



Santa Rosa City Schools Course Proposal: Chemistry in the Earth

Proposal Submitted By: Teaching and Learning

Needs Statement: Discuss how this course fits into your Site and/or the District's goals. Attach minutes of meetings where this course was approved at site or district leadership meetings.

This is a course revision and title change to the Chemistry courses currently offered at our high school sites. The course is being revised to align with the Next Generation Science Standards (NGSS).

Graduation Requirements: Specify which requirement is met. (High School only)

This course will meet the d-level Physical Science requirement for graduation.

UC a-g Requirements: Specify which requirement is met. (High School only)

This course will be submitted to the UC for "d" Lab Science.

Explain the rationale for course addition or modification. How does this fit in with district/site goals. Is this course replacing a current course, which course is it replacing and why? Will this course require new sections? Be explicit.

Our Chemistry in the Earth course offerings are being revised to fully align with the Next Generation Science Standards (NGSS). This will allow all students grades 9-12 access to NGSS High School Performance Expectations (PEs) in Physical Science as well as some integrated NGSS Earth Science PEs. In addition, this revised Chemistry in the Earth course will comprehensively integrate NGSS cross-cutting concepts (CCs) and the NGSS science and engineering practices (SEPs). The NGSS Physical and Earth Science PEs, CCs, and SEPs are thoughtfully aligned to the Common Core State Standards for Literacy in Science and Technical Subjects and the Common Core State Standards in Mathematics. (Next Generation Science Standards Appendix L and M)

Explain the measurable learning outcomes

In Chemistry of the Earth, students will develop proficient understanding of the four physical science disciplinary core ideas - Matter and Its Interactions, Motion and Stability (Forces and Interactions), Energy and Waves and Their Applications in Technology. In Chemistry in the Earth, students will also develop proficient understanding of Earth Science disciplinary core ideas involving the way stars

produce elements, the development and management of energy and mineral resources, the relationship between human activity and the Earth's other systems, the properties of water and its effects on Earth materials, cycling of matter by thermal convection, and the cycling of carbon with a special focus on the hydrosphere, ocean acidification, and the chemistry of carbon and fossil fuels.

In Chemistry in the Earth, students will deepen their understanding and application of NGSS cross-cutting concepts which includes patterns, cause and effect, scale/proportion/quantity, systems and system models, energy and matter, structure and function, and stability and change. Students will also continue growing proficiency in their use of the NGSS science and engineering practices which include 1) Asking Questions and Defining Problems, 2) Developing and Using Models, 3) Planning and Carrying Out Investigations, 4) Analyzing and Interpreting Data, 5) Using Mathematics and Computational Thinking, 6) Constructing Explanations and Designing Solutions and 7) Engaging in Argument from Evidence. Strengthening the science and engineering practices of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics to everyday life as well as strengthen their ability to read and write in technical subjects.

Students will also deepen their understanding and application of NGSS cross-cutting concepts which link the different domains of science throughout their K-12 science education. These include patterns, cause and effect, scale/proportion/quantity, systems and system models, energy and matter, structure and function, and stability and change. These cross-cutting concepts will provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically based view of the world.

Finally, students will continue growing proficiency in their use of the NGSS science and engineering practices which include 1) Asking Questions and Defining Problems, 2) Developing and Using Models, 3) Planning and Carrying Out Investigations, 4) Analyzing and Interpreting Data, 5) Using Mathematics and Computational Thinking, 6) Constructing Explanations and Designing Solutions and 7) Engaging in Argument from Evidence. These practices are behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. Strengthening the science and engineering practices of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life as well as strengthen their ability to read and write in technical subjects.

Course Description (To be used in the course catalog)

Chemistry in the Earth is the second course of a three-year Next Generation Science Standards (NGSS) course pathway (Living Earth, Chemistry in the Earth, Physics in the Universe). Chemistry in the Earth will build upon and deepen students' K-8 knowledge and skills with NGSS physical science disciplinary core ideas while integrating earth science core ideas, cross-cutting concepts and science and engineering practices. This course meets 'd' lab science credits for UC/CSU entrance.

Prerequisite: Math 1

Detailed Course Design

(Course design should include the objectives, activities, assessments, and standards to be addressed in this course.)

