MOORESTOWN TOWNSHIP PUBLIC SCHOOLS
MOORESTOWN, NEW JERSEY

Moorestown High School
Science Department

Honors Chemistry
Grades 10 - 11

Date: July 2022 revised July 2023
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Contents

Back to Table of Contents

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Back to Table of Contents

Course Description and Fundamental Concepts

This first year chemistry course encourages students to investigate phenomena, interpret findings, and create models in order to explain the phenomena. Emphasis is placed on student-driven investigations in order to answer the big questions: What is our world made of? How can matter be so different? Why does it change?

This first year honors chemistry course involves students in real-world situations that correspond to the concepts and laws of chemistry. Emphasis is placed on student-driven data collection, interpretation, modeling, and cooperative learning in order to relate the concepts being explored to real-world effects and their own lived experiences.

Fundamental concepts:

- Scientific Analysis
- Particle Nature of Matter
- Accuracy, Precision, and Uncertainty
- Numerical relationships, conversions, and moles
- Quantum Mechanics
- Energy flow
- Kinetic Molecular Theory and its effects on systems
- Chemical Bonds
- Reactions, rates, equilibria, and using chemistry to help humanity
- Acids, Bases, and their relationships
- Solutions and solution chemistry
- Oxidation and reduction reactions
- Organic chemistry
- Nuclear chemistry
- Green chemistry

Back to Table of Contents

New Jersey Student Learning Standards (NJSLS)

Subject/Content Standards
Include grade appropriate subject/content standards that will be addressed

Standard #	Standard Description
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. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]
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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]
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. [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.]
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. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]
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. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]
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.* [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]

Back to Table of Contents

HS-PS1-7.	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.]
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. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]
HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]
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. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.]
HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.]
HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*
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). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]

Back to Table of Contents

HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.] HS-PS4-2. Evaluate questions about the advantages of using a digital
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. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.]
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. [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]
HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

English Companion Standards

List grade-level appropriate companion standards for History, Social Studies, Science and Technical Subjects (CTE/Arts) 6-12. English Companion Standards are required in these subject/content areas.

Unit Addressed	Standard #	Standard Description
1,2,3,4,5,6,7,8, 10	*RST.9-10.7*	*Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)*

Back to Table of Contents

3,11	*RST.9-10.8*	*Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)*
1,2,3,4,5,6,7,8,9, 10,11	*RST.11-12.1*	*Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3),(HS-PS1-5) (HS-PS3-4)*
1,4,5,6,7,8,10	*WHST.9-12.2*	*Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS2-6),(HS-PS1- 2),(HS-PS1-5)*
2,3,4,5,6,7,8,9, 10,11	*WHST.9-12.5*	*Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2)*
1,2,3,4,5,6,7,8,9 10,11	*WHST.9-12.7*	*Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HSPS1-3),(HS-PS1-6), (HS-PS3-3), (HS-PS3-4),(HS-PS3-5)*
1,2,3,4,5,6,7,8, 10,11	*WHST.11-12. 8*	*Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3), (HS-PS3-4), (HS-PS3-5)*
1,2,4,5,6,7,8,10	*WHST.9-12.9*	*Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3) (HS-PS3-4),(HS-PS3-5)*
5,6,7	*SL.11-12.5*	*Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-1),(HS-PS3-2),(HS-PS3-5)*

Career Awareness, Exploration, Preparation, and Training (Standard 9.2)
List appropriate units below for which standards will be addressed

Back to Table of Contents

By Grade 12		
Unit Addressed	**Core Idea**	**Standard / Description**
1-11	There are strategies to improve one's professional value and marketability.	***9.2.12.CAP.1****: Analyze unemployment rates for workers with different levels of education and how the economic, social, and political conditions of a time period are affected by a recession.* ***9.2.12.CAP.2****: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.* ***9.2.12.CAP.3****: Investigate how continuing education contributes to one's career and personal growth.*
	Career planning requires purposeful planning based on research, self-knowledge, and informed choices.	***9.2.12.CAP.4****: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.* ***9.2.12.CAP.5****: Assess and modify a personal plan to support current interests and postsecondary plans.* ***9.2.12.CAP.6****: Identify transferable skills in career choices and design alternative career plans based on those skills.* ***9.2.12.CAP.7****: Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest.* ***9.2.12.CAP.8****: Determine job entrance criteria (e.g., education credentials, math/writing/reading comprehension tests, drug tests) used by employers in various industry sectors.* ***9.2.12.CAP.9****: Locate information on working papers, what is required to obtain them, and who must sign them.* ***9.2.12.CAP.10****: Identify strategies for reducing overall costs of postsecondary education (e.g., tuition assistance, loans, grants, scholarships, and student loans).* ***9.2.12.CAP.11****: Demonstrate an understanding of Free Application for Federal Student Aid (FAFSA) requirements to apply for postsecondary education.*

