Chemistry Course

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Grade Levels: 10-12

Pre-requisites: algebra 1

Qtr 1: We are star stuff.

<table>
<tr><td>Description</td><td colspan="2">Modules will have 5 components: Engage, Explore, Explain, Elaborate, Evaluate to support science learning and practice.</td></tr>
<tr><td>Standards</td><td colspan="2">HS.P1U1.1 Develop and use models to explain the relationship of the structure of atoms to patterns and properties observed within the periodic table and describe how these models are revised with new evidence.
Plus HS+C.P1U1.1 Develop and use models to demonstrate how changes in the number of subatomic particles (protons, neutrons, electrons) affect the identity, stability, and properties of the element.
Plus HS+C.P1U1.2 Obtain, evaluate, and communicate the qualitative evidence supporting claims about how atoms absorb and emit energy in the form of electromagnetic radiation.
Essential HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.
Plus HS+C.P1U3.8 Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of fission, fusion, and radioactive decay.
Plus HS+C.P1U1.7 Use mathematics and computational thinking to determine stoichiometric relationships between reactants and products in chemical reactions.</td></tr>
<tr><td>Cross Cutting Concepts</td><td>Science and Engineering Practices</td><td>Core Concepts</td></tr>
<tr><td>Patterns; Cause and Effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Structure and Function; Stability and Change</td><td>● Develop and use models
● Obtain, evaluate, and communicate information
● Engage in argument from evidence
● Use mathematics and computational thinking</td><td>P1: All matter in the Universe is made of very small particles.
U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena.
As new evidence is discovered, models and theories can be revised.
U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.</td></tr>
<tr><td colspan="3">Module 1: Forging elements</td></tr>
<tr><td>Engage</td><td colspan="2">What elements are inside us?
https://periodictable.com/Properties/A/UniverseAbundance.html
Where did those elements come from? Video</td></tr>
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Explore	How do elements get produced by fusion? Fe[26] : https://dimit.me/Fe26/ https://www.msichicago.org/science-at-home/games/goreact/ https://phet.colorado.edu/sims/html/isotopes-and-atomic-mass/latest/isotopes-and-atomic-mass_en.html MODELING
Explain	What makes elements different from one another? How does fusion lead to stable elements? Students model fusion and atom composition. How is average atomic mass calculated? MODELING, MATH
Elaborate	How do we know what elements are in stars? Students relate light data to elemental composition OEC INFO, ARGUMENT, MODELING
Evaluate	QUIZ How could we have gotten the elements we have here on Earth? What's in our star?
Module 2: Elements and properties	
Engage	What makes the periodic table - periodic? History of ptable MODELING
Explore	Reactivity of Alkali vs. Alkaline Earth vs. Halogens vs. Noble Gases **Virtual lab by watching youtube videos and recording data** MODELING, ANALYSIS, CONSTRUCT
Explain	How does electronic structure lead to periodicity? Electron shells and periodicity Periodic trends MODELING
Elaborate	How do we model electronic structure? PES, history of atomic model, quantum mechanical model MODELING, ARGUMENT
Evaluate	QUIZ Model atoms based on data, predict properties using periodicity
Module 3: Elements inside us	
Engage	What elements are inside you and how did they get there? what is the most important element for life? OEC INFO, ARGUMENT

Explore	Organic molecules and special elements - % composition **Video lab - see my EdPuzzle collection** Rearrangement of atoms chemical reactions MODELING, OEC INFO, INVEST, MATH
Explain	Cycling of matter - respiration/photosynthesis Balancing reactions MODELING, MATH
Elaborate	Stoichiometry Lab https://media.pearsoncmg.com/bc/bc_0media_chem/chem_sim/html5/stoich/Stoich.php My version https://docs.google.com/document/d/19XczkislZ43o_z8TlORkD1e5nXiAi7yu21akRTJEMPc/edit?usp=sharing Analyze, MATH, INVEST
Evaluate	QUIZ Explain how matter is changed through systems, representing organic molecules, balance equations, do stoichiometry, show %
Module 4: Harnessing Elemental Power	
Engage	Atomic power
Explore	How does coal fuel compare to uranium fuel? Students obtain info 1. http://www.nuclearpowersimulator.com/ 2. https://playgen.com/nuclear-simulator/ 3. Load this PhET simulation via Cheerpj (you have to watch the page for like 2-3 minutes to get it to load).https://phet.colorado.edu/sims/cheerpj/nuclear-physics/latest/nuclear-physics.html?simulation=nuclear-fission OEC INFO, ARGUMENT
Explain	Thermo bit, $E=mc^2$, energy transfers, fission reactions MATH, MODELING
Elaborate	Decay, radioactivity, radiation, half life, atomic weapons OEC INFO, ARGUMENT, MODELING, MATH
Evaluate	for/against nuclear power
Assessment	Test Project: choose an element, model it, spectra, history, how humans use it, radioactive isotopes

