Howard County Public School System
Curriculum for High School Science

Grades 10, 11: Chemistry G/T

Overview:

High school Chemistry G/T will equip students to address the following essential questions as identified within the Next Generation Science Standards:

1. What is the universe, and what goes on in stars?
2. How can one explain the structure, properties, and interactions of matter?
3. How can one explain and predict interactions between objects and within systems of objects?
4. How is energy transferred and conserved?
5. How are waves used to transfer energy and send and store information?
6. How do people model and predict the effects of human activities on Earth's climate?

The high school Performance Expectations (PEs) in the physical sciences address essential questions about chemistry and Earth science and build on middle school ideas and experiences. They blend Disciplinary Core Ideas (DCI) with Scientific and Engineering Practices (SEP) and Crosscutting Concepts (CCC) to support students in developing usable knowledge to explain real-world phenomena. In Chemistry G/T, students regularly engage in asking scientific questions that drive their investigations and lead to increasingly sophisticated evaluation of data and their presentation. Students also have opportunities to learn and apply engineering-specific practices such as designing solutions to identified problems. Read the full NGSS storyline for Physical Sciences and the full NGSS storyline for Earth Science.

The learning sequence in Chemistry G/T is organized around a series of driving questions that provide the context and motivation for learning. While exploring each driving question, students engage in unique learning experiences that are carefully designed to immerse them in the SEPs as they construct their understanding of important concepts. These experiences are carefully sequenced so that students encounter ideas that are developmentally and cognitively appropriate. By the end of the learning experiences, students will be able to meet the NGSS performance expectations and address the driving questions.

Performance Expectations:

The Next Generation Science Standards (NGSS), adopted as the Maryland Science Standards (MSS), are very different than previous standards documents. NGSS purposely combines the three dimensions of science learning into single, target statements for student learning known as Performance Expectations (PE). The three dimensions of science learning are: Science and Engineering Practices (SEP), Crosscutting Concepts (CCC), and Disciplinary Core Ideas (DCI). Earlier science standards treated the three dimensions as separate and distinct. This treatment

led to assessment and instruction that emphasized one dimension preferentially over the others. The combination of SEP, CCC, and DCI in each PE is not intended to limit instruction. Instead, the PEs are designed to guide assessment of student learning. The performance expectations for High School Chemistry G/T support student learning in these areas: *Matter and its interactions, Motion and Stability: Forces and Interactions, Energy, Waves and their Applications in Technologies for Information Transfer*, *Earth's Place in the Universe, Earth's Systems,* and *Earth and Human Activity.* The performance expectations for high school Chemistry G/T are listed below:

HS-PS1: Matter and Its Interactions

Students who demonstrate understanding can:

HS-PS1-1.	**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.**
HS-PS1-2.	**Construct and revise 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.**
HS-PS1-3.	**Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.**
HS-PS1-4.	**Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.**
HS-PS1-5.	**Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.**
HS-PS1-6.	**Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.**
HS-PS1-7.	**Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.**
HS-PS1-8	**Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.**

HS-PS2: Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

HS-PS2-6.	**Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.**

HS-PS3: Energy

Students who demonstrate understanding can:

HS-PS3-4.	**Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).**

HS-PS-4: Waves and Their Applications in Technologies for Information Transfer
Students who demonstrate understanding can:

HS-PS4-3	**Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.**
HS-PS4-4	**Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.**

HS-ESS1- Earth's Place in the Universe
Students who demonstrate understanding can:

HS-ESS1-1.	**Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.**
HS-ESS1-2.	**Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.**
HS-ESS1-3.	**Communicate scientific ideas about the way stars, over their life cycle, produce elements.**
HS-ESS1-6.	**Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.**

HS-ESS2: Earth's Systems
Students who demonstrate understanding can:

HS-ESS2-5.	**Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.**

HS-ESS3: Earth and Human Activity
Students who demonstrate understanding can:

HS-ESS3-5.	**Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.**
HS-ESS3-6.	**Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.**

HCPSS Learning Sequence:

Students will continue to develop their understanding of the disciplinary core ideas in the physical and Earth sciences throughout the school year. The high school performance expectations in physical science and Earth science allow high school students to explain more in-depth phenomena central to this discipline as well as to the life sciences. These performance expectations blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge to explain ideas across the science disciplines. While the performance expectations shown in high school Chemistry G/T couple particular practices with specific disciplinary core ideas, instruction will include the use of many science and engineering practices that lead to the performance expectations.

The Chemistry G/T course is organized into five units:

Unit 1:	Unit 2:	Unit 3:	Unit 4:	Unit 5:
Elements: From Stars to Atoms	**Bonding: Environmental Chemistry**	**Chemical Reactions: Materials Science**	**Thermochemistry and Gases**	**Reaction Rates, Equilibrium, and Acids: Water Chemistry**

Students develop understanding of a wide range of topics in physical science by using the science and engineering practices and crosscutting concepts. In Unit 1: *Elements: From Stars to Atoms,* students will explore the formation and transformation of elements in stars. Students will model changes to an atom's nucleus, describing the energy released during the processes of fusion, fission, and radioactive decay.

In Unit 2: *Bonding: Environmental Chemistry*, students will engage in argumentation using evidence to explain how bond formation, shape, polarity, and intermolecular forces influence the properties and behavior of materials

In Unit 3: *Chemical Reactions: Materials Science*, students will use the science and engineering practices to plan and carry out an investigation to explore how molecules interact with one another through chemical reactions while conserving mass and energy. Students will describe how the mathematical representations support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

In Unit 4: *Thermochemistry: Energy Flow & Consumption*, students will demonstrate their knowledge of chemical reactions and energy change during the reactions. Students will use molecular models to diagram the change in the arrangement of atoms and number and types of bonds before and after reactions.

In Unit 5: *Reaction Rates, Equilibrium, and Acids: Water Chemistry*, students will plan and conduct an investigation of the properties of water, solubility, solutions, & concentration and its effects of changing the temperature or concentration of a reaction. Students will analyze the effects of human activity on equilibrium of the hydrosphere using Le' Chatelier's Principle.