UNIT 1: Structure and Properties of Matter: Atoms, Elements and Molecule

Unit 1 Overview: Chemistry is the study of matter and its interactions. This unit will begin with a focus on atomic structure and an introduction to the periodic table by describing how stars and nuclear fusion are the element factories - the beginning of all elements. It will continue with an analysis of electron arrangement and an in depth look at patterns on the periodic table. From an understanding of electron positions, students can deduce how ions form to increase the stability of the elements. Students will investigate flame tests as a way to identify elements both here on earth and in stars. Students will also have the opportunity to use the knowledge of atomic spectra and flame tests to engineer low-intensity sparklers. Additionally, students will investigate how ions react to form ionic compounds and the properties of those compounds. Students will complete an activity to analyze graphs and deduce the periodic trends of ionization energy, atomic radius and electronegativity. During this unit, students will also be introduced to proper measurement techniques, proper use of significant figures, solving problems using dimensional analysis and the scientific method.

UNIT 1 NGSS Physical Science Performance Expectations:

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-PS1-8. 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-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-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Unit 1 NGSS Earth Science Performance Expectations:

HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.

(This Performance Expectation is addressed in multiple units.)*

UNIT 2: Interactions of Matter (Part 1) - Chemical Reactions

Unit 2 Overview: How substances react chemically is paramount in chemistry. Students will study the five general types of chemical reactions (synthesis, decomposition, single replacement, double replacement and combustion) and develop the ability to predict the products of a reaction. Students will also compare reactions that run in one direction and go to completion to reactions that run in both directions and reach equilibrium. Le Chatelier's Principle will be introduced as a way to determine how a change to an equilibrium system will affect the concentration of products or reactants. The chemists most important measurement tool, the mole and its relationship to Avogadro's Number will lead the students to the understanding that things must react in specific ratios, which will be investigated through an experiment to determine the empirical formula of an ionic compound or a hydrate. Students can then connect their knowledge of how things react (balanced equations) to how much reacts (moles and mass) in their discovery of stoichiometric relationships, limiting reagents and percent yield.

UNIT 2 NGSS Physical Science Expectations:

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-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical

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

Unit 2 NGSS Earth Science Performance Expectations:

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

(This Performance Expectation is addressed in multiple units.)*

UNIT 3: Interactions of Matter Part 2 - Gasses, Liquids, Solids, and Solutions

Unit 3 Overview: The investigation of phases of matter (solids, liquids and gases) provides the appropriate context for students to examine the attractions between molecules. Students will investigate intermolecular attractions to explain why water is so unique and how that affects our planet. They will determine how solutions behave when dissolving and interacting with themselves and other media. As solutions naturally lead into acids and bases, students will investigate the properties of water, acid rain and ocean acidification on Earth's materials and surface processes. Students will analyze geoscience data and global climate models to investigate global or regional climate change focused on hydrosphere and ocean chemistry.

Unit 3 NGSS Physical Science Performance Expectations:

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-PS1-5. 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-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Unit 3 NGSS Earth Science Performance Expectations:

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

- *HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. (*Focused on hydrosphere and ocean chemistry/acidification.*)
- *HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.
- *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.

(* This Performance Expectation is addressed in multiple units.)

UNIT 4: Heat and Carbon Sources of Energy

Unit 4 Overview: Potential energy is stored in the bonds of chemical compounds and molecules. This unit focuses on different types of energy by investigating hydrocarbon molecules as fuel sources in combustion reactions. Battery fuel sources created through metal reactivity using the Metal Reactivity Series will also be investigated. Students will be able to develop a quantitative model to describe how carbon and energy cycle, especially in the Earth's geosphere as it relates to the chemistry of carbon and fossil fuels. As students study and compare different energy sources, they will analyze geoscience data and evaluate design solutions for developing, managing and utilizing fossil fuels, carbon resources and other different types of energy sources (including nuclear, solar, wind and geothermal) as they relate to human activity.

- *HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.
- *HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (*Related to fossil fuels and carbon resources.*)
- *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.

Unit 4 NGSS Physical Science Performance Expectations

- 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-PS1-3. 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-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

- 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-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.

Unit 4 NGSS Earth Science Performance Expectations:

- HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
- *HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. *(Focused on geosphere and chemistry of carbon/fossil fuels.)*
- *HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth's systems.
- *HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. *(Related to fossil fuels and carbon resources.)*
- *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.