Back to Table of Contents

	An individual's income and benefit needs and financial plan can change over time.	***9.2.12.CAP.12****: Explain how compulsory government programs (e.g., Social Security, Medicare) provide insurance against some loss of income and benefits to eligible recipients.* ***9.2.12.CAP.13****: Analyze how the economic, social, and political conditions of a time period can affect the labor market.*
	Securing an income involves an understanding of the costs and time in preparing for a career field, interview and negotiation skills, job searches, resume development, prior experience, and vesting and retirement plans.	***9.2.12.CAP.14****: Analyze and critique various sources of income and available resources (e.g., financial assets, property, and transfer payments) and how they may substitute for earned income.*
	Understanding income involves an analysis of payroll taxes, deductions and earned benefits.	***9.2.12.CAP.15****: Demonstrate how exemptions, deductions, and deferred income (e.g., retirement or medical) can reduce taxable income.* ***9.2.12.CAP.16****: Explain why taxes are withheld from income and the relationship of federal, state, and local taxes (e.g., property, income, excise, and sales) and how the money collected is used by local, county, state, and federal governments.* ***9.2.12.CAP.17****: Analyze the impact of the collective bargaining process on benefits, income, and fair labor practice.* ***9.2.12.CAP.18****: Differentiate between taxable and nontaxable income from various forms of employment (e.g., cash business, tips, tax filing and withholding).* ***9.2.12.CAP.19****: Explain the purpose of payroll deductions and why fees for various benefits (e.g., medical benefits) are taken out of pay, including the cost of employee benefits to employers and self-employment income.* ***9.2.12.CAP.20****: Analyze a Federal and State Income Tax Return.*
	There are ways to assess a business's feasibility and risk and to align it with an individual's financial goals.	***9.2.12.CAP.21****: Explain low-cost and low-risk ways to start a business.* ***9.2.12.CAP.22****: Compare risk and reward potential and use the comparison to decide whether starting a business is feasible.*

Back to Table of Contents

		9.2.12.CAP.23*: Identify different ways to obtain capital for starting a business*

Life Literacies and Key Skills (Standard 9.4)
List appropriate units below for which standards will be addressed

By Grade 12		
Unit Addressed	**Core Idea**	**Standard / Description**
1,2,3,4,5,6,7,8,9,10,11	**Creativity and Innovation**: With a growth mindset, failure is an important part of success.	***9.4.12.CI.1****: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).*
1	**Creativity and Innovation**: Innovative ideas or innovation can lead to career opportunities.	***9.4.12.CI.2:*** *Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).* ***9.4.12.CI.3:*** *Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).*
1,2,3,4,5,6,7,8,9,10,11	**Critical Thinking and Problem-solving:** Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.	***9.4.12.CT.1:*** *Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).* ***9.4.12.CT.2:*** *Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).* ***9.4.12.CT.3:*** *Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).* ***9.4.12.CT.4:*** *Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.*
1,2,3,4,5,6,7,8,9,10,11	**Digital Citizenship:** Laws govern the use of intellectual property and there are legal consequences to utilizing or sharing another's original works without permission or appropriate credit.	***9.4.12.DC.1****: Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).* ***9.4.12.DC.2****: Compare and contrast international differences in copyright laws and ethics*