Qtr 2: Marvelous Materials

Description	Modules will have 5 components: Engage, Explore, Explain, Elaborate, Evaluate to support science learning and practice.	
Standards	Essential HS.P1U1.2 Develop and use models for the transfer or sharing of electrons to predict the formation of ions, molecules, and compounds in both natural and synthetic processes. Plus HS+C.P1U1.4 Develop and use models to predict and explain forces within and between molecules. Plus HS+C.P1U1.5 Plan and carry out investigations to test predictions of the outcomes of various reactions, based on patterns of physical and chemical properties. Plus HS+C.P1U1.6 Construct an explanation, design a solution, or refine the design of a chemical system in equilibrium to maximize production. Plus HS+C.P1U1.7 Use mathematics and computational thinking to determine stoichiometric relationships between reactants and products in chemical reactions. Essential HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.	
Cross Cutting Concepts	Science and Engineering Practices	Core Concepts
Patterns; Cause and Effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Structure and Function; Stability and Change	• Develop and use models • Obtain, evaluate, and communicate information • Construct an explanation, design a solution, or refine the design • Plan and carry out investigations • Use mathematics and computational thinking	P1: All matter in the Universe is made of very small particles. U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.
Module 5: Mining		
Engage	Ore vs. metal OEC INFO, MATH	
Explore	What are rocks? Mixtures vs pure substances 1. https://mrdata.usgs.gov/general/map-us.html 2. https://interactives.ck12.org/simulations/chemistry/what-is-air/app/index.html?lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html (for figuring out atom/molecule/compound/element) MODELING, ARGUMENT	

Explain #5: Minerals and Compounds	Ionic bonding, names, formulas, properties of ionic compounds, hydrates MODELING, MATH, ANALYZE
Elaborate	How are ores refined? **Lab video on my EdPuzzle account** Reactions, stoichiometry, LR, ICE MODELING, MATH, INVESTIGATE
Evaluate	Predict chemical formula from data, classify matter, evaluate refinement efficiency
Module 6: Metals	
Engage	Precious metals,
Explore	Conductors vs Insulators https://phet.colorado.edu/sims/cheerpj/conductivity/latest/conductivity.html OEC INFO, MODELING
Explain	Why can metals conduct electricity? Metallic bonding, other properties of metals, Alloys and properties MODELING, MATH
Elaborate	Pennies into gold virtual lab **EdPuzzle recorded lab** MODELING, MATH, CONSTRUCT, INVESTIGATE
Evaluate	Compare contrast bonding, use data to determine % composition of an alloy, explain how metal can be different in ore and metal
Module 7: Plastics	
Engage	Plastic ocean https://ourworldindata.org/plastic-pollution What's happening to our environment?? Why are plastics so strong but flexible? Properties of plastics and their molecules. OEC INFO
Explore	LAB: plastic at home, slime OEC INFO, MODELING, CONSTRUCT
Explain #7: Covalent Molecules	Day 1: Covalent bonding, polymers and monomers, lewis and VSEPR Day 2: Polarity and polymers MODELING, CONSTRUCT
Elaborate #7: IMFs and Physical Properties	How do molecules hold together? IMFS MODELING, CONSTRUCT
Evaluate	Compare 3 types, predict properties, draw molecules, construct explanations

Module 8: Underrated Ammonia	
Engage	History Ammonia Industrialization OEC, ARGUMENT
Explore	What makes the reaction successful? https://phet.colorado.edu/sims/cheerpj/reactions-and-rates/latest/reactions-and-rates.html Catalysts and intro to stoich for equilibrium MODELING, CONSTRUCT, MATH
Explain 8: Dynamic Equilibrium	Equilibrium, Le Chatelier, collision theory, MODELING, CONSTRUCT
Elaborate 8: Predicting Reactions	Predicting products of other reactions MODELING, INVESTIGATE, MATH
Evaluate	Predicting products, modeling equilibrium, using stoich
Assessment	TEST Compare/contrast all three types of bonding, predicting products of many types of reactions, evaluating the physical properties of each type of substance for bonding, design an experiment that maximizes production

