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Unit 4: How and Where Do We Get the Materials We Need?

45 Instructional Days

New Jersey Student Learning Standards Science

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.]

HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

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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.

Science and Engineering Practices

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)
- Refine 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)

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5)

Engaging in Argument from Evidence

- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

Asking Questions and Defining Problems

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Disciplinary Core Ideas

PS1.B 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)

ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)

ESS3.A: Natural Resources

- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

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-ETS1-1)
- 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)

Crosscutting Concepts

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)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Structure and Function

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)

Influence of Engineering, Technology, and Science on Society and the Natural World

- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2)

- Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2)
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1)

Science Addresses Questions About the Natural and Material World

- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2)
- Science knowledge indicates what can happen in natural systems— not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

Rationale and Transfer Goals :

This unit focuses on the main theme of obtaining materials needed. All forms of energy production have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. Because of the properties of water (capacity to store, absorb, release large amounts of energy and dissolve and transport materials) it plays an essential role in energy production and resource extraction. In this unit, students will also be able to examine the potential issues including cost, safety, reliability, and aesthetics, while also considering the social, cultural, and environmental impacts.

Enduring Understandings:

- As kinetic energy of colliding particles increases, the number of collisions increases and the reaction rate increases.
- Molecules that collide can break bonds and form new bonds, producing new molecules.
- Because breaking bonds requires energy, the probability of bonds breaking in a collision depends on the kinetic energy of the collision being enough to break the bond.
- Chemical equilibrium is a state in which the rate of the forward reaction equals the rate of the reverse reaction.
- According to Le Chatelier's principle, a system in equilibrium will shift in response to stress.
- The heat capacity of water, density of water in solid, liquid and gas states, and polar nature of the water molecule all contribute to the effect of water on Earth materials and surface processes.
- Energy production and resource extraction have several issues besides cost and safety including social, cultural, and environmental impacts.

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Essential Questions:

- What is the relationship between temperature and reaction rate?
- What happens when molecules collide?
- How is chemical equilibrium achieved?
- What is Le Chatelier's principle?
- What are the properties of water that make it essential for Earth and its surface processes?
- What are the potential benefits/risks of resource extraction?

Content/Objectives		Instructional Actions	
Content ***What students will know***	**Skills** ***What students will be able to do***	**Activities/Strategies** ***How we teach content and skills***	**Evidence (Assessments)** ***How we know students have learned***
• The rate of a reaction is the speed at which a reaction takes place. • As the kinetic energy of colliding particles increases, the number of collisions increases, and the reaction rate increases. • Chemical equilibrium is reached when the rate of the forward reaction equals that of the reverse reaction. • The relationship between chemical	• Explain the effect of temperature and concentration on reaction rate. • Define chemical equilibrium and describe/predict potential changes or responses to a component of a system according to LeChatelier's principle. • Explain that changing the concentration of one of the components of a system at equilibrium will	• Students will use a simulation to manipulate conditions and determine the effects of changing temperature or concentrations on reaction rate. [Link] • Students will complete a simulation activity titled "Predicting Shifts in Chemical Equilibrium." [Link] • Through scientific research, students will design and conduct an investigation as well as	• Students will take an assessment on chemical kinetics. • Students will take an assessment on chemical equilibrium and Le Chatelier's principle. • Students will present research findings and data for assessment. • Students will submit a research paper detailing the research of the global problem.

equilibrium, concentration and reaction rate. ● The connection between the properties of water and its effects on Earth materials as well as surface processes. ● How to analyze a global problem including challenges (cost, safety, etc) and describe qualitatively and quantitatively the extent of the problem and its consequences to society.	change the rate of the reaction until the system reaches a new equilibrium. ● Identify and explain unique properties of water including heat capacity, density in its three states, and the polar nature of the water molecule. ● The effects of the properties of water on energy transfer that cause the patterns of temperature, movement of air, and the movement and availability of water at the surface of the Earth. ● Conduct research on a major global challenge, identify the physical system and distinguish relationships in the system and boundaries to specify the conditions of the problem.	collect data of the properties of water and effect on Earth materials and surface processes. ● Students will research an actual global problem by reading current scientific journals. Through research students will describe societal needs and wants relative to the problem as well as constraints for acceptable solutions to the problem.	● Chemistry Unit 4 Benchmark

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Spiraling for Mastery		
Content or Skill for this Unit	**Spiral Focus from Previous Unit**	**Instructional Activity**
• The rate of a reaction is the speed at which a chemical reaction takes place, or the speed at which reactants are converted into products. • In a chemical reaction, chemical equilibrium is the state in which both reactants and products are present in concentrations which have no further tendency to change with time, so that there is no observable change in the properties of the system. • The unique physical and chemical properties of water make it essential to systems of the Earth.	• In a chemical reaction reactants are converted into products. • Chemical concentration is the amount of a substance per unit of volume of solution. • The abundance of liquid water on the Earth's surface is essential for the planet's dynamics.	• Students will investigate reactions and rates using the phET simulation on kinetics. [Link] • Students will complete a self guided POGIL activity introducing chemical equilibrium and reviewing chemical concentration. . • Students will view "The Chemistry of Water" and complete an accompanying literacy activity to solidify understanding of the importance of water to the systems of the Earth. [Link]
Key resources: Dynamic Periodic Table [Link] POGIL: Process Oriented Guided Inquiry Learning [Link] PhET Simulations [Link] American Association of Chemistry Teachers [Link]		
21st Century Life & Careers:		

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.

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.

Career Readiness, Life Literacies, & Key Skills:

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.

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.

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.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.

9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately.

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.

InterDisciplinary Connections/Companion Standards:
NJSLS-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-PS1-5)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-5), (HS-ESS2-5)

NJSLS-ELA

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-ESS3-2)

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), (HS-ESS2-5)

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-ESS3-2)

Companion Standards for ELA in Science and Technical Subjects: Reading

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.

RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

Companion Standards for ELA in Science and Technical Subjects: Writing

WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.11-12.5. 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.

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BOE Approved September 2020