence** 8. Obtaining, evaluating, and communicating information
Assessment Alignment	**Minor Assessments** ● Bonding Quiz 1 ● Classifying Quiz **Major Assessments** ● Bonding Exam
Honors Assignments	1. Bonding Honors Packet 2. Unsung Scientists (options include: Lise Meitner, Faraday, Marie Lavoisier) 3. Comic Strip - create a comic strip using at least two concepts from the bonding unit as well as one intermolecular force
20 Key Vocabulary Words	Proton, neutron, electron, isotope, electron shell diagram, ion, polyatomic ion, transition metal, conduct, dissolve, compound, ionic bond, metallic bond, covalent bond, network covalent, polarity, polar, nonpolar, partial positive, electronegativity

Prior knowledge that students have entering this unit
1. How to determine the significant digits in a number 2. Periodic table trends (atomic radius, reactivity, period, group, atomic number) 3. How to use the periodic table to identify where an element is as well as certain properties that element has based on its location in the PT (i.e. metal vs. nonmetal, reactivity, group #) 4. Lab skills and equipment use 5. How to write out chemical formulas and a chemical equation using element symbols, subscripts, and states of matter 6. How to predict products based on the Law of Conservation of Matter as well as the order that the elements go in the compounds that are produced based on where they are in the PT 7. Roman numerals

Where this knowledge goes next
1. Determining the molar mass of a compound based on its chemical formula 2. Writing chemical formulas and chemical reactions 3. Classifying chemical reactions based on the chemicals and formulas involved 4. Completing stoichiometric problems involving different amounts of chemicals that are being combined and reacted 5. Classifying compounds as acids, bases, or neutral based on their chemical formulas 6. Performing labs using a variety of lab equipment, skills, and techniques 7. Combining ions into compounds as a part of a chemical reaction 8. Determining the charge on an element or ion

Descriptive outline narrative of unit
The first topic in this unit is defining the parts of an atom (proton, neutron, electron). The periodic table and the information given for each chemical will be used to determine the number of protons, electrons, and neutrons in a given atom. This will lead into the discussion of isotopes, or atoms of the same element with different numbers of neutrons. Flame tests will then be done to as an exploration and preview of charged atoms. After the flame tests, electron shell diagrams will be constructed as a way to determine

the number of core and valence electrons on a given atom. Valence electrons are the outermost electrons core electrons are the inner electrons that are not involved in bonding. After looking at and creating shell models for neutral atoms, ion models will be constructed (an ion is a charged atom, meaning it has either gained or lost electrons). With this knowledge of ion models, ionic compounds will be named and then created using only metals and nonmetals as well as the rule of zero charge. The rule of zero charge states that the overall charge of an ionic compound must be neutral, so all of the charges on the ions must add up to zero. After using just metals and nonmetals, ionic compounds will then be written using polyatomic ions. Students must be familiar with the polyatomic ions, but are not required to memorize them. Adding onto compound knowledge, transition metals will then be used to write ionic compounds. Compounds will then be studied and classified with regards to conductivity and solubility. They will also be categorized by bonding type (ionic, covalent, network covalent, and metallic). The final topic in this unit is polarity. The behavior of molecules will be observed and predicted through a series of demonstrations that involve various polarity scenarios. Molecules will then be classified as polar or nonpolar based on their shape and characteristics (a molecule is polar if the atoms in the bond do not share the electrons equally). Electronegativity, or the tendency of an atom to attract more electrons, will be discussed in tandem with polarity. Concepts of bonding and polarity will then be reviewed and students will demonstrate their knowledge on the bonding exam.

Day	Lesson #/name	MA	CCSS	Content Objective	Language Objective	Science practice(s)
1	A12	HS-PS 1-1	RST9-10.7	SWBAT extract information from the periodic table to determine the number of protons, electrons, and neutrons in an atom.	(R) read the periodic table to identify the element with thirteen electrons when neutral	SP5: Using mathematics & computational thinking
2	A13	HS-PS 1-1,2	WHST9-10.1D	SWBAT determine the number of protons and neutrons in an atom to correctly write an isotope symbol	(W) write two isotope symbols for nitrogen atoms that have 7 and 8 neutrons	**SP4: Analyzing and interpreting data**
3	A17	HS-PS 1-1,2	RST9-10.3	SWBAT conduct a flame test and use the results to determine the identity of a cation within an ionic compound.	(R) read a data table to predict the identify of a metal atom based on flame color	SP3: Planning & carrying out investigations
4	A18	HS-PS 1-1,2	WHST9-10.2A	SWBAT create an electron shell model diagram of an atom, placing the correct	(W) draw a shell model for silicon that includes 3 shells	SP2: Developing & using models

				number of electrons in the correct shells.	and 4 valence electrons	
5	A19	HS-PS 1-1,2	RST9-1 0.7	SWBAT determine, based on an atom's position on the PT, the charge on an ion.	(W) describe how a calcium ion that has a +2 charge loses electrons in order to look like a noble gas	SP2: Developing & using models
6	A20	HS-PS 1-2;2-6	WHST9 -10.1D	SWBAT predict the chemical formulas of ionic compounds that will form between metal and nonmetal atoms based on the rule of zero charge.	(W) use the rule of zero to write the formula for an ionic compound that forms between Al and S	SP8: Obtaining, evaluating, and communicating information
7	A21	HS-PS 1-2	WHST9 -10.1D	SWBAT use the rule of zero charge to write the chemical formula of an ionic (M + NM) compound.	(S) tell a partner the compound name and formula when combining Ca and O using the rule of zero charge	SP6: Constructing scientific explanations & designing engineering solutions
8	A22	HS-PS 1-2	WHST9 -10.2E	SWBAT write the names and chemical formulas of compounds with polyatomic ions.	(W) write the compound name of $Be(NO_3)_2$ using the terms “beryllium” and “nitrate”	SP8: Obtaining, evaluating, and communicating information
9	A23	HS-PS 1-2	WHST9 -10.2E	SWBAT write the names and chemical formulas of compounds with transition metal ions.	(R) determine the charge on a transition metal ion using the roman numeral in the chemical name	SP8: Obtaining, evaluating, and communicating information
10	A23a	HS-PS 1-2	WHST9 -10.2E	SWBAT write the names of compounds with a mix of elements and polyatomic ions	(R) read a chemical formula and determine whether the compound has a polyatomic ion or transition metal	SP8: Obtaining, evaluating, and communicating information
11	A25	HS-PS 1-2	RST9-1 0.6	SWBAT use solubility and conductivity to sort substances into molecular covalent, network covalent, metallic, ionic bonding categories	(R) read a flowchart of solubility and conductivity to determine the bonding category of an ionic compound	**SP1: Asking scientific questions & defining engineering problems**
12	A26	HS-PS	RST9-1	SWBAT explain the trends in solubility and	(W) explain the bonding type	**SP7: Engaging in argument**

