Chemistry Pacing Guide 2020-2021		
Days	**Unit**	**Georgia Standards of Excellence**
42	Unit 1: Chemistry Lab/ Math skills and the Atomic Structure and Periodic Table	**SC1. Obtain, evaluate, and communicate** information about the use of the modern atomic theory and periodic law to explain the characteristics of atoms and elements. a. Evaluate merits and limitations of different models of the atom in relation to relative size, charge, and position of protons, neutrons, and electrons in the atom. b. Construct an argument to support the claim that the proton (and not the neutron or electron) defines the element's identity. c. Construct an explanation based on scientific evidence of the production of elements heavier than hydrogen by nuclear fusion. d. Construct an explanation that relates the relative abundance of isotopes of a particular element to the atomic mass of the element. e. Construct an explanation of light emission and the movement of electrons to identify elements. g. Develop and use models, including electron configuration of atoms and ions, to predict an element's chemical properties. f. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms (i.e. including atomic radii, ionization energy, and electronegativity).
20	Unit 2: Chemical Bonds and Compounds	**SC2. Obtain, evaluate, and communicate information about the chemical and physical properties of matter resulting from the ability of atoms to form bonds.** c. Construct an explanation about the importance of molecular-level structure in the functioning of designed materials. (Clarification statement: Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are

		made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.) d. Develop and use models to evaluate bonding configurations from nonpolar covalent to ionic bonding. (Clarification statement: VSEPR theory is not addressed in this element.) e. Ask questions about chemical names to identify patterns in IUPAC nomenclature in order to predict chemical names for ionic (binary and ternary), acidic, and inorganic covalent compounds. f. Develop and use bonding models to predict chemical formulas including ionic (binary and ternary), acidic, and inorganic covalent compounds.
30	Unit 3: Chemical Reactions	**SC3. Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.** a. Use mathematics and computational thinking to balance chemical reactions (i.e., synthesis, decomposition, single replacement, double replacement, and combustion) and construct an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. b. Plan and carry out an investigation to determine that a new chemical has been formed by identifying indicators of a chemical reaction (e.g., precipitate formation, gas evolution, color change, water production, and changes in energy to the system). c. Use mathematics and computational thinking to apply concepts of the mole and Avogadro’s number to conceptualize and calculate • percent composition • empirical/molecular formulas • mass, moles, and molecules relationships • molar volumes of gases
20	Unit 4: Stoichiometry, Limiting Reactants and the Gas Laws	**SC3. Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.**

		c. Use mathematics and computational thinking to apply concepts of the mole and Avogadro's number to conceptualize and calculate • percent composition • empirical/molecular formulas • mass, moles, and molecules relationships • molar volumes of gases d. Use mathematics and computational thinking to identify and solve different types of reaction stoichiometry problems (i.e., mass to moles, mass to mass, moles to moles, and percent yield) using significant figures. (Clarification statement: For elements c and d emphasis is on use of mole ratios to compare quantities of reactants or products and on assessing students' use of mathematical thinking **SC5. Obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes.** c. Develop and use models to quantitatively, conceptually, and graphically represent the relationships between pressure, volume, temperature, and number of moles of a gas.
15	Unit 5: Reaction Rates and Equilibrium	**SC4. Obtain, evaluate, and communicate information about how to refine the design of a chemical system by applying engineering principles to manipulate the factors that affect a chemical reaction.** a. Plan and carry out an investigation to provide evidence of the effects of changing concentration, temperature, and pressure on chemical reactions. (Clarification statement: Pressure should not be tested experimentally.) b. Construct an argument using collision theory and transition state theory to explain the role of activation energy in chemical reactions. (Clarification statement: Reaction coordinate diagrams could be used to visualize graphically changes in energy (direction flow and quantity) during the progress of a chemical reaction.) c. Construct an explanation of the effects of a catalyst on chemical reactions and apply it to everyday examples. d. Refine the design of a chemical system by altering the conditions that would change forward and reverse reaction rates and the