Back to Table of Contents

	Digital Citizenship: Laws govern many aspects of computing, such as privacy, data, property, information, and identity. These laws can have beneficial and harmful effects, such as expediting or delaying advancements in computing and protecting or infringing upon people's rights.	***9.4.12.DC.3****: Evaluate the social and economic implications of privacy in the context of safety, law, or ethics (e.g., 6.3.12.HistoryCA.1).* ***9.4.12.DC.4****: Explain the privacy concerns related to the collection of data (e.g., cookies) and generation of data through automated processes that may not be evident to users (e.g., 8.1.12.NI.3).* ***9.4.12.DC.5****: Debate laws and regulations that impact the development and use of software.*
	Digital Citizenship: Cultivating online reputations for employers and academia requires separating private and professional digital identities.	***9.4.12.DC.6****: Select information to post online that positively impacts personal image and future college and career opportunities.*
	Digital Citizenship: Digital communities influence many aspects of society, especially the workforce. The increased connectivity between people in different cultures and different career fields have changed the nature, content, and responsibilities of many careers.	***9.4.12.DC.7****: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society (e.g., 6.1.12.CivicsPD.16.a).*
	Digital Citizenship: Network connectivity and computing capability extended to objects, sensors and everyday items not normally considered computers allows these devices to generate, exchange, and consume data with minimal human intervention. Technologies such as Artificial Intelligence (AI) and blockchain can help minimize the effect of climate change.	***9.4.12.DC.8****: Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection.*
	Global and Cultural Awareness: Solutions to the problems faced by a global society require the contribution of individuals with different points of view and experiences.	***9.4.12.GCA.1:*** *Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).*

Back to Table of Contents

	Information and Media Literacy: Advanced search techniques can be used with digital and media resources to locate information and to check the credibility and the expertise of sources to answer questions, solve problems, and inform the decision-making.	***9.4.12.IML.1:*** *Compare search browsers and recognize features that allow for filtering of information.* ***9.4.12.IML.2:*** *Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.*
	Information and Media Literacy: Digital tools such as artificial intelligence, image enhancement and analysis, and sophisticated computer modeling and simulation create new types of information that may have profound effects on society. These new types of information must be evaluated carefully	***9.4.12.IML.3****: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)* ***9.4.12.IML.4****: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).*
	Information and Media Literacy: In order for members of our society to participate productively, information needs to be shared accurately and ethically.	***9.4.12.IML.5****: Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).* ***9.4.12.IML.6****: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5).*
	Information and Media Literacy: Accurate information may help in making valuable and ethical choices.	***9.4.12.IML.7****: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).*
	Information and Media Literacy: Media have embedded values and points of view.	***9.4.12.IML.8****: Evaluate media sources for point of view, bias, and motivations (e.g., NJSLSA.R6, 7.1.AL.IPRET.6).* ***9.4.12.IML.9****: Analyze the decisions creators make to reveal explicit and implicit messages within information and media (e.g., 1.5.12acc.C2a, 7.1.IL.IPRET.4).*
	Technology Literacy: Digital tools differ in features, capacities, and styles.	***9.4.12.TL.1****: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task (e.g., W.11-12.6.).*

Back to Table of Contents

	Knowledge of different digital tools is helpful in selecting the best tool for a given task.	***9.4.12.TL.2****: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.*
	Technology Literacy: Collaborative digital tools can be used to access, record and share different viewpoints and to collect and tabulate the views of groups of people.	***9.4.12.TL.3****: Analyze the effectiveness of the process and quality of collaborative environments.* ***9.4.12.TL.4****: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).*

Interdisciplinary Connections (2020 NJSLS)
List any other content standards addressed as well as appropriate units. All arts integration connections may be listed within this chart.

Visual & Performing Arts Integration (Standard 1)
List appropriate units below for which standards (1.1 through 1.5) may be addressed

Unit Addressed	Artistic Process	Anchor Standard
1,2,3,4,5,6,7,8,9, 10,11	**Creating**	*Anchor Standard 1: Generating and conceptualizing ideas.* *Anchor Standard 2: Organizing and developing ideas.* *Anchor Standard 3: Refining and completing products.*
	Connecting	*Anchor Standard 10: Synthesizing and relating knowledge and personal experiences to create products.* *Anchor Standard 11: Relating artistic ideas and works within societal, cultural, and historical contexts to deepen understanding.*
1,2,3,4,5,6,7,8,9, 10,11	**Performing/ Presenting/ Producing**	*Anchor Standard 4: Selecting, analyzing, and interpreting work.* *Anchor Standard 5: Developing and refining techniques and models or steps needed to create products.* *Anchor Standard 6: Conveying meaning through art.*
	Responding	*Anchor Standard 7: Perceiving and analyzing products.* *Anchor Standard 8: Applying criteria to evaluate products.* *Anchor Standard 9: Interpreting intent and meaning.*