		1-2	0.5	conductivity for each of the four bonding types.	for a substance that does not conduct or dissolve in water	**from evidence**
13	S15a	HS-PS 1-2,3	RST9-10.3	SWBAT observe, record, and predict the behavior of liquids near electrical charges as droplets.	(S) orally describe the behavior of hexane using the words “charge” and “attract”	**SP7: Engaging in argument from evidence**
14	S15b	HS-PS 1-2,3	WHST9-10.9	SWBAT determine whether a molecule is polar or nonpolar using molecule shapes and characteristics.	(W) write two characteristics of acetone using the knowledge that acetone is polar	SP8: Obtaining, evaluating, and communicating information
15	S16	HS-PS 1-2	WHST9-10.2D	SWBAT use the words "dipole" and "partial charge" to describe how one element pulls on the electrons of another element.	(S) use the words “dipole” and “partial charge” to tell a partner how H and I interact in a polar covalent bond	SP2: Developing & using models
16	S17a	HS-PS 1-2	RST9-10.7	SWBAT use the electronegativity table to determine whether bonds are polar, nonpolar, or ionic.	(R) read the periodic table and electronegativity chart to determine the whether KCl is polar, nonpolar, or ionic	**SP1: Asking scientific questions & defining engineering problems**
17	S17b	HS-PS 1-2	RST9-10.7	SWBAT use the symmetry test to identify whether a molecule is polar or nonpolar.	(R) read a diagram of PCl_3 to determine if it is polar, nonpolar, or ionic using the symmetry test	SP8: Obtaining, evaluating, and communicating information
18	S15-17	HS-PS 1-2	RST9-10.8	SWBAT distinguish between different kinds of molecules and their intermolecular forces based on their polarity.	(W) use a flowchart and electronegativity table to justify that CH_4S is a polar covalent molecule	SP6: Constructing scientific explanations & designing engineering solutions
19	Review	HS-PS 1-1,2,3; 2-6	RST9-10.8	SWBAT review bonding concepts and skills in preparation for Exam B1.	(W) solve bonding problems with a partner using the reference sheet and notes	SP8: Obtaining, evaluating, and communicating information
20	Exam	HS-PS 1-1,2,3; 2-6	WHST9-10.1C	SWBAT show knowledge on Exam B1	(W) independently solve bonding problems using a	SP6: Constructing scientific explanations & designing

					reference sheet	engineering solutions

Subject	Chemistry
Unit	Unit 3: Gases
Est. Length	21 lessons (Dec - Feb)
Big Idea	Gas behavior is predicted by the relationships between pressure, volume, and temperature.
Essential Questions	1. How are pressure, volume, and temperature related? 2. How does a scientist use mathematics to predict and observe the behavior of gases?
MA State Standards *Power standards in bold	**HS-PS2- 8. Use kinetic molecular theory to compare the strengths of electrostatic forces and the prevalence of interactions that occur between molecules in solids, liquids, and gases. Use the combined gas law to determine changes in pressure, volume, and temperature in gases.**
Common Core State Standards (CCSS)	**Reading** RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. RST.9-10.2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*). RST.9-10.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

Writing
WHST.9-10.1. Write arguments focused on *discipline-specific content*.

WHST.9-10.1.A. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

WHST.9-10.1.B. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

WHST.9-10.1.C. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

WHST.9-10.1.D. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

WHST.9-10.1.E. Provide a concluding statement or section that follows from or supports the argument presented.

WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

	WHST.9-10.2.A. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. WHST.9-10.2.B. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. WHST.9-10.2.C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. WHST.9-10.2.D. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. WHST.9-10.2.E. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.2.F. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

	WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research. WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Science Practices (SP)	**1. Asking scientific questions & defining engineering problems** 2. Developing & using models 3. Planning & carrying out investigations **4. Analyzing & interpreting data** 5. Using mathematics & computational thinking 6. Constructing scientific explanations & designing engineering solutions **7. Engaging in argument from evidence** 8. Obtaining, evaluating, and communicating information
Assessment Alignment	**Minor Assessments** ● Weather Quiz 1 **Major Assessments** ● Boyle's Law Lab ● Weather Exam
Honors Assignments	1. Global Climate Change Project (see pg. 344 in Living by Chemistry) - students research some of the causes and effects of global warming in relation to the atmosphere 2. Unsung Scientists (options include: Norbert Rillieux, Percy Julian) 3. Weather Balloon Project - students research the mechanics and chemistry involved in weather balloons and present their findings to the class. Their project must make two connections to material being covered in class, one of which must be a sample calculation. a. Second honors credit - building a prototype for the balloon
20 Key Vocabulary Words	Temperature, Pressure, Volume, mole, Kinetic Molecular Theory, Celsius, Kelvin, absolute zero, Charles' Law, Boyle's Law, Avogadro's Law, Gay-Lussac's Law, Combined gas law, Ideal gas law, Standard Temperature and Pressure, universal gas constant, syringe, gas pressure sensor,

	directly proportional, indirectly proportional

Prior knowledge that students have entering this unit
1. Phases of matter 2. Temperature - Fahrenheit vs. Celsius (only celsius will be used) 3. Solving algebraic equations and fractions 4. How to determine the significant digits in a number 5. Periodic table trends (atomic radius, reactivity, period, group, atomic number) 6. How to use the periodic table to identify where an element is as well as certain properties that element has based on its location in the PT (i.e. metal vs. nonmetal, reactivity, group #) 7. Lab skills and equipment use 8. How to write out chemical formulas and a chemical equation using element symbols, subscripts, and states of matter 9. How to predict products based on the Law of Conservation of Matter as well as the order that the elements go in the compounds that are produced based on where they are in the PT 10. Roman numerals 11. Direct and indirect proportionality 12. Attractions between molecules and polarity of molecules 13. Use of a calculator to solve fractions 14. How to make observations in the laboratory using the five senses