Qtr 3: Global Carbon

Description	Modules will have 5 components: Engage, Explore, Explain, Elaborate, Evaluate to support science learning and practice.	
Standards	Essential HS.P1U1.3 Ask questions, plan, and carry out investigations to explore the cause and effect relationship between reaction rate factors. Plus HS+C.P1U1.4 Develop and use models to predict and explain forces within and between molecules. Plus HS+C.P1U1.5 Plan and carry out investigations to test predictions of the outcomes of various reactions, based on patterns of physical and chemical properties. Plus HS+C.P1U1.3 Analyze and interpret data to develop and support an explanation for the relationships between kinetic molecular theory and gas laws. Plus HS+C.P1U1.6 Construct an explanation, design a solution, or refine the design of a chemical system in equilibrium to maximize production. Plus HS+C.P1U1.7 Use mathematics and computational thinking to determine stoichiometric relationships between reactants and products in chemical reactions. Essential HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications.	
Cross Cutting Concepts	Science and Engineering Practices	Core Concepts
Patterns; Cause and Effect; Scale,	• Develop and use models • Analyze and interpret data	P1: All matter in the Universe is made of very small particles.

Proportion and Quantity; Systems and System Models; Energy and Matter; Structure and Function; Stability and Change	• Obtain, evaluate, and communicate information • Construct an explanation, design a solution, or refine the design • Plan and carry out investigations • Use mathematics and computational thinking	U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.
Module 9: Carbon in the Air		
Engage	Greenhouse effect and climate change https://phet.colorado.edu/sims/cheerpj/greenhouse/latest/greenhouse.html CONSTRUCT, MODEL, OEC INFO	
Explore	How much carbon is in the air? Relationship between quantity and warming https://docs.google.com/document/d/1EjQ5NHWV8KuGrx9TUVp4Rk5kuOK33XjV1TiDGbx4aEc/edit?usp=sharing CONSTRUCT, MATH, ANALYZE	
Explain 9: The Atmosphere	Components of the atmosphere, pressure, KMT, experiment for gas laws How do gases behave? https://docs.google.com/document/d/1zAnyrKAov6a3Sm0xZ9MzxrznZrNtPtVKVG9XefUd78M/edit?usp=sharing virtual lab link inside MODELING, CONSTRUCT, ARGUMENT, INVESTIGATE, ANALYZE	
Elaborate 9: Gas Laws	Predicting gas behavior, gas laws MATH, CONSTRUCT	
Evaluate	QUIZ Predict gas behavior, explain warming, model atmosphere	
Module 10: Carbon in the water		
Engage	Demo: water becoming more acidic with breath Reaction rates video, investigation planning (Alkaseltzer Tabs and water) CONSTRUCT, INVESTIGATE	
Explore	What affects reaction rates? At home Alkaseltzer experiment + https://teachchemistry.org/classroom-resources/reaction-rates-simulation ANALYZE, INVESTIGATE, CONSTRUCT	
Explain #10: Rates and Solutions	Solutions, collision theory, factors affecting rates MODEL, MATH, CONSTRUCT	
Elaborate #10: Applying Carbon Quantities	equilibrium, henry's law, IMFs MODEL MATH CONSTRUCT	

Evaluate	Use data sets to determine reaction rate, model reactions and equilibrium, explain climate drivers, apply gases and aqueous
Module 11: Ocean Acidification	
Engage	Ecosystem effects of acidification, The other CO2 problem https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html
Explore	Why is the pH of the ocean decreasing? https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=adec7620009d439c85109ab9aa1ea227 ANALYZE, OEC INFO, MODEL, INVESTIGATE
Explain #11: Acids and Bases	pH, acidity, proton transfer, equilibrium, neutralization LAB: acids and bases At-Home Lab - acids and bases, testing pH with paper MATH, MODEL, INVESTIGATE
Elaborate	Buffers and Virtual Lab http://www.chemcollective.org/vlab/104 Students make a buffer and test pH in response to acids and bases INVESTIGATE, MATH, CONSTRUCT
Evaluate	QUIZ Compare acidification, quantify concentrations, predict direction of reactions, model acids and bases
Module 12: Carbon in the ground	
Engage	How can carbon be removed from the ocean? OEC INFO, CONSTRUCT
Explore	What reactions cause carbonate to be turned to solid? **Video Labs** **https://docs.google.com/document/d/1HZyKuogJjlKXZq9ZpvkmSeNPoyf_BAQSCqBjtDtt8iY/edit?usp=sharing** ANALYZE, MODEL
Explain #12: Precipitation, Solubility, and Slow C	Precipitation reactions, solubility, net ionic equations, Ksp, slow carbon cycle MODELING, CONSTRUCT EXPLANATION, MATH
Elaborate 12: Quantifying Precipitation	Stoich and uses of precipitation, tackle a scenario that needs precipitation for solving. MATH, CONSTRUCT, MODELING
Evaluate	QUIZ Predict and model precipitation, explain the slow carbon cycle, predict products and do stoichiometry