Back to Table of Contents

Unit Addressed	Content / Standard #	Standard Description
1,2,3,4,5,6,7,8,9, 10,11	*Math / MP.2*	*Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7), (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5)*
3,4,5,6,7,9,11	*Math / MP.4*	*Model with mathematics. (HS-PS1-4),(HS-PS1-8),(HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS3-1),(HS-PS3-2),(HS-PS3-3),(HS-PS3-4),(HS-PS3-5)*
1,2,3,4,5,6,7,8,9, 10,11	*Math / HSN-Q.A.1*	*Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8),(HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6). (HS-PS3-1),(HS-PS3-3)*
1,3,5,6,7,8,9,10, 11	*Math / HSN-Q.A.2*	*Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4),(HS-PS1-7),(HS-PS1-8), (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6), (HS-PS3-1),(HS-PS3-3)*
1,2,3,4,5,6,7,8,9, 10,11	*Math / HSN-Q.A.3*	*Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8),(HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6), (HS-PS3-1),(HS-PS3-3)*
3,9,11	*HSA-SSE.A.1*	*Interpret expressions that represent a quantity in terms of its context. (HS-PS2-1),(HS-PS2-4),(HS-PS4-1),(HS-PS4-3)*
3,9,11	*HSA-SSE.B.3*	*Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS4-1),(HS-PS4- 3)*
3,11	*HSA.CED.A.4*	*Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1),(HS-PS4-3)*

Back to Table of Contents

Pacing Guide (All Dates are approximate based on the school calendar)

Unit/ Topic	Month (w/Approx number of Teaching Days)
Unit 1 - Properties of Matter	September (~19 days)
Unit 2 - The Mole & Nuclear Chemistry	October (~19 days)
Unit 3 - Electrons & Quantum Mechanics	November (~16 days)
Unit 4 - Bonding	December (~15 days)
Unit 4 - Bonding	January (~18 days)
Unit 5 - Kinetic Molecular Theory	February (~18 days)
Unit 6 - Gas Laws Unit 7 - Reactions	March (~15-20 days)
Unit 7 - Reactions	April (~15-20 days)
Unit 8 - Solutions Unit 9 - Kinetics, Equilibrium and Acid-Base Equilibria	May (~18 days)
Unit 9 - Kinetics, Equilibrium and Acid-Base Equilibria	June (~15 days)

Back to Table of Contents

Units Scope and Sequence

Unit 1: Properties of Matter

Learning Goals: What do I want my students to learn?

Standards

NJSLS -
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-PS1-3: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-PS1-7:Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

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

NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:
- What is stuff?
- Why is there different stuff?
- What happens when stuff is mixed together?
- What are the smallest parts of stuff?
- How do we measure different types of matter?

Phenomenon: Density
- Amount of matter contained within a volume
- Graphing relationships between properties (mass Vs length, area, volume) with meaning of slope
- Effects of errors on results/calculations

Modeling: Atoms
- Individual (Planetary Model w/ p^+, n, e^-) [Relate to differences between elements, ions, isotopes]
- Bulk [Relate to density]
- Mixtures