Where this knowledge goes next
1. Calculating changes in variables such as temperature as it relates to reaction rates 2. Using temperature scales in calculations 3. Describing interactions between molecules as gases, liquids, and solids 4. Using the amount of a substance to perform various calculations to find more information about a reaction (i.e. amount of product, number of moles of a substance, volume of a substance, etc.) 5. Comparing amounts of substances based on the number of moles of a substance

6. Determining the molar mass of a compound based on its chemical formula
7. Writing chemical formulas and chemical reactions
8. Classifying chemical reactions based on the chemicals and formulas involved
9. Completing stoichiometric problems involving different amounts of chemicals that are being combined and reacted
10. Performing labs using a variety of lab equipment, skills, and techniques
11. Interpreting a phase change graph using KMT

Descriptive outline narrative of unit

The first lesson of this unit involves the 5 postulates of the Kinetic Molecular Theory (KMT), which describes the behavior of gases. This knowledge of KMT is then applied to electrostatic forces between solids, liquids and gases. Coulomb's law will also be addressed in this lesson. From there, the major three gas laws will be explored over multiple days. Charles' Law will be discussed first, which relates the temperature and volume of a gas in a direct relationship. Next is Gay-Lussac's Law, which relates the temperature and pressure of a gas in a direct relationship. The last is Boyle's Law, which relates the pressure and volume of a gas in an inverse relationship. After learning Boyle's Law, students will head into the laboratory to perform an experiment using a pressure sensor and a syringe to experimentally demonstrate the inverse relationship between pressure and volume as Boyle's Law suggests. In the few days following the procedural portion of the lab, the lab write-up will begin. This lab write-up will be presented by students during Roundtables at the end of the year. The write-up process will be broken down into three days so that students are working in chunks to complete the report. After completing the lab report, the three gas laws will be synthesized into the combined gas law, which can be used to describe the behavior of gases using all three variables (P, V, and T). These calculations will be practiced and then reviewed in preparation for Benchmark 2. The Roundtable Reflection for the Boyle's Law Lab report will be written after Benchmark 2. Then a fourth law, Avogadro's law, will be introduced. Avogadro's law demonstrates that if two gases have the same P, V, and T, they also have the same number of particles. After including this law, all four laws can then be combined into the ideal gas law. Concepts and calculations for all laws, including the ideal gas law, will then be practiced. Students will then demonstrate their knowledge of gases and gas behavior on the Gases exam.

Day	Lesson #/name	MA	CCSS	Content Objective	Language Objective	Science practice(s)

1	W2C/D	HS-PS 1- 8	WHST. 9-10.9	SWBAT use the 5 KMT postulates to describe the forces and behaviors of different phases of matter	(S) describe, using the words “attraction” and “radius,” how Coulomb’s Law connect to the behavior of matter	**SP1: Asking scientific questions & defining engineering problems**
2	W6	HS-PS 1- 8	WHST. 9-10.1C	SWBAT explain the relationship described in Charles's Law mathematically, graphically, and verbally, and use it to solve gas law problems involving volume and temperature.	(W) correctly solve a Charles’ Law problem using Kelvin and liters as units for T and V respectively	SP5: Using mathematics & computational thinking
3	W11	HS-PS 1- 8	WHST9 -10.1C	SWBAT explain the relationship described in Gay-Lussac's Law mathematically, graphically, and verbally, and use it to solve gas law problems involving pressure and temperature.	(W) describe the change in the T of a gas when V stays the same but P decreases	SP2: Developing & using models
4	W11a	HS-PS 1- 8	WHST9 -10.1C	SWBAT demonstrate in the laboratory the relationship described in Gay-Lussac's Law.	(R) read a graph of the temperature and pressure inside a flask to determine the relationship between T and P	SP3: Planning & carrying out investigations
5	W10	HS-PS 1- 8	WHST. 9-10.1C	SWBAT explain the relationship described in Boyle's Law mathematically, graphically, and verbally, and use it to solve gas law problems involving volume and pressure.	(S) predict for a partner, using your knowledge of direct relationships, when T is constant how P will change when V decreases	SP2: Developing & using models
6	W10A	HS-PS 1- 8	RST.9- 10.3	SWBAT demonstrate the relationship described by Boyle's Law in the laboratory.	(R) read a graph of the volume and pressure inside a syringe to determine the relationship between V and P	SP3: Planning & carrying out investigations
7	W10B	HS-PS 1- 8	WHST9 -10.2A	SWBAT write the results section and start the analysis section of their lab report.	(W) use a model to create and format a graph of the data from the Boyle’s Law lab	**SP1: Asking scientific questions & defining engineering problems**

8	W10C	HS-PS 1- 8	WHST9 -10.1B	SWBAT finalize the analysis and write the sources of error and abstract of their lab report	(R) read the graph and data to analyze the results and justify that P and V have an indirect relationship	**SP4: SP7: Engaging in argument from evidence**
9	W10D	HS-PS 1- 8	WHST9 -10.10	SWBAT complete their Boyle's Law lab report by reflecting on feedback from a peer about their written work	(R) read the rubric to identify areas where written work falls short of guidelines	**SP7: Engaging in argument from evidence**
10	W13B	HS-PS 1- 8	RST9-1 0.8	SWBAT use the combined gas law to solve problems involving gases.	(R) read a gas law problem to determine the given information and the unknown variable	SP2: Developing & using models
11	W13A	HS-PS 1- 8	RST9-1 0.8	SWBAT solve word problems involving changes in P, V, T	(R) read a word problem to identify whether P, V, and T are being manipulated and then identify the gas law	SP5: Using mathematics & computational thinking
12	B2R1	HS-PS 1-1,2,3, 8; 2-6	RST9-1 0.4	SWBAT review matter and bonding concepts and skills in preparation for B2.	(W) solve matter and bonding problems with a partner using the reference sheet and notes	SP6: Constructing scientific explanations & designing engineering solutions
13	B2R2	HS-PS 1-1,2,3, 8; 2-6	RST9-1 0.5	SWBAT review bonding and gas law concepts and skills in preparation for B2.	(W) answer questions about bonding and gases topics independently using a reference sheet and a calculator	SP6: Constructing scientific explanations & designing engineering solutions
14	RT Ref RD	HS-PS 1- 8	WHST9 -10.2B	SWBAT write a rough draft of a cover letter for their RT artifact.	(W) describe how Boyle's Law lab provides evidence about the relationship between P and V	**SP7: Engaging in argument from evidence**
15	RT Ref FD	HS-PS 1- 8	WHST9 -10.1D	SWBAT write a final draft of a cover letter for their RT artifact.	(R) read through feedback on their cover letter to revise their letter for their RT artifact	**SP7: Engaging in argument from evidence**

