

Chemistry Curriculum

The Georgia Performance Standards are designed to provide students with the knowledge and skills for proficiency in science. The Project 2061's *Benchmarks for Science Literacy* is used as the core of the curriculum to determine appropriate content and process skills for students. The GPS is also aligned to the National Research Council's *National Science Education Standards*. Technology is infused into the curriculum. The relationship between science, our environment, and our everyday world is crucial to each student's success and should be emphasized.

The performance standards should drive instruction. Hands-on, student-centered, and inquiry-based approaches should be the emphases of instruction. This curriculum is intended as a required curriculum that would show proficiency in science, and instruction should extend beyond the curriculum to meet the student needs.

The hands-on nature of the science curriculum standards increases the need for teachers to use appropriate precautions in the laboratory and field. It is recommended that micro-chemistry techniques be used where appropriate. The guidelines for the safe use, storage, and disposal of chemicals must be observed. Safety of the student should always be foremost in science instruction.

Science consists of a way of thinking and investigating, and includes a growing body of knowledge about the natural world. To become literate in science, therefore, students need to acquire understandings of both the **Characteristics of Science** and its **Content**. The Georgia Performance Standards for Science require that instruction be organized so that these are treated together. Therefore, **A CONTENT STANDARD IS NOT MET UNLESS APPLICABLE CHARACTERISTICS OF SCIENCE ARE ALSO ADDRESSED AT THE SAME TIME**. For this reason they are presented as co-requisites.

This Performance Standards include four major components. They are

The Standards for Georgia Science Courses. The Characteristics of Science co-requisite standards are listed first, followed by the Content co-requisite standards. Each Standard is followed by benchmarks that indicate the specific learning goals associated with it.

Tasks that students should be able to perform during or by the end of the course. These tasks are keyed to the relevant Standards. Some of these can serve as activities that will help students achieve the learning goals of the Standard while others can be used to assess student learning. Many of these tasks can serve both purposes.

Samples of student work. As a way of indicating what it takes to meet a Standard, examples of successful student work are provided. Many of these illustrate how student work can bridge the Content and Characteristics of Science Standards. The Georgia DOE Standards web site will continue to add samples as they are identified, and teachers are encouraged to submit examples from their own classroom experiences.

Teacher commentary. Teacher commentary is meant to open the pathways of communication between students and the classroom teacher. Showing students why they did or did not meet a standard enables them to take ownership of their own learning.

Georgia Performance Science Standards-- Explanation of Coding

Characteristics of Science Standards

SKCS1

Science Kindergarten Characteristics of Science Standard #1****

S8CS2

Science Grade **8 Characteristics of Science Standard #**2****

SCSh8

Science Characteristics of Science high school Standard #8****

Content Standards

S5P3

Science Grade **5 Physical Science Standard #**3****

S4E2

Science Grade **4 Earth Science Standard #**2****

S7L4

Science Grade **7 Life Science Standard #**4****

SC1

Science Chemistry Standard #1****

SB4

Science Biology Standard #4****

SPS6

Science Physical Science Standard #6****

SP3

Science Physics Standard #3****

Chemistry

The Chemistry curriculum is designed to continue student investigations of the physical sciences that began in grades K-8 and provide students the necessary skills to be proficient in chemistry. This curriculum includes more abstract concepts such as the structure of atoms, structure and properties of matter, and the conservation and interaction of energy and matter. Students investigate chemistry concepts through experience in laboratories and field work using the processes of inquiry.

Major Concepts/ Skills:	Concepts/Skills to Maintain:
Classifications of Matter	Characteristics of Science
Atomic Theory/Configuration	Records investigations clearly and accurately
Periodicity	Uses scientific tools
Bonding/Nomenclature	Interprets graphs, tables, and charts
Chemical Reactions	Writes clearly
Law of Conservation of Matter	Uses proper units
Empirical/Molecular Formulas	Organizes data into graphs, tables, and charts
Stoichiometry	Uses models
Kinetic Molecular Theory/Phase Changes	Asks quality questions
Gas Laws	Uses technology
Solutions/Concentrations	Uses safety techniques
Acid/Base Chemistry	Analyzes scientific data via calculations and inferences
	Recognizes the importance of explaining data with precision and accuracy

Co-Requisite – Characteristics of Science

Habits of Mind

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

- Exhibit the above traits in their own scientific activities.
- Recognize that different explanations often can be given for the same evidence.
- Explain that further understanding of scientific problems relies on the design and execution of new experiments which may reinforce or weaken opposing explanations.