Back to Table of Contents

Learning Objectives
Students will be able to… ● Classify matter by investigating properties o Differentiate between physical / chemical properties ; intensive / extensive properties (prior) o Understand the difference between atom, element, and compound (prior) o Classify matter as pure substance or mixture (prior) ● Use and convert units of matter in scientific investigations ● Use the scientific method to conduct investigations [HS-PS1-3.4.a.] ● Construct and interpret graphical models ● Calculate percent error and evaluate the limitations of the data [HS-PS1-3.5.a.i.] ● Identify possible errors and calculate the effects they would produce in results. [HS-PS1-3.5.a.ii.] ● Identify mixtures as combinations of properties of pure substances ● Calculate percent compositions [HS-PS1-71.b.] ● Model individual atoms of different elements [HS-PS1-1.1.a.ii.] ● Relate subatomic particles in atoms to differences in properties of matter. ● Model bulk atoms of different substances [HS-PS1-3.1.a.] ● Relate bulk model to differences in densities [HS-PS1-3.2.b.iii.] ● Identify an element based on the number of protons [HS-PS1-8.1.a.i.] ● Write and interpret isotopic symbols (A, Z, Q, atomic symbol) ● Calculate Relative Atomic Weights using Atomic Masses of Stable Isotopes and their abundances. ● Identify relative abundances of isotopes in elements with two stable isotopes.

Back to Table of Contents

Unit 2: The Mole & Nuclear Chemistry

Learning Goals: What do I want my students to learn?

Standards

NJSLS -
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-PS1-7: 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.

NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:

- How can we tell how many atoms are in something? (e.g. pile of sand) [HS-PS1-1,7]
- How do we name atoms that combine into a compound?
- How are moles useful? [HS-PS1-7]
- How can we tell how many atoms are in a chemical? (e.g. salt or water) [HS-PS1-2.1.a.i.]
- Where do chemical formulas come from? [HS-PS1-7.3.b.]
- What is the nucleus?
- How is the nucleus created?
- What can the nucleus do? (How does it change?)
- What is nuclear radiation?
- What happens in a nuclear explosion?
- What is nuclear energy?

Phenomenon: Equivalent Amounts and Nuclear Energy

- Amounts of elements always proportional (e.g. volumes of gas from hydrolysis of water [2:1 H:O]) {Avogadro's Law, Law of Conservation of Mass, and Law of Definite Proportions} [HS-PS1-7.1.a.iv.]
- Nuclear Decay: Change in $p^+ \rightarrow$ Change in identity

Modeling

- Equivalent amounts

Back to Table of Contents

- Molar Masses [HS-PS1-7.1.a.ii]
- Reaction Equivalences for Empirical and Molecular Formulas [HS-PS1-7.3.b.]
- Nuclear Fusion (Changes in nucleus)
- Nuclear Decay (Changes and energy) {alpha, beta, and gamma required, positron and EC optional}
- Nuclear Fission (Changes and energy)
- Develop 5 Nuclear Models
- Stars: Fusion & Stellar Nucleosynthesis
- Students investigate changes in and the conservation of matter and energy in nuclear processes. They explore the decay of unstable nuclei and the binding energy of elements. They consider how nuclear technologies impact individuals and society.
- Students use knowledge of radioactive processes and half-lives to explain how nuclear energy can power the Mars rover for many years.

Learning Objectives

Students will be able to…

- Interpret the Law of Conservation of Mass
- Model atoms in bulk scale to demonstrate equivalent amounts. (e.g. 5 g H_2O = 4.4 g O and 0.56 g H; 10 g H_2O = 8.9 g O and 1.1 g H → 7.9 g O: 1 g H) (Law of Conservation of Mass)
- Use the model to equate mass, moles, and particles.
- Use the model to interconvert between mass, moles, and particles.
- Create an appropriate data table for gravimetric laboratory experiments.
- Create empirical formulas from experimental data.
- Practice naming ionic and molecular compounds.
- Create simple stoichiometric equations
- Create molecular formulas from empirical formulas and molar masses.
- Model fusion of lighter elements to produce heavier elements
- Identify fusion as the driving force behind the sun.
- Model fission of heavier elements to produce lighter elements
- Model nuclear decay (alpha, beta, positron emission, electron capture, and gamma release)
- Predict final stable daughter isotopes of a nuclear decay series.
- Identify dangers of different types of nuclear radiation relative to scale of energy.
- Determine the scale of energy changes associated with nuclear processes compared to chemical processes (e.g. nuclear Vs. coal fuels used in power plants; nuclear Vs. conventional payloads in weapons)
- Identify common sources of nuclear energy.
- Compare and contrast nuclear, conventional, and renewable energy systems.
- Use the model to develop a half-life formula.
- Calculate initial mass and final mass ($m_f = m_i(½)^n$ where $n = t/t_{½}$)
- Calculate half-life and time-to-decay ($t = t_{½} \cdot \ln(X)/\ln(½)$ where $X = m_f/m_i$)
- Calculate energy and mass deficit of nuclear reaction ($E = \Delta mc^2$ where $\Delta m = m_f - m_i$)
- explain how the battery of the Mars rover is charged using energy released by uranium isotopes as they decay.
- relate uranium's half-life to its ability to provide energy for an extended period.
- develop models to explain the conversion of mass and energy during the process of fission and fusion.
- explain that the uranium used to power the Mars rover originally formed from solar fusion.
- explain that the nuclear generator in the Mars rover is a technology that transforms nuclear energy into electrical energy.

