Scope & Sequence: 10th / 11th Grade NGSS Chemistry

Division of Curriculum & Instruction: STEM – Science Department

High School Course Sequence – 3 Year Model with Earth and Space Science Integration

(June 9, 2019)

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Overview:

In this NGSS aligned chemistry course, students will explore physical science concepts that build comprehension around matter, its properties, and its interactions with other matter and energy. The units and chapters within this scope and sequence are presented thematically to provide a context for student learning.. The integration of relevant Earth and Space Science concepts such as stars and climate change are designed to deepen student understanding of chemistry's role in Earth's systems and society.

In the fall semester, students will investigate the formation of the first elements and their transformation to heavier elements in the context of stars as "element factories." They will use this knowledge to explore the structure of an atom and patterns in the periodic table. Students will investigate the forces that hold matter together and how society uses its understanding of elements and molecules to develop useful materials. Students will finish the semester by exploring the interactions of atoms and molecules as illustrated by chemical reactions.

In the spring semester, students will begin by investigating Earth's climate and human impact on it. Students will explore energy and the factors that drive chemical and physical changes based on their understanding of elements and materials science. They will follow the flow of energy into and out of chemical systems, extending the concept to the movement of energy through Earth's systems. Finally, students will investigate greenhouse gasses, their effect on the atmosphere, and how the atmosphere affects the ocean and other bodies of water on Earth. The semester will conclude with students synthesizing their knowledge in the study of the carbon cycle.

Rationale for flow:

This Chemistry Scope & Sequence follows a microscopic to macroscopic design. The fall semester focuses on building foundational concepts of chemistry and in the spring semester, students apply their learning of chemistry concepts to the global issue of climate change. This overarching theme makes chemistry concepts relevant while integrating Earth and Space Science concepts in a meaningful way. When students are provided with the opportunity to apply their foundational knowledge of chemistry concepts to relevant topics like the global issue of climate change, we help prepare students for college, career, and life. Our students will graduate with learning experiences that prepare them to apply learning to personal decisions related to real-world problems.

Fall and Spring semester each contain three main units. Spring semester contains more topics because the semester is 3 weeks longer (in SFUSD). Unit 5 is meant to be one week and introduces students to climate change as the theme of Spring Semester. There will be several opportunities for students to focus on solutions to climate change-related issues throughout the semester.

Semester	**Fall**				**Spring**			
Unit Title	**Unit 1: What is an Atom?**	**Unit 2: From Stars to Atoms**	**Unit 3: Diving into Materials**	**Unit 4: Chemical Reactions: Energy and Mass**	**Unit 5: Introduction to Climate Change**	**Unit 6: Earth's Energy**	**Unit 7: Atmosphere**	**Unit 8: Water**
Chapter(s)	**1, 2**	**3, 4**	**5, 6, 7**	**8**	**9**	**10, 11**	**12, 13, 14**	**15, 16, 17**
Essential Question(s)	• *How are macroscopic properties like density governed by the atoms in a substance?*	• *Where do elements come from and how do they form?* • *How are elements different from or similar to each other?*	• *How can we use our knowledge of molecular structure and molecular bonds to determine the best materials to use for a given problem?*	• *How can we use our knowledge of mass, matter, and energy to predict a chemical reaction?*	• *What is happening to Earth's climate?*	• *How does transfer of energy drive changes in the Earth's systems over different time scales?*	• *How do changes in the composition of Earth's atmosphere drive climate change?* • *What influences the outcome and rate of a chemical reaction?*	• *How have humans impacted the equilibrium of the hydrosphere?*
Sub Questions	• *What are atoms?* • *How can density be used to identify an element?*	• *What trends are found within the periodic table?* • *What is the structure of an atom?* • *How do the processes of fusion and fission differ, and their impact upon element formation?*	• *What are the different types of bonds that hold elements together, and how do they influence materials properties?* • *How can we use molecular structure to make predictions about the properties of different substances?* • What are intermolecular forces, and how do they demonstrate various properties of molecules?	• *How do mass, matter, and energy change in a chemical reaction?*	• *What is the physical and chemical evidence that climate change has been strongly impacted by human activity?*	• *How do global temperature changes lead to changes here at home?* • *How does energy and matter flow (rearrange) and change in and between systems?*	• *How do human actions influence Earth's atmosphere and our life on Earth?* • *What factors drive chemical and physical changes?*	• *How is the chemistry of the oceans and water systems changing and how do these changes affect global climate?* • *How are Earth's systems interconnected?*
NGSS Performance Expectations	HS-PS1-1	HS-PS1-1 HS-ESS1-3 HS-PS1-2 HS-ESS1-6 HS-PS1-8	HS-PS1-3 HS-ESS2-5 **HS-PS2-6***	HS-PS1-2 HS-PS1-4 HS-PS1-7	HS-ESS2-4 HS-ESS2-6 HS-ESS3-5	HS-ESS2-4 HS-ESS3-5 HS-PS3-1 HS-PS3-2 HS-PS3-4	HS-PS1-5 HS-ESS2-2 **HS-PS1-6*** HS-ESS2-4 HS-PS1-7 HS-PS3-4 HS-ESS3-5 **HS-ESS3-4***	HS-PS1-5 HS-ESS2-5 **HS-PS1-6*** HS-ESS2-6 HS-ESS3-5 HS-ESS3-6
Unit Description	In this unit, students are introduced to the	In this unit, students explore the formation and transformation of	In this unit students will explore bond formation, valence shell electron pair repulsion (VSEPR),	In this unit, students will explore how molecules interact	In this introductory unit, students will look at patterns in	In this unit, students will continue to explore the	In this unit, students will explore atmospheric composition and structure,	In this unit, students will explore the properties of water, solubility, solutions