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

- Follow correct procedures for use of scientific apparatus.
- Demonstrate appropriate techniques in all laboratory situations.
- Follow correct protocol for identifying and reporting safety problems and violations.

SCSh3. Students will identify and investigate problems scientifically.

- Suggest reasonable hypotheses for identified problems.
- Develop procedures for solving scientific problems.
- Collect, organize and record appropriate data.

- d. Graphically compare and analyze data points and/or summary statistics.
- e. Develop reasonable conclusions based on data collected.
- f. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

- a. Develop and use systematic procedures for recording and organizing information.
- b. Use technology to produce tables and graphs.
- c. Use technology to develop, test, and revise experimental or mathematical models.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

- a. Trace the source on any large disparity between estimated and calculated answers to problems.
- b. Consider possible effects of measurement errors on calculations.
- c. Recognize the relationship between accuracy and precision.
- d. Express appropriate numbers of significant figures for calculated data, using scientific notation where appropriate.
- e. Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas as appropriate.

SCSh6. Students will communicate scientific investigations and information clearly.

- a. Write clear, coherent laboratory reports related to scientific investigations.
- b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data
- c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
- d. Participate in group discussions of scientific investigation and current scientific issues.

The Nature of Science

SCSh7. Students will analyze how scientific knowledge is developed.

Students recognize that:

- a. The universe is a vast single system in which the basic principles are the same everywhere.
- b. Universal principles are discovered through observation and experimental verification.
- c. From time to time, major shifts occur in the scientific view of how the world works. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge. Major shifts in scientific views typically occur after the observation of a new phenomenon or an insightful interpretation of existing data by an individual or research group.
- d. Hypotheses often cause scientists to develop new experiments that produce additional data.
- e. Testing, revising, and occasionally rejecting new and old theories never ends.

SCSh8. Students will understand important features of the process of scientific inquiry.

Students will apply the following to inquiry learning practices:

- a. Scientific investigators control the conditions of their experiments in order to produce valuable data.
- b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations' hypotheses, observations, data analyses, and interpretations.
- c. Scientists use practices such as peer review and publication to reinforce the integrity of scientific activity and reporting.
- d. The merit of a new theory is judged by how well scientific data are explained by the new theory.
- e. The ultimate goal of science is to develop an understanding of the natural universe which is free of biases.
- f. Science disciplines and traditions differ from one another in what is studied, techniques used, and outcomes sought.

Reading Standard Comment

After the elementary years, students are seriously engaged in reading for learning. This process sweeps across all disciplinary domains, extending even to the area of personal learning. Students encounter a variety of informational as well as fictional texts, and they experience text in all genres and modes of discourse. In the study of various disciplines of learning (language arts, mathematics, science, social studies), students must learn through reading the communities of discourse of each of those disciplines. Each subject has its own specific vocabulary, and for students to excel in all subjects, they must learn the specific vocabulary of those subject areas *in context*.

Beginning with the middle grades years, students begin to self-select reading materials based on personal interests established through classroom learning. Students become curious about science, mathematics, history, and literature as they form contexts for those subjects related to their personal and classroom experiences. As students explore academic areas through reading, they develop favorite subjects and become confident in their verbal discourse about those subjects.

Reading across curriculum content develops both academic and personal interests in students. As students read, they develop both content and contextual vocabulary. They also build good habits for reading, researching, and learning. The Reading Across the Curriculum standard focuses on the academic and personal skills students acquire as they read in all areas of learning.

SCSh9. Students will enhance reading in all curriculum areas by:

- a. Reading in All Curriculum Areas
 - Read a minimum of 25 grade-level appropriate books per year from a variety of subject disciplines and participate in discussions related to curricular learning in all areas
 - Read both informational and fictional texts in a variety of genres and modes of discourse
 - Read technical texts related to various subject areas
- b. Discussing books
 - Discuss messages and themes from books in all subject areas.
 - Respond to a variety of texts in multiple modes of discourse.