Back to Table of Contents

Unit 3: Electrons and Quantum Mechanics

Learning Goals: What do I want my students to learn?

Standards

NJSLS -
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-PS4-1: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

*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.
NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:

- What do electrons do?
- Why do electrons do what they do?
- Why do electrons determine how an atom behaves?
- Where does light come from?
- Why are things different colors?

Phenomenon: Light

- Line spectra
- Glow-in-the-dark (charging using red light and UV)
- Fluorescence

Modeling

- Bohr Model
- Wavelength Vs. Energy
- Atomic Orbitals
- Electron Configurations
- Wave-Particle Duality

Back to Table of Contents

Learning Objectives

Students will be able to…

- Use the Bohr Model to predict line spectra of hydrogen.
- Calculate wavelength, frequency, and energy using $c=\lambda\nu$ and $E=h\nu$.
- Identify types of electromagnetic radiation and compare energy content (e.g. microwaves < visible < x-rays)
- Use Quantum Model to explain line spectra of other elements.
- Interpret light production and absorption as reverse processes.
- Relate light production and absorption with energy level transitions.
- Relate distance from nucleus (n) with potential energy.
- Relate complexity of orbital (l) with potential energy.
- Relate energy level transitions with energy of photons produced.
- Identify 4 quantum numbers (n, l, m_l, m_s) and what property they determine.
- Model ground state electron configurations using Aufbau Principle, Pauli's Exclusion Principle, and Hund's Rules.
- Write and interpret electron configurations
- Model excited state electron configurations
- Use the Periodic Table to write abbreviated (Noble Gas) electron configurations.
- Identify core and valence electrons.
- Identify paired and unpaired valence electrons using box diagrams (or similar).
- Predict common ionic charges from electron configurations.
- Interpret fundamental components of Quantum Mechanics (e.g. wave-particle duality, quantization, Heisenberg's Uncertainty Principle, Pauli's Exclusion Principle, Probabilistic nature of the universe, etc.)

Back to Table of Contents

Unit 4: Bonding

Learning Goals: What do I want my students to learn?

Standards

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

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

NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:

- Why do elements have different properties?
- How are compounds named?
- Why do things like alcohol evaporate faster than water?
- Why do some things dissolve in water and other things do not?
- What does soap do?
- Why does oil float on top of water?

Phenomena:

- Periodic Trends
- Chemical Bonding
- Intermolecular Forces

Modeling

- Periodic Trends
- Chemical Bonding
- 3-D structures
- IMFAs

Back to Table of Contents

Learning Objectives
Students will be able to… ● Model atoms in the Periodic Table to identify trends (radius, electronegativity, & first ionization energy) ● Use their model to identify types of bonds that would form between two elements. ● Predict formulas of binary ionic compounds. ● Draw and interpret Lewis Dot Structures of simple covalent compounds. ● Calculate percent composition of reactants and products using principles of stoichiometry (Law of Conservation of Mass) from Unit 2 ● Model simple compounds in 3-D ● Use bulk atom model to describe Coulombic attractions between molecules leading to relative differences in intermolecular forces of attraction (IMFAs). ● Identify types of IMFAs exhibited by pure compounds using bulk atom and 3-D molecule models. ● Correlate strength of IMFAs with phase change data (e.g. melting & boiling points, vapor pressure, etc.) ● Predict relative physical properties of simple compounds (e.g. boiling points of NaCl, H_2O, and CH_4, etc) ● Explain solubility in terms of IMFAs.