(This Performance Expectation is addressed in multiple units.)*

Daily Assignments:

- Phenomenon observation and inquiry
- Storytelling (Scientist Biographies)/People to Ponder/Research a Scientist
- Collaborative group work
- Citizen science inquiry and data collection
- Claim-evidence-reasoning (CER) writing
- Formal lab report writing (with particular focus on data analysis and evidence-based writing)
- Close-reading annotations and leveled questioning for science texts
- Direct instruction
- Reflective/strategic note-taking
- Reflective science notebooks
- NGSS Science and Engineering Practices (1) *Asking Questions and Defining Problems*, 2) *Developing and Using Models*, 3) *Planning and Carrying Out Investigations*, 4) *Analyzing and Interpreting Data*, 5) *Using Mathematics and Computational Thinking*, 6) *Constructing Explanations and Designing Solutions* and 7) *Engaging in Argument from Evidence*.)

Key Assignments:

Formative and summative assessment will be used throughout involving:

- Quick writes
- Close reading current events
- Science and engineering lab investigations (authentic science and engineering practices opportunities)

- Whiteboard responses
- Pair-share/group share oral and written responses
- Diagrams/graphs/illustrations
- Reading and notetaking annotations and summaries
- Quizzes and other larger assessments
- Computer modeling activities and projects
- Research reports and other projects
- Written lab reports, including writing from evidence and/or design solutions
- Evidence-based writing and explanations
- Presentations

Budget- budget figures must be included even if they are an estimate.

Projected Costs	Start-up	Ongoing
Personnel (Not to include classroom instructor unless a new section is needed)		
Instructional Material Supplies per student (textbooks, software, etc.)	These costs covered in textbook adoption for science. Estimated costs for textbooks and remaining Chromebook carts is approximately 1.5 million.	
Services (training, equipment maintenance, contracts, etc.)		
Capital Outlay (remodeling, technology, etc.)		
Total Projected Costs		

Instructional Materials- must include estimate for new materials even if none have been selected. Place in chart above. **Instructional materials in pilot process.**

Type	Publisher	Title	ISBN	Author	Copyright	# Have/Need

Funding Source(s) for Costs and Instructional Materials

Grants (indicate specific grant and grant timeline)	
Categorical Funds (include related programs)	
Career Technical Education (must be for an approved CTE course)	
Department Funds	
Other (be specific)	

Appendix of Additional Documents

<p><u>* Required additional documents include meeting minutes where the course was discussed and approved</u></p>											
<p align="center">NGSS HS Pathway Collaboration Team November 29, 2017 3:45 – 5:00 C & I Conference room</p>											
<p align="center">Alignment to the District's Local Control Accountability Plan (LCAP)</p>											
<p>Secondary LCAP Goal #1:</p>	<p><i>Provide a coherent, rigorous and relevant teaching and learning program to graduate college and career ready students.</i></p>										
<p>LCAP Action/Services:</p>	<ul style="list-style-type: none"> • Create and implement Next Generation Science Standards based curriculum for all students that include assessments, an online repository for the curriculum and resources • Develop and implement a three-year high school a - g program that meets NGSS standards for all SRCS students 										
<p>Norms:</p> <p>Members: Doug Benenson (MHS) Kyla Bradylong (MCHS) Debbi Crapeau () Elaine Dolcini (SRHS) Doug Gibson (EAHS) Linda Kastanis (HSMS) Mark Mantoani (PHS) Gale Ligotti (MCHS) Connie Rice (SRHS) Katheryne Stoural (HCMS), Kelly Makura (EAHS) Steven Williams (TOSA)</p>											
<table border="1"> <thead> <tr> <th>Topic</th><th>Who</th><th>Outcome <u>Notes/Agreements/Ownership:</u></th></tr> </thead> <tbody> <tr> <td> Welcome <ul style="list-style-type: none"> • Shared NGSS folder • Review of MHS new course and book </td><td>Rani</td><td>Doug discussed the course being proposed (IB Environmental Systems) and the rationale for the course. He also shared the textbook for recommendation. All signed off.</td></tr> <tr> <td> What are the agreements we have (or not) regarding </td><td>All</td><td>After incredibly rich conversation the following was agreed upon:</td></tr> </tbody> </table>			Topic	Who	Outcome <u>Notes/Agreements/Ownership:</u>	Welcome <ul style="list-style-type: none"> • Shared NGSS folder • Review of MHS new course and book 	Rani	Doug discussed the course being proposed (IB Environmental Systems) and the rationale for the course. He also shared the textbook for recommendation. All signed off.	What are the agreements we have (or not) regarding	All	After incredibly rich conversation the following was agreed upon:
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What are the agreements we have (or not) regarding	All	After incredibly rich conversation the following was agreed upon:									

