Unit 4: How and where do we get the materials we need?

Content Area: **Science**
Course(s):
Time Period: **MP4**
Length: **45 days**
Status: **Published**

NJSLS - Science

9-12.HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
9-12.HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
9-12.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.
9-12.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.
9-12.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.

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 invasion 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, me), and refine the design accordingly. (HS-ESS2-5)

Engaging in Argument from Evidence

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

Asking Questions and Defining Problems

Analyze complex real-world problems by specifying criteria and constraints for successful soluons. (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)

Deliming Engineering Problems

Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk migration 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 paerns 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 their 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 technology decisions. (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 technology decisions. (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 soluons. (HS-ESS3-2)

Science knowledge indicates what can happen in natural systems— not what should happen. The law 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 the 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 the 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 shi in response to stress.
- The heat capacity of water, the density of water in solid, liquid, and gas states, and the polar nature of the water molecule all contribute to the effect of water on Earth's materials and surface processes.
- Energy production and resource extraction have several issues besides cost and safety including social, cultural, and environmental impacts.

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 - What will students know?

- 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 equilibrium, concentration, and reaction rate.
- The connection between the properties of water and its effects on Earth's 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.

Skills - What will students be able to do?

- 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 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 an energy transfer that cause the paerns of temperature, movement of air, and the movement and availability of water at the surface of the Earth.
- Research a major global challenge, identify the physical system, and distinguish relationships in the system and boundaries to specify the conditions of the problem.

Activities - How will we teach the content and skills?

- 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 similar acvity titled "Predicng Shis in Chemical Equilibrium." [Link]
- Through scientific research, students will design and conduct an invasion as well as collect data on the properties of water and its effect on Earth's materials and surface processes.
- Students will research an actual global problem by reading current scientific journals. Through research, students will describe societal needs and want relave to the problem as well as constraints for acceptable soluons to the problem

Evidence/Assessments - How will we know what students have learned?

- 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.
- Chemistry Unit 4 Benchmark

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 that have no further tendency to change with me 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 reasons and rates using the phET simulation on kinetics. [Link] • Students will complete a self-guided POGIL acvity introducing chemical equilibrium and reviewing chemical concentration. • Students will view "The Chemistry of Water" and complete an accompanying literacy acvity to solidify their 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]

Career Readiness, Life Literacies, & Key Skills

TECH.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).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.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).
TECH.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.
TECH.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).
TECH.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).
TECH.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).
TECH.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).

Interdisciplinary Connections/Companion Standards