Back to Table of Contents

Unit 5: Kinetic Molecular Theory

Learning Goals: What do I want my students to learn?

Standards

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

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

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-PS3-2:Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

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

NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:

- What is the difference between solids, liquids, and gases?
- What happens when ice melts / water freezes / water boils?
- What is temperature?
- Why do we sweat?
- Why does metal feel colder than plastic?

Phenomena:

- Temperature
- Phase Changes
- Absolute Zero
- Heat capacity

Back to Table of Contents

Modeling

- Particles in motion
- Phase changes
- Gas Laws
- Heat flow (Thermodynamics)

Learning Objectives

Students will be able to…

- Model molecular motion to correlate energy content and phase.
- Describe temperature in terms of molecular motion.
- Explain phase changes in terms of changes in particle motion.
- Describe Absolute Zero in terms of particle motion.
- Interconvert between °C, °F, and K.
- Model the behavior of solids, liquids, and gases from a particulate point of view.
- Describe Heat Flow in terms of particle motion.
- Model Specific Heat Capacity in terms of particle motion.
- Use heat capacity to relate ΔT, m, and q.
- Conduct a laboratory experiment to determine specific heat capacity.
- Create a heating/cooling curve from experimental data to illustrate heat flow.
- Describe properties of particles at any point of a heating/cooling curve.
- Describe energy changes in a reaction profile related to products, reactants, and activated complexes

Back to Table of Contents

Unit 6: Gas Laws

Learning Goals: What do I want my students to learn?

Standards

NJSLS -
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-PS1-3: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-PS1-7:Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

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

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-PS3-2:Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

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

NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:

- Why are gases so much different than solids and liquids?
- Why are gases affected by pressure, temperature, and volume?

Back to Table of Contents

Phenomena:

- Why does a marshmallow expand in a syringe?
- Why does a soda can collapse in an ice bucket?
- How come the air pressure in your tires gets low in the cold?

Modeling

- Particles in motion
- Gas Laws

Learning Objectives

Students will be able to…

- Model molecular motion to correlate energy content and phase.
- Describe temperature in terms of molecular motion.
- Explain phase changes in terms of changes in particle motion.
- Describe Absolute Zero in terms of particle motion.
- Interconvert between °C, °F, and K.
- Model the behavior of gases from a particulate point of view.
- Interconvert between different units of pressure.
- Use Empirical Gas Laws to relate P, V, & T.
- Use Ideal Gas Law to relate P, V, n, & T (with R).
- Describe diffusion and effusion in terms of particle motion.
- Use Graham's Law to relate rate of effusion with molar mass.
- Calculate stoichiometric volumes.
- Describe Heat Flow in terms of particle motion.
- Model Specific Heat Capacity in terms of particle motion.
- Use heat capacity to relate ΔT, m, and q.
- Movie - the Aeronauts (Amazon Prime)
- Interpret Phase Diagrams

Back to Table of Contents

Unit 7: Reactions

Learning Goals: What do I want my students to learn?

Standards

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

HS-PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:

- Why do we make jewelry out of specific substances and not others?
- Why do we paint cars, bridges, etc?
- Why are there expiration dates on things (e.g. medicines, foods, etc)
- Why is chemistry like cooking?
- Why is fire hot? (What is fire?)

Phenomena:

- Reactions
- Solubility
- Electricity
- The Self-Inflating Balloon
- Roasting a Marshmallow

Back to Table of Contents

Modeling

- Balancing Chemical Reactions
- Endothermic Vs. Exothermic Reactions [HS-PS1-4]
- Activity of Metals (and nonmetals?)
- Solubility as a driving force
- Electron flow (e.g. in a battery)

Learning Objectives

Students will be able to…

- Writing formulas from names
- Balance chemical equations
- Describe the driving forces of reactions in terms of their bulk atomic model.
- Model changes in bond energy leading to exothermic/endothermic reactions.
- Describe difference in bond energies of reactants and products as being responsible for energetics of reaction (contrast with typical biology concept of bonds storing energy).
- Use stoichiometric principles to calculate reactants, products, yields and energy.
- Model the activity series using their Periodic Trends model form Unit 6.
- Predict single displacement reactions based on the activity series.
- Model solubility rules using their IMFAs model from Unit 6.
- Predict double displacement reactions based on solubility of products.
- Identify important components of a reaction by writing Net Ionic Equations.
- Modify activity series model to incorporate harnessing the flow of electrons in a battery.
- Predict Redox reactions and voltage potentials.
- Balance Redox reactions under acidic conditions.
- Apply stoichiometry to chemical reactions

Back to Table of Contents

Unit 8: Solutions

Learning Goals: What do I want my students to learn?