	basics of any beginning chemistry class through the lens of density. They learn about safety in a chemistry classroom, practice their measuring techniques and begin to bridge their middle school experiences with high school chemistry. They begin their chemistry experience by investigating the properties of elements, periodic table trends, and the structure of atoms.	elements in stars and changes to an atom's nucleus. This exploration will include spectra (to identify atoms in and the age of a star), valence electrons and energy levels, and nuclear fusion, fission, half-lives, and radiation. Optionally, radioactive dating and electron configurations may be introduced. Students will be prepared to explore what holds matter together in Unit 3.	electronegativity and how it determines molecular polarity, intermolecular forces, and how humans utilize these properties of molecules in designed materials. Optionally, nomenclature may be introduced. Students will be prepared to explore how chemicals react and change in Unit 4.	with each other, chemical reactions, the Law of the Conservation of Matter, changes in bond energies in chemical reactions, and chemical energy (ONLY endothermic and exothermic). Students will be prepared to apply knowledge of chemistry concepts in the context of climate change.	data in a wide variety of contexts that show how Earth's climate is changing. Throughout the spring semester, students will apply their knowledge of chemistry concepts as they explore issues of climate change in Earth's Systems.	conservation energy through dimensional analysis, chemical energy, 1st and 2nd Laws of Thermodynamics, phase changes, and heat/enthalpy. Chemical energy will be explored as it relates to climate change and the energy balance on Earth. Optionally, Gibbs Free Energy may be introduced.	mole concept, and stoichiometry, kinetic molecular theory of gases with an emphasis on greenhouse gases and their effect on climate, and rates of reactions, Le Chatelier's Principle, and equilibrium in the atmosphere. Airborne pollutants and possible human interventions to reduce human impact will be explored. Optionally, limiting reagent calculations and gas laws may be introduced.	and concentration, acids and bases, and pH. They will explore how these concepts relate to the chemistry of, and interactions between, the atmosphere and the hydrosphere (i.e., ocean acidification). Pollutants also affect water systems, and their impact and possible human interventions will be explored. The year will culminate in a chapter that studies the cycling of carbon through the atmosphere, hydrosphere, biosphere, and geosphere of Earth. Optionally, acid base titration may be introduced.
Disciplinary Core Ideas addressed in NGSS PEs	**PS1.A:** Structure and Properties of Matter	**PS1.A:** Structure and Properties of Matter **PS1.C:** Nuclear Processes **ESS1.A:** The Universe and Its Stars	**PS1.A:** Structure and Properties of Matter **PS2.B:** Types of Interactions **ESS2.C:** The Role of Water in Earth's Surface Processes	**PS1.A:** Structure and Properties of Matter **PS1.B:** Chemical Reactions	**ESS2.D:** Weather and Climate **ESS3.D:** Global Climate Change	**PS1.B:** Chemical Reactions **PS3.A:** Definitions of Energy **PS3.B:** Conservation of Energy and Energy Transfer **ESS1.B:** Earth and the Solar System **ESS2.A:** Earth Materials and Systems **ESS2.D:** Weather and Climate	**PS1.B:** Chemical Reactions **PS3.B:** Conservation of Energy and Energy Transfer **PS3.D:** Energy in Chemical Reactions **ESS1.B:** Earth and the Solar System **ESS2.A:** Earth Materials and Systems **ESS3.C:** Human Impacts on Earth's Systems **ESS3.D:** Global Climate Change	**PS1.B:** Chemical Reactions **ESS2.C:** The Roles of Water in Earth's Surface Processes **ESS2.D:** Weather and Climate **ESS3.D:** Global Climate Change **ETS1.C:** Optimizing the Design Solution **ESS3.D:** Global Climate Change
Science and Engineering Practices **addressed in NGSS PEs**	**The 8 Science and Engineering Practices should be used throughout each year with an emphasis on 2-3 per unit.**							
	• Analyzing and Interpreting Data	• Developing and Using Models • Constructing Explanations and Developing Solutions • Obtaining, Evaluating, and Communicating Information	• Planning and Carrying Out Investigations • Obtaining, Evaluating, and Communicating Information	• Constructing Explanations and Developing Solutions • Developing and Using Models • Using Mathematics and Computational Thinking	• Developing and Using Models • Analyzing and Interpreting Data	• Developing and Using Models • Planning and Carrying Out Investigations • Using Mathematics and Computational Thinking	• Developing and Using Models • Constructing Explanations and Developing Solutions • Analyzing and Interpreting Data • Planning and Carrying Out Investigations	• Constructing Explanations and Developing Solutions • Analyzing and Interpreting Data • Planning and Carrying Out Investigations • Using Mathematics and Computational Thinking
Crosscutting Concepts	**The 7 Crosscutting Concepts should be used throughout each year with an emphasis on 2-3 per unit.**							

addressed in NGSS PEs	• Structure and Function	• Patterns • Energy and Matter • Stability and Change	• Patterns • Structure and Function	• Patterns • Energy and Matter	• Cause and Effect • Energy and Matter • Stability and Change	• Energy and Matter • Systems and System Models • Cause and Effect	• Patterns • Systems and System Models • Stability and Change • Cause and Effect • Energy and Matter	• Stability and Change • Systems and System Models • Patterns • Structure and Function