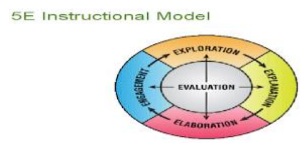
		amount of products at equilibrium. (Clarification statement: Emphasis is on the application of LeChatelier's principle.)
20	Unit 6: Energy in Chemical Reactions	**SC5. Obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes**. a. Plan and carry out an investigation to calculate the amount of heat absorbed or released by chemical or physical processes. (Clarification statement: Calculation of the enthalpy, heat change, and Hess's Law are addressed in this element.) **SC2. Obtain, evaluate, and communicate information about the chemical and physical properties of matter resulting from the ability of atoms to form bonds.** g. Develop a model to illustrate the release or absorption of energy (endothermic or exothermic) from a chemical reaction system depends upon the changes in total bond energy
12	Unit 7: States and Properties of Matter	**SC2. Obtain, evaluate, and communicate information about the chemical and physical properties of matter resulting from the ability of atoms to form bonds.** a. Plan and carry out an investigation to gather evidence to compare the physical and chemical properties at the macroscopic scale to infer the strength of intermolecular and intramolecular forces. b. Construct an argument by applying principles of inter- and intra-molecular forces to identify substances based on chemical and physical properties. **SC5. Obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes** b. Construct an explanation using a heating curve as evidence of the effects of energy and intermolecular forces on phase changes.
15	Unit 8: Mixtures, Solutions, and Solubility	**SC6. Obtain, evaluate, and communicate information about the properties that describe solutions and the nature of acids and**

		bases. a. Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation. a. Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation. b. Plan and carry out an investigation to evaluate the factors that affect the rate at which a solute dissolves in a specific solvent. c. Use mathematics and computational thinking to evaluate commercial products in terms of their concentrations (i.e., molarity and percent by mass). d. Communicate scientific and technical information on how to prepare and properly label solutions of specified molar concentration. e. Develop and use a model to explain the effects of a solute on boiling point and freezing point.
15	Unit 9: Acids and Bases	**SC6. Obtain, evaluate, and communicate information about the properties that describe solutions and the nature of acids and bases. a. Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation.** f. Use mathematics and computational thinking to compare, contrast, and evaluate the nature of acids and bases in terms of percent dissociation, hydronium ion concentration, and pH. (Clarification statement: Understanding of the mathematical relationship between negative logarithm of the hydrogen concentration and pH is not expected in this element. Only a conceptual understanding of pH as related to acid/basic conditions is needed.) g. Ask questions to evaluate merits and limitations of the Arrhenius and Bronsted-Lowry models of acid and bases. h. Plan and carry out an investigation to explore acid-base neutralization.

What is STEM

STEM education is an interdisciplinary approach to learning which removes the traditional instructional setting of teaching isolated subjects and integrates science, technology, engineering and math into real world learning experiences for students.

5 E Instructional Model



The 5E instructional model is built on the idea that learners build on and construct new ideas on top of their old ones. Advantages of the 5E model include: Enhancing mastery of subject matter,Developing scientific reasoning, Understanding the complexity and ambiguity of empirical work, Developing practical skills, Understanding the nature of science, Cultivating interest in science and interest in learning science,Developing teamwork abilities.

Engagement	Exploration	Explanation	Extend/Elaboration	Evaluation
Teacher generates interest, assess prior knowledge, connects prior knowledge, sets instructional focus on the concept,	Students experience key concepts, learn new skills, asking question,reflect on their thinking and develop relationships and understanding of concepts	Connecting prior knowledge to new content/discoveries, use of academic language, teacher and students work together	Apply learning to similar situations, explain new situation with formal academic language,	Should be ongoing throughout the learning phase, shows evidence of accomplishment,Teacher, peer and self assessments
Teacher actions: Motivates, creates interest, raises questions, taps into prior knowledge	**Teacher actions:** Moves into a facilitator role, observes students, asks guiding questions, encourages teamwork, provides materials and resources, provide adequate time for students to engage	**Teacher actions:** Encourages students to explain understandings in their own words, provides explanations of definitions, laws, theories, ask clarifying questions, builds onto students understanding,	**Teacher actions:** Provide an opportunity for students to apply their new gained information to enhance additional learning, remind students to look for alternative ways to solve the problem,providing guidance	**Teacher actions:** Observes students, asks open-ended questions,assess students, encourages students to self assess