16	B2 RT	HS-PS 1-1,2,3, 8; 2-6	TBD	SWBAT reflect on work from S1 to identify areas of growth before BA3	TBD	SP8: Obtaining, evaluating, and communicating information
17	W15/16	HS-PS 1- 8	RST9-1 0.4	SWBAT define the mole as a counting unit and define the number of particles in a mole (Avogadro's Law).	(S) tell a partner the relationship between the V and n of a gas when P and T are constant	**SP1: Asking scientific questions & defining engineering problems**
18	W17	HS-PS 1- 8	RST9-1 0.7	SWBAT complete calculations for a gas using PV = nRT.	(W) correctly find the T of a gas law with P, V, and n given using the ideal gas law	SP5: Using mathematics & computational thinking
19	W17b	HS-PS 1- 8	RST9-1 0.8	SWBAT determine the gas law required to solve a problem involving multiple variables	(R) read a gas law problem to identify the gas law needed to find the unknown value	**SP4:Analyzing & interpreting data**
20	Exam Review	HS-PS 1- 8	RST9-1 0.8	SWBAT review gas law concepts and skills in preparation for Exam W1.	(W) solve gases problems with a partner using the reference sheet and notes	SP8: Obtaining, evaluating, and communicating information
21	Gases Exam	HS-PS 1- 8	WHST9 -10.1C	SWBAT show knowledge on Exam W1	(W) independently solve gases problems using a reference sheet	SP8: Obtaining, evaluating, and communicating information

Subject	Chemistry
Unit	Unit 4: Stoichiometry
Est. Length	26 lessons (Feb - Apr)
Big Idea	Stoichiometry quantifies the relationships between reactants and products in a chemical reaction.
Essential Questions	1. How do we measure, calculate, and predict quantities of chemicals? 2. How can we use properties of solutions to quantify concentration, mass, and volume?
MA State Standards *Power standards in bold	HS-PS1- 2. Use the periodic table model to predict and design simple reactions that result in two main classes of binary compounds, ionic and molecular. Develop an explanation based on given observational data and the electronegativity model about the relative strengths of ionic or covalent bonds ● Clarification Statements: ○ Simple reactions include synthesis (combination), decomposition, single displacement, double displacement, and combustion. ○ Predictions of reactants and products can be represented using Lewis dot structures, chemical formulas, or physical models. ○ Observational data include that binary ionic substances (i.e., substances that have ionic bonds), when pure, are crystalline salts at room temperature (common examples include NaCl, KI, Fe2O3); and substances that are liquids and gases at room temperature are usually made of molecules that have covalent bonds (common examples include CO2, N2, CH4, H2O, C8H18) **HS-PS1- 7. Use mathematical representations and provide experimental evidence to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Use the mole concept and proportional relationships to evaluate the quantities (masses or moles) of specific reactants needed in order to obtain a specific amount of product** **● Clarification Statements:** **○ Mathematical representations include balanced chemical equations that represent the laws of conservation of mass and constant composition (definite proportions), mass-to-mass stoichiometry, and calculations of percent yield.** **○ Evaluations may involve mass-to-mass stoichiometry and atom economy comparisons, but only for single-step reactions that do not involve complexes**

	HS-PS1- 9. Relate the strength of an aqueous acidic or basic solution to the extent of an acid or base reacting with water as measured by the hydronium ion concentration (pH) of the solution. Make arguments about the relative strengths of two acids or bases with similar structure and composition ● Clarification Statements: ○ Reactions are limited to Arrhenius and Bronsted-Lowry acid-base reaction patterns with monoprotic acids. ○ Comparisons of relative strengths of aqueous acid or base solutions made from similar acid or base substances is limited to arguments based on periodic properties of elements, the electronegativity model of electron distribution, empirical dipole moments, and molecular geometry. Acid or base strength 2016 Massachusetts Science and Technology/Engineering Curriculum Framework 83 comparisons are limited to homologous series and should include dilution and evaporation of water HS-PS1-11. Design strategies to identify and separate the components of a mixture based on relevant chemical and physical properties. ● Clarification Statements: ○ Emphasis is on compositional and structural features of components of the mixture. ○ Strategies can include chromatography, distillation, centrifuging, and precipitation reactions. ○ Relevant chemical and physical properties can include melting point, boiling point, conductivity, and density HS-PS2- 7. Construct a model to explain how ions dissolve in polar solvents (particularly water). Analyze and compare solubility and conductivity data to determine the extent to which different ionic species dissolve ● Clarification Statement: Data for comparison should include different concentrations of solutions with the same ionic species, and similar ionic species dissolved in the same amount of water
Common Core State Standards (CCSS)	**Reading** RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. RST.9-10.2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*.

	RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*). RST.9-10.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. **Writing** WHST.9-10.1. Write arguments focused on *discipline-specific content*. WHST.9-10.1.A. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. WHST.9-10.1.B. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. WHST.9-10.1.C. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. WHST.9-10.1.D. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

	WHST.9-10.1.E. Provide a concluding statement or section that follows from or supports the argument presented. WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-10.2.A. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. WHST.9-10.2.B. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. WHST.9-10.2.C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. WHST.9-10.2.D. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. WHST.9-10.2.E. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.2.F. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly

	and dynamically. WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research. WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Science Practices (SP)	**1. Asking scientific questions & defining engineering problems** 2. Developing & using models 3. Planning & carrying out investigations **4. Analyzing & interpreting data** 5. Using mathematics & computational thinking 6. Constructing scientific explanations & designing engineering solutions **7. Engaging in argument from evidence** 8. Obtaining, evaluating, and communicating information
Assessment Alignment	**Minor Assessments** ● Classifying/Predicting Products Quiz (changed the name only) ● Stoichiometry Practice Packet **Major Assessments** ● Titration Lab ● Dream Vacation Project ● Toxins Exam
Honors Assignments	1. Toxins Honors Packet 2. Poisons in History - students investigate the use of a famous poison in history. Students explain how the poison harms the body, talk about the historical uses of it, and then calculate the lethal

	dose of the poison for a 175-lb person 3. Unsung Scientists (options include: Emmett Chapelle, Jerome Nriagu)
20 Key Vocabulary Words	Single exchange, double exchange, combination, decomposition, molarity, concentration, acid, base, conjugate acid, conjugate base, pH scale, indicator, neutralization, reactant, product, solution, solvent, solute, dilution, titration

