Grade: 9-12

Unit 4: The Dynamics of Chemical Reactions and Ocean Acidification

New Jersey Student Learning Standards

Established Date 2016-2017
Revised Date 2018-2019
Revised Date 2020-2021
Revised Date 2022-2023

Marking Period	Unit Title	Recommended Instructional Days
3-4	**Unit 4: The Dynamics of Chemical Reactions and Ocean Acidification**	**30**

NJSLS - Science: *TItle*	NJSLS - Science: *Performance Expectations*	
• **HS-PS1: Matter and Its Interactions** • **HS-ESS2: Earth's Systems** • **HS-ESS3: Earth and Human Activity** • **HS-ETS1: Engineering Design**	• **HS-PS1-5 -** Apply scientific principles and evidence to provide an explanation about the effects of changes 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-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 systems. • **HS-ESS2-6 -** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. • **HS-ESS3-4 -** Evaluate or refine a technological solution that reduces impacts of human	**Recommended Activities, Investigations, Interdisciplinary Connections, and/or Student Experiences to Explore NJSLS-S within Unit**

	activities on climate change and other natural 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 (i.e., climate change). ● **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.	
FOUNDATION Disciplinary: ***Core Idea***	**FOUNDATION Disciplinary:** ***Statement***	
● **HS-PS1.B Chemical Reactions** ● **HS-ESS2.A Earth Materials and Systems** ● **HS-ESS2.D Weather and Climate** ● **HS-ESS3.C Human Impacts on Earth Systems** ● **HS-ESS3.D Global Climate Change** ● **HS-ETS1.A Delimiting Engineering Problems** ● **HS-ETS1.B Developing Possible Solutions** ● **HS-ETS1.C Optimizing the Design Solution**	**Chemical Reactions** ● Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-5) ● In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6) ● The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-7) **Earth Materials and Systems** ● Earth's systems, being dynamic and interacting, cause feedback effects that can increase or	**Essential Questions:** ● What is the impact of concentration, temperature, and pressure on reaction rates and equilibrium? ● How is human activity affecting the balance of acids and bases in the environment? ● What causes changes to pH level, carbon cycling, and currents on the ocean system and how do these changes disrupt ocean ecosystems ? **Activity Description**: **Reaction Rates and Equilibrium** ● Inquiry Lab - Reaction Rates: Iodine Clock ● Analyzing Data - Factors that Affect Reaction Rate ● Modeling - Model Factors that Affect Reaction Rate ● Inquiry Lab - Collision Theory ● Interactivity - Reaction Rates and Activation Energy ● CER - The Concept of Activation Energy ● Analyzing Data - Interpret Energy Diagrams ● POGIL Guided Inquiry Activity - Equilibrium ● Inquiry Lab - Explore Chemical Equilibrium ● Virtual Lab - Equilibrium Shifting ● CER - Optimize a Reversible Reaction ● Engineering Design Challenge - Use Equilibrium for a Commercial Application ● Inquiry Lab - Supersaturation and Thermodynamics ● Analyzing Data - Interpret Thermodynamics Data ● Modeling - Graphical Models of Entropy Changes **Acid-Base Equilibria** ● POGIL Guided Inquiry Activity - Calculating pH ● Inquiry Lab - Measure pH with Indicators

	decrease the original changes. (HS-ESS2-2) **Weather and Climate** ● The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2) ● Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6) ● Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) **Human Impacts on Earth Systems** ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) **Global Climate Change**	● Analyzing Data - Compare pH of Everyday Solutions ● Modeling - Connect pH Changes to Particle-Level Changes ● Engineering Design Challenge - Design a Natural pH Indicator ● Inquiry Lab - Measure Acid Strength ● Interactivity - Exploring Acid Strength and Concentration ● POGIL Guided Inquiry Activity - Strong versus Weak Acids ● Modeling - Compare Equilibrium Positions of Weak Acids ● Analyzing Data - Interpret Ionization Constant Data ● Inquiry Lab - Titrations: The Study of Acid-Base Chemistry ● Spotlight on St. Elmo Brady [AMISTAD, DEI] ● Analyzing Data - Stoichiometric Analysis of Vinegar ● Modeling - Model an Acid-Base Titration ● Analyzing Data - Salt Hydrolysis ● Inquiry Lab - Analysis of Buffer Solutions and Ranges ● Virtual Lab - Explore Buffer Systems ● CER - Acid Rain Tolerance **Ocean Acidification** ● Inquiry Lab - The pH of Seawater ● Interactivity - Ocean pH ● CER - Ocean Acidity ● Analyzing Data - Pacific Ocean pH Changes ● Inquiry Lab - Carbon Dioxide Levels in Water ● Analyzing Data - Greenhouse Gas Emissions and Climate Change [CLIMATE CHANGE] ● Modeling - Carbon Flow in the Ocean ● Inquiry Lab - Ocean Currents ● Analyzing Data - The Changing Ocean and the Biosphere [CLIMATE CHANGE] ● CER - Hurricanes and the Carbon Cycle ● Analyzing Data - Correlating Flu Outbreaks and La Nina Weather Patterns [CLIMATE CHANGE] ● Inquiry lab - The Fate of Carbonate in Acidifying Oceans ● Virtual Lab - The Effect of Ocean Acidification on Shells [CLIMATE CHANGE] ● CER - Changing Climate and Ocean Ecosystems ● Engineering Design Challenge - Design a Model of Ocean Acidification

	● Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) **Delimiting Engineering Problems** ● Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-3) ● Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **Developing Possible Solutions** ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider	● Research Activity - Dissolved Gases and Climate Change: What is causing ocean acidification and how is it impacting the world? [CLIMATE CHANGE] **<u>Interdisciplinary Connections:</u>** ***Connections to NJSLS – English Language Arts*** ● **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-PS1-5)(HS-ESS2-2) (HS-ESS3-4) ● **RST.11-12.2** Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. (HS-ESS2-2) ● **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1)(HS-ETS1-3) ● **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-4)(HS-ETS1-1)(HS-ETS1-3) ● **RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1)(HS-ETS1-3) ● **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-5) ● **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. (HS-PS1-6) ***Connections to NJSLS – Mathematics***

	social, cultural, and environmental impacts. (HS-ETS1-3) ● Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	● **MP.2** Reason abstractly and quantitatively. (HS-PS1-5)(HS-PS1-7) (HS-ESS2-2)(HS-ESS2-6)(HS-ESS3-4)(HS-ESS3-6)(HS-ETS1-1) (HS-ETS1-3)(HS-ETS1-4) ● **MP.4** Model with mathematics.(HS-ETS1-3)(HS-ESS2-6)(HS-ESS3-6) (HS-ETS1-1) (HS-ETS1-2)(HS-ETS1-3)(HS-ETS1-4) ● **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-PS1-5)(HS-PS1-7)(HS-ESS2-2) (HS-ESS2-6)(HS-ESS3-4)(HS-ESS3-6) ● **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling (HS-PS1-7)(HS-ESS2-6)(HS-ESS3-4) (HS-ESS3-6) ● **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-5)(HS-PS1-7) (HS-ESS2-2)(HS-ESS2-6)(HS-ESS3-4))(HS-ESS3-6)
FOUNDATION **Science and Engineering Practices:** ***Core Idea***	**FOUNDATION** **Science and Engineering Practices:** ***Statement***	
● **SEP-1 Asking Questions and Defining Problems** ● **SEP-3 Analyzing and Interpreting Data** ● **SEP-4 Developing and Using Models**	**Asking Questions and Defining Problems** ● Analyze complex real-world problems by specifying criteria	

● **SEP-5 Constructing Explanations and Designing Solutions** ● **SEP-7 Using Mathematics and Computational Thinking**	and constraints for successful solutions. (HS-ETS1-1) **Analyzing and Interpreting Data** ● Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2) **Developing and Using Models** ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-6) **Constructing Explanations and Designing Solutions** ● Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) ● Design, refine, and evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)(HS-ESS3-4) (HS-ETS1-2)(HS-ETS1-3)	

	Using Mathematics and Computational Thinking ● Use mathematical representations of phenomena to support claims. (HS-PS1-7) ● Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6) ● Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)	
FOUNDATION **Crosscutting Concepts:** ***Core Idea***	**FOUNDATION** **Crosscutting Concepts:** ***Statement***	
● **CCC-1 Patterns** ● **CCC-4 Systems and System Models** ● **CCC-5 Energy and Matter** ● **CCC-7 Stability and Change**	**Patterns** ● Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-5) **Systems and System Models** ● When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)	

	● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS- ETS1-4) **Energy and Matter** ● The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) (HS-ESS2-6) **Stability and Change** ● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6) ● Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2) (HS-ESS3-4)	
Social and Emotional Learning: ***Competencies***	**Social and Emotional Learning:** ***Sub-Competencies***	
● **Self-Awareness** ● **Self-Management** ● **Social Awareness** ● **Responsible Decision-Making** ● **Relationship Skills**	● Recognize one's personal traits, strengths, and limitations ● Recognize the importance of self-confidence in handling daily tasks and challenges ● Recognize the skills needed to establish and achieve personal and educational goals ● Identify and apply ways to persevere or overcome barriers	

	through alternative methods to achieve one's goals ● Demonstrate an understanding of the need for mutual respect when viewpoints differ ● Demonstrate an awareness of the expectations for social interactions in a variety of settings ● Develop, implement, and model effective problem-solving and critical thinking skills ● Identify the consequences associated with one's actions in order to make constructive choices ● Evaluate personal, ethical, safety, and civic impact of decisions ● Utilize positive communication and social skills to interact effectively with others ● Identify who, when, where, or how to seek help for oneself or others when needed	
Assessments (Formative) ***To show evidence of meeting the standard/s, students will successfully engage within:***		**Assessments (Summative)** ***To show evidence of meeting the standard/s, students will successfully complete:***
<u>Formative Assessments:</u> ● Guided Inquiry Activities ● CER Tasks ● Virtual Labs ● Data Analysis Activities ● Group Discussions ● Lab Notebook ● Experience Notebook ● Engineering Design Challenges ● Lesson Checks		**<u>Benchmarks:</u>** ● Chemistry Diagnostic Assessment ● Chemistry District Assessments **<u>Summative Assessments:</u>** ● Unit Assessment - Reaction Rates and Equilibrium ● Unit Assessment - Acid-Base Equilibria ● Unit Assessment - Ocean Acidification ● Collaborative Group Project(s)