<ul style="list-style-type: none"> • years of science <ul style="list-style-type: none"> ◦ SRCS will develop and implement a 3-year science program that meets all NGSS standards for all SRCS students. (Implementation beginning with 2019-2020 9th graders) • timeline • models <ul style="list-style-type: none"> ◦ We will develop and offer two pathways (six courses): Model/Pathway One: <ul style="list-style-type: none"> • 9th: The Living Earth • 10th: Chemistry in the Earth • 11th: Physics in the Universe ◦ Model/Pathway Two: <ul style="list-style-type: none"> • 9th: Earth Science • 10th: Biology • 11th: Physical Science • others 		<p>SRCS will develop two foundational sequences on which other pathways can be built to support a 3-year science program that meets all NGSS standards for all SRCS students. (Implementation beginning with 2019-2020 9th graders)</p> <p>We agreed that the two foundational sequences are the two models to the right and that we will collaboratively create blueprints of these first. These then become the bones to base other courses on. For example: Gale would compare her standards in zoology to the foundational sequences. She would determine what PEs and other NGSS standards she meets. She would then know what to add or not so that students who took her course were meeting the NGSS standards from one of the foundational sequence courses. This allows the department to make a sequence that includes zoology so that students can be exposed to all NGSS standards.</p>
<p>What are our next steps:</p> <ul style="list-style-type: none"> • timeline • communication with administrators, counselors, colleagues, and community • other 	All	<p>It was decided that a small group of teachers representing the NGSS team would go to each HS to meet with counselors and site admin to discuss the work of the science teaches and timeline for implementation. Rani will be a part of this group too.</p> <ul style="list-style-type: none"> • Who will these 2 - 4 teacher be? Please email me. You will be out of classroom for a day probably <p>Talking points will be a collaborative effort of all by using our team drive to make a ppt</p> <p>Timeline: 2019: 9th grade NGSS or course 1 2020: 10th grade NGSS or course 2 2021: 11th grade NGSS or course 3</p>




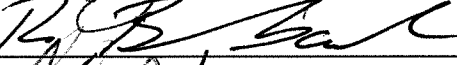


Full Day of PD for all science teachers

We have three days for science teacher PD in second semester (2 provided by district and 1 written into C&I budget). We need to develop a coherent scope of PD that builds on each day. **The work will also be started in our team drive.**

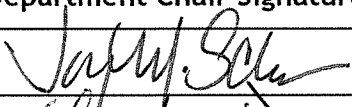
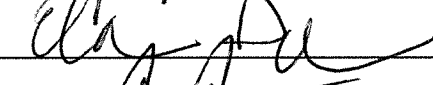

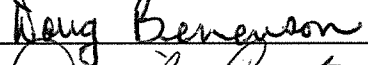
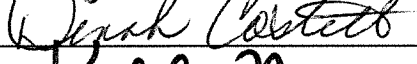
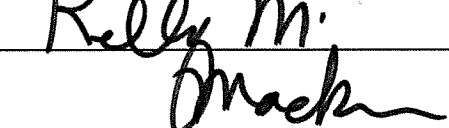
Meeting Schedule:

Meeting Schedule		
Jan. 23 3:45 - 5:00	NGSS Pathway Team	C & I conf. room
Feb. 27 3:45 - 5	6 - 12 DC	C&I conf. room

District Principal Review and Approvals:

Principal's Signatures	Site	Approved / Not Approved
	PHS	approved
	RHS	approval
	SRHS	Approval
	MHS	Approved
	EHS	approved
	MCIS	approved.

District Department Chair Review and Approvals:

Department Chair Signatures	Site	Approved / Not Approved
	MCHS	approve
	SRHS	approve
	PHS	APPROVE
	MHS	Approved
	RHS	Approved
	EHS	Approved