	with the materials	provide a variety of instructional strategies, develop academic language, formative assessments to gauge understanding	on perseverance	
Student actions: Ask questions, attentive to teacher/classmates, makes connections to prior learning, self reflects on what they already know, what do they want to know	**Student actions:** Conducts experiments, activities, work with groups to make meaning of the problem, record observations, use journals, listen to others ideas,	**Student actions:** Explain solutions, critiques or ask further questions of others solutions,refers back to notes and journals to communicate findings and understanding, self assesses their own learning	**Student actions:** Generates interest in new learning, explore related content, records observations and interacts with peers to broaden one's o	**Student actions:** Self evaluates, uses academic language, demonstrates understanding of concept, solves problems
Example: Topic : Observe and describe the process of erosion, transportation, and deposition of the earth's land surface using natural phenomena and models Materials : paint tray (the kind used for a paint roller), pieces of sod (enough for each group), potting soil, heavy clay like soil, Rainmaker (paper cup with about ten tiny holes poked in the bottom) , Water. Activity 1.bottom of slide under swing 2.end of splash guard by rain	**Example:** Construct a model to investigate how these changes may have occurred. Provide materials so the students can construct their own model of a landscape. It should include a piece of sod, fine potting soil, and a heavy clay like soil. Have them use a paint roller tray as the base of the landscape. Do not put any landscape materials in the bottom well; it should remain empty. Once students have constructed their models, have them diagram and label their models and make a prediction as to what will happen if it "rains" on their landscape.	**Example:** Tell me what some of your prediction were before it rained on your landscape. (Record on board.) What actually happened to your landscape when it rained on it? (record so you can make comparisons.) How is your landscape different after the rain than before it rained on it? What happened to the soil? Where did it go? Why did this happen? As students share their ideas and understandings, record key phrases on the board. Some phases that may be valuable to your later discussion may include:dirt	**Example:** Using the same paint roller tray as the base for their landscape, have the groups of students plan a method to decrease or eliminate erosion. Students should draw a diagram of the model planned and label the materials used in their landscape. They should write a short explanation explaining why they think this will work to curb erosion. (Tell students that you will provide the same materials that they used today and they are responsible for supplying the rest of the materials to build their new landscape tomorrow.)	**Example:** Have photographs representing each process and have students identify and explain why they identified it as such. Have students take a walk in their own neighborhood tonight to find examples of each process. They should draw and write one sentence telling what they observed. Have students write their own definition and list an example for each process in their science journals.

spout at entrance to door 3. path leading to the playground at the bottom of hill/slope Do you notice anything different about these areas? (They are just dirt; no grass is growing here.) What do you think caused these changes? (Students walking over them; water running through it)	One student pours a cup of water all at once into the rainmaker. Hold the rainmaker about 4 inches above the upper end of the landscape and slowly move it back and forth so the water "rains" down on the model landscape. Observe what happens to the landscape. When it is finished raining the students observe the final effects of the rain on their landscape. Have students go back to their predictions and record what actually happened.	and soil washed away,the soil collected at the bottom of the slope,the water hollowed out the soil, the rain carried the soil down the hill,when the water washed away the soil it formed a hole Relate their observations to the processes scientists observe over an extended period of time. Use student models to identify and label erosion and deposition. Have students work to create definitions for these terms. When you are sure students have a real understanding of the terms, formulate a final definition and post on board or chart in the classroom for future reference. Demonstrate the process of transportation and lead students to understand that it is the movement of soil particles from one place to another. Refer to the list generated during the engagement and have students make connections; they should use the new terms to discuss and explain what they saw. Help them to understand that they just used water to simulate erosion, transportation, and	Have students use a variety of resources and references to research various landmarks that are the result of these processes.	

		deposition, but it can also be caused by wind, people, animals, etc.		