• Lesson Quizzes	

Differentiated Student Access to Content:
Teaching and Learning *Resources/Materials*

Core Resources	**Alternate Core Resources** ***IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core Resources**
• Experience Chemistry TE • Experience Chemistry SE • POGIL Activities for High School Chemistry • Argument Driven Inquiry in Chemistry: Lab Investigations for Grades 9-12 • Student Chromebooks • Evidence Notebooks	• Auditory Aids • Visual Aids • Science Glossary and Thesaurus • Picture Glossary • Manipulatives • Virtual Nerd	• Multilingual Science Glossary and Thesaurus • Picture Glossary • BrainPOP ELL • Khan Academy En Español	• Chemistry for the Gifted and Talented • Crash Course

Supplemental Resources

Technology:
- Schoology
- Google Apps for Education
- SMARTBoard
- Calculators

Other:
- Teacher created video tutorials
- American Association for the Advancement of Science
- American Chemical Society
- Concord Consortium: Virtual Simulations
- International Technology and Engineering Educators Association
- National Earth Science Teachers Association
- National Science Digital Library
- National Science Teachers Association
- North American Association for Environmental Education
- Phet: Interactive Simulations
- Science NetLinks

Differentiated Student Access to Content:
Recommended *Strategies & Techniques*

Core Resources	**Alternate Core Resources** ***IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core**
● Restructure lessons using UDL principles ● Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community ● Provide students with multiple choices for how they can represent their understandings ● Provide opportunities for students to connect with people of similar backgrounds ● Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures ● Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding ● Use project-based science learning to connect science with observable phenomena ● Structure learning around explaining or solving a social or community-based issue ● Collaborate with after-school programs or clubs to extend learning opportunities	● Utilize a multi-sensory (VAKT) approach during instruction ● Provide alternate presentations of skills by varying the method (repetition, simple explanations, additional examples, modeling, etc.) ● Modify test content and/or format ● Allow students to retake test or make corrections to test for additional credit ● Provide extended time ● Provide preferential seating as needed ● Review, restate and repeat directions ● Provide study guides, and/or break assignments into segments of shorter tasks ● Deliver instruction utilizing varied learning styles including audio, visual, and tactile/kinesthetic ● Provide individual instruction as needed ● Provide modified assessments and/or rubrics when needed	● Provide extended time ● Provide preferential seating as needed ● Provide positive reinforcement ● Check often for understanding of and/or review of course objectives ● Provide oral/visual directions/prompts when necessary ● Provide students with multiple literacy strategies ● Provide supplemental materials including use of an online bilingual dictionary ● Offer choices of what students can say when they are called on and aren't sure how to respond ● Integrate project-based learning to enhance hands-on activities, peer interaction, rich language use, and opportunities to explore personal interests ● Provide modified assessments and/or rubrics when needed ● Repeat instructions as needed ● Provide individual instruction as needed	● Create an enhanced set of introductory activities ● Implement a multi-level and multi-dimensional curriculum ● Create tiered assignments ● Integrate active teaching/learning opportunities ● Incorporate authentic components ● Propose interest-based extension activities ● Infuse enrichment activities ● Build in time for flexible learning groups ● Embrace creative questioning ● Explore many points of view about contemporary topics and allow opportunity to analyze and evaluate materia ● lEncourage self directed learning ● Connect students to related talent development opportunities

<table>
<tr><td rowspan="3">NJSLS CAREER READINESS, LIFE LITERACIES & KEY SKILLS</td><td colspan="2">Disciplinary Concept:</td></tr>
<tr><td>Core Ideas:</td><td>Creativity and Innovation
With a growth mindset, failure is an important part of success.
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.
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. 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.
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.
In order for members of our society to participate productively, information needs to be shared accurately and ethically.
Accurate information may help in making valuable and ethical choices.</td></tr>
<tr><td>Performance Expectation/s:</td><td>Creativity and Innovation
9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
Critical Thinking and Problem-solving
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.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).</td></tr>
</table>

Global and Cultural Awareness

- 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).

Information and Media Literacy

- 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.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.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).

Career Readiness, Life Literacies, & Key Skills Practices

- Act as a responsible and contributing community member and employee.
- Attend to financial well-being.
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Plan education and career paths aligned to personal goals.
- Use technology to enhance productivity, increase collaboration and communicate effectively.
- Work productively in teams while using cultural/global competence.

New Jersey Legislative Statutes and Administrative Code (place an "X" before each law/statute if/when present within the curriculum map)									
X	Amistad Law:		Holocaust Law:		LGBT and Disabilities	X	Diversity & Inclusion:	X	Standards in Action:

	N.J.S.A. 18A 52:16A-88		*N.J.S.A. 18A:35-28*		Law: *N.J.S.A. 18A:35-4.35*		*N.J.S.A. 18A:35-4.36a*		*Climate Change*