Prior knowledge that students have entering this unit
1. Phases of matter 2. Temperature - Fahrenheit vs. Celsius (only celsius will be used) 3. Solving algebraic equations and fractions 4. How to determine the significant digits in a number 5. Periodic table trends (atomic radius, reactivity, period, group, atomic number) 6. How to use the periodic table to identify where an element is as well as certain properties that element has based on its location in the PT (i.e. metal vs. nonmetal, reactivity, group #) 7. Lab skills and equipment use 8. How to write out chemical formulas and a chemical equation using element symbols, subscripts, and states of matter 9. How to predict products based on the Law of Conservation of Matter as well as the order that the elements go in the compounds that are produced based on where they are in the PT 10. Roman numerals 11. Direct and indirect proportionality 12. Attractions between molecules and polarity of molecules 13. Use of a calculator to solve fractions 14. How to make observations in the laboratory using the five senses 15. Vocab terms: concentration, dilute 16. Behavior of molecules based on KMT 17. Mole concept (amount of particles in 1 mole of a substance)

Where this knowledge goes next
1. Using written equations to understand chemical reactions 2. Distinguishing between the different categorizations of reactions 3. Writing chemical formulas and chemical reactions 4. Solution calculations to determine concentration 5. Using written equations to determine bonds formed and broken, and net energy change 6. Interpretations of energy diagrams based on the reactants and products in a reaction 7. Interpreting oxidation-reduction reactions using knowledge of reactions and equations 8. Equilibrium of a reaction, and shifts in equilibrium due to an applied stress 9. Calculating changes in variables such as temperature as it relates to reaction rates 10. Using temperature scales in calculations 11. Comparing amounts of substances based on the number of moles of a substance

Descriptive outline narrative of unit
The first lesson of this unit draws on students' bonding knowledge of the law of conservation of matter, where they have to justify the conservation of mass using a chemical equation. Then, students balance chemical equations using the law of conservation of mass. After balancing equations, students learn how to classify equations into different categories based on the elements and compounds involved in the reactants and products. After learning the classifications of equations, students predict the products of equations using their knowledge of the classifications. Students then practice these new skills and demonstrate them on the first stoichiometry quiz. After this, we begin conversions, where students learn and practice how to convert between molar mass and moles using the periodic table. Molarity, or the amount of moles per volume of a substance, is then discussed. In this discussion, students learn the distinction between the terms "solute," "solvent," and "solution." Then, all of the stoichiometry concepts that have been discussed will be practiced and tested. From there, the molarity of solutions is calculated mathematically. This leads into a practice lab and then a real lab experiment using different concentrations of a solution to create an absorbance vs. concentration graph (absorbance referring to the amount of light absorbed by a solution). Building on this knowledge, we begin discussing acids and bases and how to identify them based on an indicator, or a solution added to the acid or base that changes color based on the pH of the solution. Acids and bases are then covered in more detail, and students are required to identify different kinds of acids and bases, as well as whether or not an acid or a base is strong or weak based on a particle-level diagram. In preparation for the

titration lab, the difference between dilution and neutralization is identified in a reaction between an acid and a base. The titration lab is then performed, where students are titrating an unknown sample of acidic pond water to determine its concentration. A lab report is then created for this experiment. After finalizing the lab report, all concepts of stoichiometry are reviewed. Students then demonstrate this knowledge on the unit exam.

Day	Lesson #/name	MA	CCSS	Content Objective	Language Objective	Science practice(s)
1	T4	HS-PS 1-7, 11	WHST9-10.9	SWBAT justify using a chemical equation as evidence that mass is conserved in a chemical reaction.	(S) justify that mass is conserved in a chemical reaction	**SP7: Engaging in argument from evidence**
2	T5	HS-PS 1-7	RST9-10.4	SWBAT balance chemical equations based on the principle of the Law of Conservation of Mass.	(W) use the Law of Conservation of Mass to accurately write coefficients for compounds in a chemical equation	SP5: Using mathematics & computational thinking
3	T6	HS-PS 1-7	RST9-10.2	SWBAT classify chemical equations as combination, decomposition, single exchange, double exchange, or combustion	(S) explain to a partner the difference between single and double exchange reactions using the terms “reactants” and “products”	SP2: Developing & using models
4	Quiz T1/Reteach	HS-PS 1-7, 11	WHST9-10.2D	SWBAT demonstrate knowledge of equations on quiz T1.	(R) use a reference sheet to balance and classify a chemical equation .	SP8: Obtaining, evaluating, and communicating information
5	T6 Lab	HS-PS 1-7	RST9-10.2	SWBAT determine the classification of a reaction based on observations during the lab	(W) accurately identify and classify the five chemical reactions observed in the lab	SP3: Planning & carrying out investigations
6	Predicting Products	HS-PS 1-2	RST9-10.6	SWBAT determine the products of a reaction based on classification and the reactants in the equation.	(W) predict in writing based on a set of reactants what the products of a chemical reaction are	SP8: Obtaining, evaluating, and communicating information

7	T10	HS-PS 1-7	RST9-10.8	SWBAT convert between molar mass of elements/compounds and moles using the periodic table.	(R) use the average atomic mass of the element from the periodic table to accurately convert molar mass to moles	SP2: Developing & using models
8	T10b	HS-PS 1-7	RST9-10.7	SWBAT accurately solve problems that require mass-to-mole conversions.	(W) correctly set up a mass-to-mole conversion using a mathematical formula	SP5: Using mathematics & computational thinking
9	T24	HS-PS 1-7, 11; 2-7	RST9-10.5	SWBAT (1) use a balanced chemical equation to define a mole ratio between two compounds; (2) complete stoichiometric calculations for a variety of chemical reactions.	(S) tell a partner a mole ratio between two reactants based on a balanced equation	SP8: Obtaining, evaluating, and communicating information
10	T25	HS-PS 1-7, 11; 2-7	WHST9-10.2C	SWBAT: correctly determine the unknown value based on the molar mass and mole ratios of the substances	(W) write a stoichiometric conversion from moles to molecules using Avogadro's number	SP8: Obtaining, evaluating, and communicating information
11	T25b	HS-PS 1-7, 11; 2-7	WHST9-10.2C	SWBAT: practice accurately answering stoichiometric problems	(R) read a stoichiometry problem and determine the steps needed to accurately solve the problem	SP8: Obtaining, evaluating, and communicating information
12	Stoich Proj 1	HS-PS 1-7, 11; 2-7	WHST9-10.6	SWBAT: identify a dream vacation as a group and write a background for the vacation	(S) estimate with a partner how many miles away your dream vacation is and then research the correct answer	**SP1: Asking scientific questions & defining engineering problems**
13	Stoich Proj 2	HS-PS 1-7, 11; 2-7	WHST9-10.2C	SWBAT: identify the unit conversions needed to solve for the amount of CO_2 emitted during a roundtrip flight to their dream vacation	(R) identify unit conversions for gallons to liters and miles per gallon for anairplane	SP2: Developing & using models
14	Stoich Proj 3	HS-PS 1-7, 11; 2-7	RST9-10.4	SWBAT: accurately solve for the grams of CO_2 emitted for a roundtrip flight to their dream vacation	(W) write a multi-step stoichiometric conversion using given unit conversions	SP5: Using mathematics & computational thinking