Science and Engineering Practices

Asking questions and defining problems	Developing and using models
A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.	A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.
Planning and carrying out investigations	Using mathematics and computational thinking
Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions	In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions.
Analyzing and interpreting data	Constructing explanations and designing solutions
Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis. Engineering investigations	The end-products of science are explanations and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of

include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.	desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.
Engaging in argument from evidence	Obtaining, evaluating, and communicating information
Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims	Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs

The Science Standards-Based Classroom Instructional Framework provides a common language of instruction in order to successfully implement high quality practices. The tool can be used to develop lesson plans as well as a guide for teachers to reference during instruction. It is imperative that an opening, transition, work and closing is addressed with each lesson.

SCIENCE
STANDARDS-BASED CLASSROOM
INSTRUCTIONAL FRAMEWORK

Instructional Framework

Time will vary based on instructional focus

OPENING

Teacher:
- Introduces phenomena to engage students in investigations
- Engages students/accesses prior knowledge and makes connections by encouraging them to ask questions
- Provides explicit instruction aligned to standard(s), including skill development and conceptual understanding
- Models science and engineering practices and questioning based on crosscutting concepts

Student:
- Accesses prior knowledge
- Asks thought-provoking and clarifying questions.
- Participates in classroom discussions; engages in investigations and analyzes thinking

TRANSITION TO WORK SESSION

Teacher:
- Provides guidance to engage in exploration of phenomena
- Helps students in identifying routines to engage in collaboration
- Introduces organizing tools
- Reviews success criteria and expectations for work

Student:
- Engages in exploration of phenomena
- Participates in discussion
- Prepares organizing tools
- Asks questions or define problems

WORK SESSION

Teacher:
- Facilitates independent and small group work; scaffolds learning tasks
- Engages students in the 3-dimensions of science instruction
- Monitors, assesses and documents student progress and provides standards-based feedback
- Provides small group instruction
- Allows students to engage in productive struggle, make mistakes, and engage in error analysis
- Conferences formally and informally with students

Student:
- Engages in independent or collaborative learning
- Demonstrates proficiency of science and engineering practices, crosscutting concepts and core disciplinary ideas
- Completes conceptually rich performance tasks, research or guided practice
- Conferences with teacher and receives standards-based feedback

CLOSING

Teacher:
- Formally or informally assesses student understanding
- Asks questions targeting students' explanations and claims to provide feedback
- Provides phenomena that challenges students' explanations
- Engages students in summarizing learning and celebrates progress toward mastery of standard(s)
- Identifies next steps for instruction based on data analysis

Student:
- Shares, assesses, and justifies work using language of the standards
- Provides peer feedback and asks clarifying questions using language of the standards
- Reflects and summarizes progress toward mastery of learning target/standard based on success criteria

PERVASIVE LESSON PRACTICES

Teacher will embed pervasive practices throughout lesson based on instructional focus

Literacy Across the Content:
- Disciplinary literacy
- Content literacy
- Close reading
- Disciplinary research/ reading to learn

Writing Across the Content
- Content writing
- Writing process
- Writing to learn

Vocabulary Development:
- Academic vocabulary
- Content vocabulary
- Discipline vocabulary
- Engages in three-dimensional learning

Formative Assessment:
- Formal assessments
- Informal assessments
- Standards-based feedback

Classroom Culture:
- Models practices and procedures
- Encourages risk-taking and collaboration
- Demonstrates high expectations in classroom discourse
- Emphasizes safety practices