Grade: 9-12

Unit 5: Industrial Applications

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
4	**Unit 5: Industrial Applications**	**22**

NJSLS - Science: *TItle*	NJSLS - Science: *Performance Expectations*	
• **HS-PS1: Matter and Its Interactions** • **HS-PS2: Motion and Stability** • **HS-LS1: From Molecules to Organisms: Structures and Processes** • **HS-ESS1: Earth's Place in the Universe** • **HS-ESS3: Earth and Human Activity** • **HS-ETS1:Engineering Design**	• **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-PS1-6 -** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. • **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. • **HS-ESS1-1 -** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. • **HS-ESS1-2 -** Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.	**Recommended Activities, Investigations, Interdisciplinary Connections, and/or Student Experiences to Explore NJSLS-S within Unit**

	• **HS-ESS1-3 -** Communicate scientific ideas about the way stars, over their life cycle, produce elements. • **HS-ESS1-6 -** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. • **HS-ESS3-2 -** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. • **HS-ESS3-3 -** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. • **HS-ESS3-4 -** Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems. • **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.A Structure and Properties of Matter** ● **HS-PS1.B Chemical Reactions** ● **HS-PS1.C Nuclear Processes** ● **HS-ESS1.A The Universe and Its Stars** ● **HS-ESS1.C The History of Planet Earth** ● **HS-ESS3.A Natural Resources** ● **HS-ESS3.C Human Impacts on Earth Systems** ● **HS-ETS1.B Developing Possible Solutions**	**Structure and Properties of Matter** ● Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1) ● The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1) **Chemical Reactions** ● In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines	**Essential Questions:** ● What changes in matter and energy occur during nuclear processes? ● How do nuclear technologies impact individuals and societies? ● What impact does the chemical industry have on Earth's systems? ● How can green chemistry lessen or eliminate the various impacts on Earth's systems? **Activity Description**: **Nuclear Processes** ● Inquiry Lab - Radioactive Decay ● Virtual Lab - Geologic Variation and Radon ● Modeling - What Happens When an Atom Decays? ● Analyzing Data - Geologic Age and Half-Life ● Modeling - Radioactive Half-Lives ● Inquiry Lab - Nuclear Energy ● Interactivity - Comparing Nuclear and Chemical Reactions ● CER - Energy from Nuclear Processes ● Spotlight on Mae Jemison [AMISTAD, DEI] ● Project Wasted - How is nuclear waste contained, stored, and disposed of? ● "Can Nuclear Power Help Save Us From Climate Change?" - Argument Driven Inquiry Project [CLIMATE CHANGE] ● Analyzing Data - The Composition of Stars ● Inquiry Lab - Nuclear Radiation and Shielding

	the numbers of all types of molecules present.(HS-PS1-6) **Nuclear Processes** ● Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8) **The Universe and Its Stars** ● The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1) ● Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2) (HS-ESS1-3) **The History of Planet Earth** ● Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar	● Analyzing Data - Radiation and Space Travel ● CER - Ionizing Radiation Hazards ● Group Research Project - Applications of Nuclear Radiation **Green Chemistry** ● Inquiry Lab - Toxicity of Road Deicers ● Analyzing Data - Getting the Lead Out ● CER - Discuss the Emergence of Green Chemistry ● Inquiry Lab - Green Chemistry Analysis of a Reaction ● Virtual Lab - Energy-Efficient Ammonia Production ● CER - Choices When Designing Chemical Processes ● Engineering Design Challenge - Uses and Production of Ash Water ● Inquiry Lab - How to Recycle Polylactic Acid Plastics ● Interactivity - Paper Mill Wastewater Treatment ● Modeling - Revise and Industrial Process ● Analyzing Data - Resource Management Scenarios and Outcomes ● Spotlight on Winifred Burks-Houck [AMISTAD, DEI] ● Engineering Design Challenge - Plastic from Biowaste **<u>Interdisciplinary Connections:</u>** ***Connections to NJSLS – English Language Arts*** ● **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) ● **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-PS2-6)(HS-LS1-6) (HS-ESS1-1)(HS-ESS1-2)(HS-ESS1-6) ● **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-PS1-2) ● **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video,

	system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6) **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) **Human Impacts on Earth Systems** ● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.(HS-ESS3-3) ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) **Developing Possible Solutions** ● When evaluating solutions, it is important to take into account a	multimedia) in order to address a question or solve a problem. (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-ESS1-6)(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-ETS1-3) ● **WHST.9-12.1** Write arguments focused on discipline-specific content. (HS-ESS1-6) ● **WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.(HS-PS2-6)(HS-LS1-6)(HS-ESS1-2)(HS-ESS1-3) ● **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)(HS-LS1-6) ● **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) ● **WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-6) ● **SL.11-12.4** Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. (HS-ESS1-3) ● **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-PS1-4) ***Connections to NJSLS – Mathematics***