15	Stoich Proj 4	HS-PS 1-7, 11; 2-7	WHST9-10.4	SWBAT: write a reflection about the importance of knowing the environmental impact for dream vacations	(W) write an individual reflection using the group calculations as evidence	SP6: Constructing scientific explanations & designing engineering solutions
16	T13	HS-PS 2-7	WHST9-10.2D	SWBAT describe in writing solution and concentration on a particle level using the terms solution, solute, and solvent.	(W) write a sentence using the words “solute,” “solution,” and “solvent” correctly	SP6: Constructing scientific explanations & designing engineering solutions
17	T14	HS-PS 2-7	RST9-10.7	SWBAT solve problems involving concentration by calculating the molarity of a solution.	(W) accurately calculate the molarity of a solution using the equation M = mol/L	SP5: Using mathematics & computational thinking
18	T15	HS-PS 2-7	WHST9-10.2	SWBAT use a colorimeter to determine the concentration of a known solution	(R) read a colorimeter to determine the concentration of a solution	**SP4: Analyzing & interpreting data**
19	T15a	HS-PS 2-7	RST9-10.7	SWBAT interpret absorbance vs. concentration graphs to determine the concentration of an unknown solution.	(R) read an absorbance vs. concentration graph to determine the concentration of blue dye in Gatorade	**SP4: Analyzing & interpreting data**
20	T17	HS-PS 1-9	WHST9-10.9	SWBAT explain how indicator solutions can be used to determine if a solution is acidic or basic.	(S) argue whether a solution is acidic or basic based on the color an indicator turns in the original solution	**SP1: Asking scientific questions & defining engineering problems**
21	T18a	HS-PS 1-9	RST9-10.5	SWBAT identify Arrhenius and Bronsted-Lowry bases based on chemical formulas and equations and identify the acid, base, conjugate acid, and conjugate base.	(W) label an equation using the terms acid, base, conjugate acid, and conjugate base	**SP7: Engaging in argument from evidence**
22	T18b	HS-PS 1-9	RST9-10.4	SWBAT identify strong and weak acids based on a particulate level diagram and use classification to make predictions about the macroscopic properties of those solutions.	(R) read a particle level diagram to identify a strong acid as a substance that is completely dissociated in solution into ions	**SP4: Analyzing & interpreting data**

23	T20	HS-PS 1-9	WHST9 -10.1D	SWBAT tell the difference between dilution and neutralization, and write a balanced neutralization reaction between an acid and a base.	(S) explain to a partner how dilution raises the pH of an acidic solution	**SP1: Asking scientific questions & defining engineering problems**
24	Rev	HS-PS 1-2,7,9 ,11; 2-7	WHST9 -10.1C	SWBAT review toxins concepts and skills in preparation for Exam T1	(W) solve stoichiometry problems with a partner using the reference sheet and notes	SP5: Using mathematics & computational thinking
25	Toxins Exam	HS-PS 1-2,7,9 ,11; 2-7	WHST9 -10.1D	SWBAT show toxins knowledge on Exam T1	(W) independently solve gases problems using a reference sheet	SP8: Obtaining, evaluating, and communicating information
26	T22a	HS-PS 1-9	RST9-1 0.3	SWBAT practice how to perform a titration experiment.	(R) read a buret to determine the volume of base being added to an acid in a titration	SP2: Developing & using models
27	T22b	HS-PS 1-9	RST.9- 10.3	SWBAT perform a titration experiment to determine the concentration of an unknown sample of acidic pond water.	(R) read a lab procedure step-by-step to perform a titration to determine the concentration of a solution	SP3: Planning & carrying out investigations
28	T22c	HS-PS 1-9	WHST9 -10.2A	SWBAT write the results and begin the analysis sections of their lab report	(W) create a data table with information about the volume before and at the equivalence point of the titration	**SP1: Asking scientific questions & defining engineering problems**
29	T22d	HS-PS 1-9	WHST9 -10.1B	SWBAT finalize the analysis section and write the sources of error for their lab report	(W) determine the concentration of the pond water and argue whether it is to acidic for fish to survive	**SP7: Engaging in argument from evidence**
30	T22e	HS-PS 1-9	WHST9 -10.10	SWBAT write the abstract of their lab report and finalize their report	(W) summarize the background information and results of the lab	SP8: Obtaining, evaluating, and communicating information
31	AB Rev	HS-PS 1-9	RST9-1 0.10	SWBAT practice determining the difference in strengths of acids and bases using the concepts of pH and	(R) determine the difference between a strong acid and a weak acid on a particle level diagram	SP2: Developing & using models

				reactivity.		

