Lindenwold Public Schools

Unit 2: Why Do We Use Gasoline For Energy?

45 Instructional Days

New Jersey Student Learning Standards Science

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-PS1-7: 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-LS2-5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]

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HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

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). [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

Science and Engineering Practices

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4), (HS-LS2-5), (HS-ESS2-6)

Analyzing and Interpreting Data

- Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

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-PS1-3)

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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)

Obtaining, Evaluating, and Communicating Information

- Communicate scientific ideas (e.g. about phenomena and/or 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)

Disciplinary Core Ideas

PS1.A Structure and Properties of Matter

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3)
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

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-PS1-4)
- 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)

PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (secondary to HS-PS1-1), (secondary to HS-PS1-3)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)

PS3.D: Energy in Chemical Processes and Everyday Life

- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)

ESS2.D: Weather and Climate

- 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)

ESS3.D: Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)
- 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)

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-PS1-3)

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (HS-PS1-7), (HS-ESS2-6)
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4)

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7)

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1)

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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-LS2-5)
- 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)

Stability and Change

- 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), (HS-ESS3-5)

Scientific Investigations Use a Variety of Methods

- Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)
- New technologies advance scientific knowledge. (HS-ESS3-5)

Scientific Knowledge Based on Empirical Evidence

- Science knowledge is based on empirical evidence. (HS-ESS3-5)
- Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)

Rationale and Transfer Goals :

This unit focuses on developing an understanding of how the properties of an element determine the way its atoms will react with other atoms. Students will develop models, use mathematical representations and analyze data to explore the law of conservation of mass and the role of energy in chemical bonds and reactions. Students will apply this understanding to real world examples of chemical reactions including the role of photosynthesis and cellular respiration in atmospheric carbon cycling. Students will then move to understanding systems of the Earth and the impact of human activity on those systems.

Enduring Understandings:

- The Law of Conservation of Mass: In an isolated system mass is neither created or destroyed by chemical reactions or physical transformations. [Anchor]

- A chemical bond is the physical phenomenon of chemical substances being held together by attraction of atoms to each other through sharing, as well as exchanging of electrons or electrostatic forces. [Anchor]
- When a chemical reaction occurs, molecular bonds are broken and other bonds are formed to make different molecules. Energy is always required to break a bond.
- The abundance of liquid water of the Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics.
- Water contains an extensive network of hydrogen bonds resulting in a high heat capacity and a high heat of vaporization. [Anchor]
- All forms of energy production have associated economic, social, environmental, and geopolitical costs and risks as well as benefits.

Essential Questions:

- How do properties of an element determine the way its atoms will react with other atoms?
- What is the role of energy in a chemical bond?
- What is the role of energy in a chemical reaction?
- How does carbon cycle through the ocean, atmosphere, soil and biosphere?
- How are humans impacting the relationships among Earth systems?

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 Law of Conservation of Mass: In an isolated system mass is neither created nor destroyed by chemical reactions or physical transformations. • The strength of forces between particles (ions,	• Students will be able to state, explain and demonstrate the law of conservation of mass as well as understand the meaning of reactant and product.	• Calculate the mass of product formed in a chemical reaction given the mass of reactants and determine quantities of reactants and products of a chemical reaction in	• Students will complete a laboratory activity titled "Achieving a photosynthetic balance." [Link] This activity will introduce the chemical reaction that is photosynthesis as well as

atoms, molecules and networked materials) ● Develop a model to identify and describe the bonds formed and broken in a chemical reaction and the role of energy in a chemical reaction including the energy transfer between system and surroundings as well as the change of potential energy to kinetic energy. ● The cycling of carbon in the hydrosphere, atmosphere, geosphere and biosphere as well as the role of photosynthesis and cellular respiration in this process. ● The current science behind climate change and the human impact on the systems of the Earth and predictions for the future.	● Provide evidence that indicates that some intermolecular attractions are stronger than others and how properties of a substance (like melting point, boiling point, and volatility) can be used to make inferences about the strength of forces between particles. ● Describe the net change in energy within a system that results from broken bonds during a chemical reaction and calculate bond energies. ● Explain the exchange of carbon between organisms and the environment through photosynthesis and cellular respiration, as well as the cycling of carbon from one sphere to another. ● Analyze and interpret data showing the evidence of global	terms of atoms, moles and mass. [Link] ● Students will complete an activity titled "Interactions Between Particles." [Link] ● Students will create and interpret energy level diagrams as well as analyzing graphs of relative energies of reactants and products showing energy is conserved. ● Students will view a short documentary [Link] as well as complete a literacy activity on carbon cycling via photosynthesis and cellular respiration. [Link] ● Students will read an article from the American Chemical Society titled "Global Climate Change." [Link] Additionally students will analyze images and data from NASA. [Link]	student understanding of the law of conservation mass. ● Students will take an assessment on the role of energy in chemical bonds and in chemical reactions. ● Students will take an assessment on the role of photosynthesis and cellular respiration in carbon cycling as well as climate change and human impact on the Earth. ● Chemistry Unit 2 Benchmark

	climate change as well as the impact of human activity on the systems of the Earth and also make predictions based on data.		

Spiraling for Mastery		
Content or Skill for this Unit	**Spiral Focus from Previous Unit**	**Instructional Activity**
● In a chemical reaction mass and energy are conserved and energy is essential to understanding chemical bonds and chemical reactions. ● Photosynthesis and cellular respiration are an essential part of the cycling of carbon in the hydrosphere, atmosphere, geosphere and biosphere. ● Human activity has an impact on the systems of the Earth and climate change.	● Potential energy stored in molecules is converted to chemical energy and kinetic energy. ● Photosynthesis is a process used by plants and other organisms to convert light energy into chemical energy that can later be released to fuel the organisms' activities. Cellular respiration breaks down a product of photosynthesis (sugar) into ATP. ● Global warming is the rising average temperature of Earth's climate system.	● Students will complete a self guided POGIL activity on types of energy. ● Students will read an article reviewing the concepts of photosynthesis and cellular respiration. [Link] ● Students will complete the activity "Finding Chemistry Connections in Climate Change." [Link] Students will be able to
Key resources:		

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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-PS1-3), (HS-PS1-4), (HS-PS1-7), (HS-ESS2-6), (HS-ESS3-5), (HS-ESS3-6)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4), (HS-PS1-7), (HS-ESS2-6), (HS-ESS3-5), (HS-ESS3-6)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-3), (HS-PS1-4), (HS-PS1-7), (HS-ESS2-6), (HS-ESS3-5), (HS-ESS3-6)

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-PS1-3), (HS-ESS3-5)

RST.11-12.2 Determine the central ideas 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-ESS3-5)

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-ESS3-5)

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-PS1-3)

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)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)

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)

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.