	range of constraints, including cost, safety, reliability, and aesthetics, and to consider 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)	● **MP.2** Reason abstractly and quantitatively. (HS-PS1-7)(HS-ETS1-3) (HS-ESS1-1)(HS-ESS1-2)(HS-ESS1-3)(HS-ESS1-6) ● **MP.4** Model with mathematics. (HS-PS1-4)(HS-PS1-8)(HS-ESS1-1) (HS-ETS1-3) ● **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-PS1-4)(HS-PS1-7) (HS-PS1-8)(HS-PS2-6) (HS-ESS1-1)(HS-ESS1-2)(HS-ESS1-6) ● **HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling (HS-PS1-4)(HS-PS1-7)(HS-PS1-8) (HS-PS2-6) (HS-ESS1-1)(HS-ESS1-2)(HS-ESS1-6) ● **HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2)(HS-PS1-4) (HS-PS1-7)(HS-PS1-8)(HS-ESS1-1)(HS-ESS1-2)(HS-ESS1-6)
FOUNDATION **Science and Engineering Practices:** ***Core Idea***	**FOUNDATION** **Science and Engineering Practices:** ***Statement***	
● **SEP-1 Asking Questions and Defining Problems** ● **SEP-2 Planning and Carrying Out Investigations** ● **SEP-3 Analyzing and Interpreting Data** ● **SEP-4 Developing and Using Models** ● **SEP-5 Constructing Explanations and Designing Solutions**	**Developing and Using Mode** ● Develop and use a model to predict and, based on evidence, to illustrate the relationships between systems or between components of a system. (HS-PS1-1)(HS-PS1-8) (HS-ESS1-1) **Constructing Explanations and Designing Solutions**	

● **SEP-6 Engaging in Argument from Evidence** ● **SEP-7 Using Mathematics and Computational Thinking** ● **SEP-8 Obtaining, Evaluating, and Communicating Information**	● Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.(HS-ESS1-2) ● 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-ETS1-3) ● Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6) **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) **Using Mathematics and Computational Thinking** ● Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3) ● 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) **Obtaining, Evaluating, and Communicating Information** ● Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS1-3)	
FOUNDATION **Crosscutting Concepts:** ***Core Idea***	**FOUNDATION** **Crosscutting Concepts:** ***Statement***	
● **CCC-1 Patterns** ● **CCC-3 Scale, Proportion, and Quantity** ● **CCC-4 Systems and System Models**	**Patterns** ● Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for	

● **CCC-5 Energy and Matter** ● **CCC-7 Stability and Change**	causality in explanations of phenomena. (HS-PS1-1) **Scale, Proportion, and Quantity** ● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1) **Systems and System Models** ● 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** ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8)(HS-ESS1-3) ● Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2) **Stability and Change** ● Much of science deals with constructing explanations of how things change and how	

	they remain stable. (HS-PS1-6) (HS-ESS1-6) ● Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4) ● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3)	
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:***
Formative Assessments: • Guided Inquiry Activities • CER Tasks • Virtual Labs • Data Analysis Activities • Group Discussions • Lab Notebook • Experience Notebook • Engineering Design Challenges • Lesson Checks • Lesson Quizzes	**Benchmarks:** • Chemistry Diagnostic Assessment • Chemistry District Assessments **Summative Assessments:** • Unit Assessment - Nuclear Processes • Unit Assessment - Green Chemistry • Collaborative Group Project(s)

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	• Auditory Aids • Visual Aids • Science Glossary and Thesaurus • Picture Glossary	• Multilingual Science Glossary and Thesaurus • Picture Glossary • BrainPOP ELL • Khan Academy En Español	• Chemistry for the Gifted and Talented • Crash Course

Chemistry: Lab Investigations for Grades 9-12 ● Student Chromebooks ● Evidence Notebooks	● Manipulatives ● Virtual Nerd		

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	● Utilize a multi-sensory (VAKT) approach during instruction ● Provide alternate presentations of skills by varying the method (repetition, simple explanations, additional examples, modeling, etc.)	● 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	● Create an enhanced set of introductory activities ● Implement a multi-level and multi-dimensional curriculum ● Create tiered assignments ● Integrate active teaching/learning opportunities

• 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	• 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 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	• 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

NJSLS CAREER READINESS, LIFE LITERACIES & KEY SKILLS	**Disciplinary Concept:**	
	Core Ideas:	• With a growth mindset, failure is an important part of success. • Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed. • 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. ● 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.
	Performance Expectation/s:	● 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a). ● 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). ● 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). ● 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: *N.J.S.A. 18A 52:16A-88*		Holocaust Law: *N.J.S.A. 18A:35-28*		LGBT and Disabilities Law: *N.J.S.A. 18A:35-4.35*	X	Diversity & Inclusion: *N.J.S.A. 18A:35-4.36a*	X	Standards in Action: *Climate Change*