Subject	Chemistry
Unit	Unit 5: Thermodynamics
Est. Length	20 lessons (Apr - Jun)
Big Idea	Chemical reactions and changes to matter involve changes in energy.
Essential Questions	1. How can energy changes in chemical reactions be observed, quantified, and predicted? 2. How can changes to chemical reactions be predicted based changes to the system and surroundings?
MA State Standards *Power standards in bold	**HS-PS1-4. Develop a model to illustrate the energy transferred during an exothermic or endothermic chemical reaction based on the bond energy difference between bonds broken (absorption of energy) and bonds formed (release of energy).** ● **Clarification Statement: Examples of models may include molecular-level drawings and diagrams of reactions or graphs showing the relative energies of reactants and products.** ● **State Assessment Boundary: Calculations using Hess's law are not expected in state assessment.** HS-PS1-5. Construct an explanation based on kinetic molecular theory for why varying conditions influence the rate of a chemical reaction or a dissolving process. Design and test ways to slow down or accelerate rates of processes (chemical reactions or dissolving) by altering various conditions. ● Clarification Statements: ○ Explanations should be based on three variables in collision theory: (a) quantity of collisions per unit time, (b) molecular orientation on collision, and (c) energy input needed to induce atomic rearrangements. ○ Conditions that affect these three variables include temperature, pressure, concentrations of reactants, agitation, particle size, surface area, and addition of a catalyst. ● State Assessment Boundary: State assessment will be limited to simple reactions in which there are only two reactants and to specifying the change in only one variable at a time. HS-PS1-6. Design ways to control the extent of a reaction at equilibrium (relative amount of products to reactants) by altering various conditions using Le Chatelier's principle. Make arguments based on kinetic molecular theory to account for how altering conditions would affect the forward and reverse rates of the reaction until a new equilibrium is established. ● Clarification Statements:

	○ Conditions that can be altered to affect the extent of a reaction include temperature, pressure, and concentrations of reactants. ○ Conditions that can be altered to affect the rates of a reaction include temperature, pressure, concentrations of reactants, agitation, particle size, surface area, and addition of a catalyst. ● State Assessment Boundaries: ○ Calculations of equilibrium constants or concentrations are not expected in state assessment. ○ State assessment will be limited to simple reactions in which there are only two reactants and to specifying the change in only one variable at a time HS-PS1-10. Use an oxidation-reduction reaction model to predict products of reactions given the reactants, and to communicate the reaction models using a representation that shows electron transfer (redox). Use oxidation numbers to account for how electrons are redistributed in redox processes used in devices that generate electricity or systems that prevent corrosion. ● Clarification Statement: Reactions are limited to simple oxidation-reduction reactions that do not require hydronium or hydroxide ions to balance half-reactions HS-PS3-4b. Provide evidence from informational text or available data to illustrate that the transfer of energy during a chemical reaction in a closed system involves changes in energy dispersal (enthalpy change) and heat content (entropy change) while assuming the overall energy in the system is conserved. ● State Assessment Boundary: Calculations involving Gibbs free energy are not expected in state assessment.
Common Core State Standards (CCSS)	**Reading** RST.9-10.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. RST.9-10.2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9-10 texts and topics*. RST.9-10.5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

	RST.9-10.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address. RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. RST.9-10.8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. RST.9-10.9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts. RST.9-10.10. By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently. **Writing** WHST.9-10.1. Write arguments focused on *discipline-specific content*. WHST.9-10.1.A. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. WHST.9-10.1.B. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. WHST.9-10.1.C. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. WHST.9-10.1.D. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.1.E. Provide a concluding statement or section that follows from or supports the argument presented.

	WHST.9-10.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. WHST.9-10.2.A. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. WHST.9-10.2.B. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. WHST.9-10.2.C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. WHST.9-10.2.D. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. WHST.9-10.2.E. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. WHST.9-10.2.F. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). WHST.9-10.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. WHST.9-10.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. WHST.9-10.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. WHST.9-10.7. Conduct short as well as more sustained research projects to answer a question (including a

	self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. WHST.9-10.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. WHST.9-10.9. Draw evidence from informational texts to support analysis, reflection, and research. WHST.9-10.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Science Practices (SP)	**1. Asking scientific questions & defining engineering problems** 2. Developing & using models 3. Planning & carrying out investigations **4. Analyzing & interpreting data** 5. Using mathematics & computational thinking 6. Constructing scientific explanations & designing engineering solutions **7. Engaging in argument from evidence** 8. Obtaining, evaluating, and communicating information
Assessment Alignment	**Minor Assessments** ● Quiz F1 ● Quiz F2 ● Thermodynamics Practice Packet **Major Assessments** ● Le Chatelier's Principle Lab
Honors Assignments	1. Unsung Scientists (see above) 2. Dorito lab design - design a procedure to determine the heat transfer from a chip using the textbook as a guide (if it is a good procedure, they can perform the experiment in lieu of classroom assignments as incentive)
20 Key Vocabulary	Energy, enthalpy, entropy, endothermic, exothermic, activation energy, heat transfer, phase change, solid, liquid, gas, bond energy, bond formation, reaction rate, collision theory, Le Chatelier's

Words	Principle, oxidation, reduction, equilibrium, equilibrium shift

Prior knowledge that students have entering this unit
1. Phases of matter 2. Temperature - Fahrenheit vs. Celsius (only celsius will be used) 3. Solving algebraic equations and fractions 4. How to determine the significant digits in a number 5. Periodic table trends (atomic radius, reactivity, period, group, atomic number) 6. How to use the periodic table to identify where an element is as well as certain properties that element has based on its location in the PT (i.e. metal vs. nonmetal, reactivity, group #) 7. Lab skills and equipment use 8. How to write out chemical formulas and a chemical equation using element symbols, subscripts, and states of matter 9. How to predict products based on the Law of Conservation of Matter as well as the order that the elements go in the compounds that are produced based on where they are in the PT 10. Roman numerals 11. Direct and indirect proportionality 12. Attractions between molecules and polarity of molecules 13. Use of a calculator to solve fractions 14. How to make observations in the laboratory using the five senses 15. Vocab terms: concentration, dilute 16. Behavior of molecules based on KMT 17. Mole concept (amount of particles in 1 mole of a substance) 18. Categorizations of chemical reactions 19. Use written equations to understand chemical reactions 20. Using temperature scales in calculations 21. Unit conversions: mole-mole, mass-mole, molecule-mole 22. Acids and bases - identification, strong vs. weak 23. How to neutralize acids and bases to produce a salt and water

24. How to titrate in the lab
25. Chemical equilibrium - when a chemical reaction reaches it and how to reach it
26. Solution calculations to determine concentration

Where this knowledge goes next

1. Writing arguments to support a set of data from a lab experiment
2. Identifying chemical structures in DNA and other biological molecules
3. Interpretations of and predictions about chemical reactions
4. Making scientific observations during lab experiments
5. Performing extensive lab experiments and procedures
6. Analyzing data and observations in a lab experiment
7. Interpreting graphs and diagrams
8. Quantifying energy in a system