- Relate messages and themes from one subject area to messages and themes in another area.
 - Evaluate the merit of texts in every subject discipline.
 - Examine author's purpose in writing.
 - Recognize the features of disciplinary texts.
- c. Building vocabulary knowledge
- Demonstrate an understanding of contextual vocabulary in various subjects.
 - Use content vocabulary in writing and speaking.
 - Explore understanding of new words found in subject area texts.
- d. Establishing context
- Explore life experiences related to subject area content.
 - Discuss in both writing and speaking how certain words are subject area related.
 - Determine strategies for finding content and contextual meaning for unknown words.

Co-Requisite - Content

SC1 Students will analyze the nature of matter and its classifications.

- a. Relate the role of nuclear fusion in producing essentially all elements heavier than helium.
- b. Identify substances based on chemical and physical properties.
- c. Predict formulas for stable ionic compounds (binary and tertiary) based on balance of charges.
- d. Use IUPAC nomenclature for both chemical names and formulas:
 - Ionic compounds (Binary and tertiary)
 - Covalent compounds (Binary and tertiary)
 - Acidic compounds (Binary and tertiary)

SC2 Students will relate how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.

- a. Identify and balance the following types of chemical equations:
 - Synthesis
 - Decomposition
 - Single Replacement
 - Double Replacement
 - Combustion
- b. Experimentally determine indicators of a chemical reaction specifically precipitation, gas evolution, water production, and changes in energy to the system.
- c. Apply concepts of the mole and Avogadro's number to conceptualize and calculate
 - Empirical/molecular formulas,
 - Mass, moles and molecules relationships,
 - Molar volumes of gases.
- d. Identify and solve different types of stoichiometry problems, specifically relating mass to moles and mass to mass.
- e. Demonstrate the conceptual principle of limiting reactants.
- f. Explain the role of equilibrium in chemical reactions.

SC3 Students will use the modern atomic theory to explain the characteristics of atoms.

- Discriminate between the relative size, charge, and position of protons, neutrons, and electrons in the atom.
- Use the orbital configuration of neutral atoms to explain its effect on the atom's chemical properties.
- Explain the relationship of the proton number to the element's identity.
- Explain the relationship of isotopes to the relative abundance of atoms of a particular element.
- Compare and contrast types of chemical bonds (i.e. ionic, covalent).
- Relate light emission and the movement of electrons to element identification.

SC4. Students will use the organization of the Periodic Table to predict properties of elements.

- Use the Periodic Table to predict periodic trends including atomic radii, ionic radii, ionization energy, and electronegativity of various elements.
- Compare and contrast trends in the chemical and physical properties of elements and their placement on the Periodic Table.

SC5. Students will understand that the rate at which a chemical reaction occurs can be affected by changing concentration, temperature, or pressure and the addition of a catalyst.

- Demonstrate the effects of changing concentration, temperature, and pressure on chemical reactions.
- Investigate the effects of a catalyst on chemical reactions and apply it to everyday examples.
- Explain the role of activation energy and degree of randomness in chemical reactions.

SC6. Students will understand the effects motion of atoms and molecules in chemical and physical processes.

- Compare and contrast atomic/molecular motion in solids, liquids, gases, and plasmas.
- Collect data and calculate the amount of heat given off or taken in by chemical or physical processes.
- Analyzing (both conceptually and quantitatively) flow of energy during change of state (phase).

Teacher Note: The use of Gas Laws to achieve this standard is permissible, but not mandated.

SC7. Students will characterize the properties that describe solutions and the nature of acids and bases.

- Explain the process of dissolving in terms of solute/solvent interactions:
 - Observe factors that effect the rate at which a solute dissolves in a specific solvent,
 - Express concentrations as molarities,
 - Prepare and properly label solutions of specified molar concentration,
 - Relate molality to colligative properties.
- Compare, contrast, and evaluate the nature of acids and bases:
 - Arrhenius, Bronsted-Lowry Acid/Bases
 - Strong vs. weak acids/bases in terms of percent dissociation
 - Hydronium ion concentration
 - pH
 - Acid-Base neutralization