Assessment	PROJECT Model large carbon cycle to a high detail

Qtr 4: Fuels and Power

Description	Modules will have 5 components: Engage, Explore, Explain, Elaborate, Evaluate to support science learning and practice.	
Standards	Essential HS.P4U1.8 Engage in argument from evidence that the net change of energy in a system is always equal to the total energy exchanged between the system and the surroundings. Plus HS+Phy.P4U1.6 Analyze and interpret data to quantitatively describe changes in energy within a system and/or energy flows in and out of a system. Plus HS+C.P1U1.5 Plan and carry out investigations to test predictions of the outcomes of various reactions, based on patterns of physical and chemical properties. Plus HS+C.P1U1.3 Analyze and interpret data to develop and support an explanation for the relationships between kinetic molecular theory and gas laws. Plus HS+C.P1U1.7 Use mathematics and computational thinking to determine stoichiometric relationships between reactants and products in chemical reactions. Essential HS.P1U3.4 Obtain, evaluate, and communicate information about how the use of chemistry related technologies have had positive and negative ethical, social, economic, and/or political implications. Essential HS.P4U3.9 Engage in argument from evidence regarding the ethical, social, economic, and/or political benefits and liabilities of energy usage and transfer.	
Cross Cutting Concepts	Science and Engineering Practices	Core Concepts
Patterns; Cause and Effect; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter; Structure and Function; Stability and Change	● Analyze and interpret data ● Obtain, evaluate, and communicate information ● Argument from evidence ● Construct an explanation, design a solution, or refine the design ● Plan and carry out investigations ● Use mathematics and computational thinking	P1: All matter in the Universe is made of very small particles. U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products. U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.
Module 13: Fuels and Energy		
Engage	What's inside an engine? How does chemical energy translate into motion? CONSTRUCT, INVESTIGATE	
Explore	At home lab on fuels and ΔT INVESTIGATE, MATH, CONSTRUCT, ANALYZE	
Explain #13: Fuels and Enthalpy	Quantifying chemical energy, relative energies of fuels, Hess's Law reaction diagrams	

	MATH, ARGUMENT, OEC INFO
Elaborate	Where does the rest of the energy go? Entropy and Gibb's MATH, MODELING
Evaluate	QUIZ Compare fuels, predict useable energy output, show energy transfers
Module 14: Power of Water	
Engage	How does a power plant produce electricity? OEC INFO, ARGUMENT
Explore	How does phase change relate to energy? https://interactives.ck12.org/simulations/chemistry/phases-of-matter/app/index.html?screen=sandbox&lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html MATH, MODELING, CONSTRUCT
Explain #14: Power Plant Enthalpy	Calorimetry, heating, ΔHvap ANALYZE, INVESTIGATE, MATH
Elaborate #14: Food as Fuel Elaborate #14.5: Calorimetry LAB at-home!	Food as fuel, how does this relate to human bodies? CONSTRUCT, INVESTIGATE, MATH
Evaluate	QUIZ Map energy transfers inside power plant, person, explain chemical energy, calculate quantities of fuel
Module 15: Battery Power	
Engage	Galvanic cell (lemon battery), environmental issues with lithium batteries OEC INFO
Explore	How can simple reactions make electrons flow? https://javalab.org/en/standard_reduction_potentials_en/ http://web.mst.edu/~gbert/Electro/Electrochem.html https://interactives.ck12.org/simulations/chemistry/redox-reaction/app/index.html?screen=sandbox&lang=en&referrer=ck12Launcher&backUrl=https://interactives.ck12.org/simulations/chemistry.html INVESTIGATE, ANALYZE, MODEL, CONSTRUCT
Explain	Redox reactions, electrode potential energy, electrochemical cells, Le Chatelier MODEL, MATH

Elaborate	Reversing electrochemical reactions https://media.pearsoncmg.com/bc/bc_0media_chem/chem_sim/html5/Electro/Electro.php OEC INFO, INVESTIGATE, CONSTRUCT
Evaluate	QUIZ Model redox reactions, build galvanic cell with maximum electricity output
Module 4: End of Year Projects	
Project 1	At-home Experiment - use chemistry skills and knowledge to investigate, analyze, and explain a phenomenon that interests you
Project 2	Research project presentation: societal problems and solutions - use chemistry skills and knowledge to obtain, evaluate, and communicate information about a relationship between chemistry and society that interests you
Project 3	You CAN take it with you! Summarize and outline the information learned this year