Descriptive outline narrative of unit

The first lesson of this unit introduces students to reactions that release heat during the reaction, also known as exothermic reactions. Then exothermic reactions are compared to endothermic reactions, where heat is absorbed during the reaction. From here, the thermal energy released or absorbed during a reaction is quantified using the equation $q=mc\Delta T$. Students then explore the total energy released and absorbed by each bond that is broken or formed during a chemical reaction using chemical modeling kits. After using the kits to demonstrate this energy exchange, the net energy exchange is quantified using the structural formulas of the molecules and a chart of bond energies for various bonds. Phase diagrams and energy diagrams will then be introduced and interpreted. Phase diagrams demonstrate the changes of phase of matter in relation to temperature and heat added. Energy diagrams demonstrate the energy added and removed during a chemical reaction. Collision theory and KMT concepts will then be briefly discussed in relation to the rate of a reaction. The discussion of reactions will then narrow into a focus on oxidative-reduction reactions, or redox reactions. The oxidized and reduced terms in a reaction will be identified. The final topic of this unit will be chemical equilibrium. Equilibrium will be defined as when the rate of the forward reaction is equal to the rate of the reverse reaction. Equilibrium shifts will then be discussed through Le Chatelier's Principle. Many applied stresses will be identified and the

effects of these stresses on the equilibrium will be predicted. This unit will end with a Le Chatelier's lab and a lab analysis. If time, Gibbs free energy and the distinction between entropy and enthalpy will be introduced.

Day	Lesson #/name	MA	CCSS	Content Objective	Language Objective	Science practice(s)
1	F1	HS-PS1-4	RST9-10.4	SWBAT identify energy changes in exothermic reactions.	(W) record accurate observations of reactions and identify the exothermic reactions	**SP4: Analyzing & interpreting data**
2	F2	HS-PS1-4	RST9-10.8	SWBAT determine whether a reaction demonstrates an exothermic or endothermic process.	(R) read a statement or graph and determine whether or not it describes an endothermic or exothermic reaction	SP2: Developing & using models
3	F4	HS-PS1-4	WHST 9-10.4	SWBAT quantify the thermal energy that exists in samples of water at varying temperatures and volumes.	(W) use the words "temperature" and "heat transfer" to describe which of two solutions has more thermal energy	SP5: Using mathematics & computational thinking
4	F6	HS-PS3-4b	RST9-10.7	SWBAT interpret a phase change graph to explain how matter converts between solids, liquids, and gases.	(R) read a phase change graph to determine the states of matter of a substance when the graph is horizontal	SP3: Planning & carrying out investigations
5	F11	HS-PS3-4b	RST9-10.3	SWBAT use ball-and-stick models to model chemical reactions and determine the net energy exchange in those chemical reactions	(R) identify a reaction as endothermic or exothermic based on the sign of the net energy exchange	SP2: Developing & using models
6	F11b	HS-PS1-4	RST9-10.7	SWBAT calculate the energy released and absorbed in bonds during chemical reactions	(W) accurately solve for the net energy exchange in methane combustion using bond energies	SP5: Using mathematics & computational thinking
7	F12/ST2	HS-PS3-4b	WHST 9-10.1D	SWBAT draw and label energy diagrams for reversible reactions.	(W) draw an exothermic energy diagram and label the ΔH with a downward arrow	SP2: Developing & using models

8	F13a	HS-PS1-5	WHST 9-10.2 C	SWBAT use collision theory to identify factors that control the rate of a reaction.	(W) use the words “temperature” and “collisions” to state the relationship between rate of reaction and temperature	**SP1: Asking scientific questions & defining engineering problems**
9	F13b	HS-PS1-4	RST9-10.6	SWBAT apply knowledge of chemical reactions and charges to complex problems involving energy diagrams.	(R) predict the direction of energy transfer based on an energy diagram	SP8: Obtaining, evaluating, and communicating information
10	F15/16	HS-PS1-10	WHST 9-10.2 D	SWBAT identify the terms being oxidized in a chemical reaction.	(W) label the oxidized term in a chemical reaction	SP6: Constructing scientific explanations & designing engineering solutions
11	F17a	HS-PS1-10	WHST 9-10.2 D	SWBAT identify the terms being reduced in a chemical reaction.	(W) label the reduced term in a chemical reaction	SP6: Constructing scientific explanations & designing engineering solutions
12	F17b	HS-PS1-10	RST9-10.8	SWBAT apply redox rules to determine which terms are being reduced and oxidized in a chemical reaction.	(S) argue which term in a reaction is oxidized using the rule that oxidation means loss of electrons	**SP7: Engaging in argument from evidence**
13	ST3/6	HS-PS1-6	WHST 9-10.1 C	SWBAT define a chemical equilibrium and identify a reaction at chemical equilibrium .	(S) explain to a partner that chemical equilibrium means equal rates of forward and reverse reactions, not equal amounts of reactants and products	SP2: Developing & using models
14	ST6	HS-PS1-6	RST9-10.2	SWBAT determine the direction of an equilibrium shift in a chemical reaction due to an applied stress.	(S) predict to a partner the direction a reaction will shift at equilibrium due to an applied stress	**SP1: Asking scientific questions & defining engineering problems**
15	ST6a	HS-PS1-6	RST.9-10.3	SWBAT observe the effect of an applied stress on chemical systems at equilibrium.	(W) identify the expected color change due to an equilibrium shift when decreasing the temperature of a reaction	SP3: Planning & carrying out investigations

16	ST6b	HS-PS1-6	WHST 9-10.2 A	SWBAT write the heading, title, question, and hypothesis of their lab report.	(W) state a hypothesis about the observed change due to an applied stress for a reaction	SP8: Obtaining, evaluating, and communicating information
17	ST6c	HS-PS1-6	WHST 9-10.1 B	SWBAT write the results section and start the analysis section of their lab report.	(W) create a data table with observations of the changes in the reaction for each applied stress	**SP4: Analyzing & interpreting data**
18	ST6d	HS-PS1-6	WHST 9-10.10	SWBAT finalize the analysis and write the argument of their lab report.	(W) justify the effect of an applied stress on the equilibrium of their reaction	**SP7: Engaging in argument from evidence**
19	GFE	HS-PS1-5	RST9-10.9	SWBAT differentiate between enthalpy & entropy using the Gibbs free energy equation.	(R) identify enthalpy and entropy based on a statement about the free energy in a reaction	SP5: Using mathematics & computational thinking