Standards

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

NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:
- How is soap made?
- Why do we stir sugar to dissolve it?
- Why is simple syrup used to sweeten iced coffee?
- Why do we put salt on the roads in the winter time?

Phenomena:
- Freezing Point Depression
- Boiling Point Elevation
- Vapor Pressure
- Osmotic Pressure

Modeling
- Concentration and Dilutions
- Limiting Reactant
- Colligative Properties

Learning Objectives

Students will be able to…
- Model concentration with respect to solubility, KMT, and IMFAs.
- Calculate concentration in %, ppm, ppb, molarity, and molality.
- Calculate stoichiometric amounts using concentration.
- Differentiate between Limiting and Excess reactants and their effects on reactions.

Back to Table of Contents

- Model colligative properties as crystal formation (freezing point depression) and/or kinetic energy (boiling point elevation) interference.
- Calculate colligative effects on physical properties.
- Investigate the role of temperature and surface area in the formation of solutions.
- Interpret solubility curves and factors that affect the solubility of a substance.

Back to Table of Contents

Unit 9: Kinetics, Equilibrium, & pH

Learning Goals: What do I want my students to learn?

Standards

NJSLS -
*HS-PS1-2:*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-PS1-5:*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-PS2-4:*Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

NJSLS - Career Awareness, Exploration, Preparation, and Training
NJSLS - Life Literacies and Key Skills
NJSLS - Interdisciplinary Standards

Fundamental Concepts / Big Ideas

Big Questions:

- Are acids as dangerous as depicted in movies?
- Why does it hurt when we hold our breath for a while?
- What role does the ocean serve for the environment? What causes ocean acidification?
- How do limestone caves form?

Phenomena:

- Reaction Rates
- Acidity
- Equilibria
- Buffers

Modeling

- Collision Theory (Reaction Rates) [HS-PS1-5]
- Le Châtelier's Principle (Effects on Equilibrium) [HS-PS1-6]
- Weak Acids and Bases (Buffering)
- Students define acids and bases and learn the strengths of both. They explore acid-base neutralization reactions and acid-base titrations. They discover buffers and buffer systems.

Back to Table of Contents

- Students use acid-base reactions to explain how acid rain impacts the environment. They apply this knowledge towards explaining ocean acidification.
- Students calculate reaction rates. They examine energy diagrams and the role of activation energy. They apply Le Chatelier's Principle to equilibria of chemical systems.
- Students use reaction rates and energy diagrams to explain collision theory

Learning Objectives

Students will be able to…

- Explain kinetic effects of temperature and concentration
- Model ways to improve yield (i.e. "discover" LeChâtelier's Principle)
- Apply LeChâtelier's Principle
- Calculate equilibrium values (constants and concentrations).
- Calculate changes in concentration of reactants and products. (ICE table)
- Characterize acidic and basic solutions.
- Describe acids and bases according to Arrhenius, Brønsted-Lowry, and Lewis.
- Calculate pH from concentrations of strong acids and bases.
- Calculate the amount of strong acid required to neutralize a strong base (and reverse).
- Calculate concentration of strong acid/base from titration.
- Explain buffering systems in a body of water and use this to refine explanations on how acid rain impacts the environment or modulates the pH of the blood
- Explain a pattern of the effect of temperature on reactions and relate that to the phenomenon of how limestone caves form.
- Investigate if chemical reactions are exo- or endothermic
- Utilize knowledge on Le Chatelier's Principle to identify patterns and explain how increasing acidity of precipitation affects the processes that form limestone caves.
- Explain how the concept of entropy relates to the phenomenon of how limestone caves form.

Please contact the Content Supervisor for any questions.

Back to Table of Contents