Integrated Science Unit 4: The Energy of Everyday Chemistry

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

NJSLS - Science

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-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
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.
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.
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-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

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),
- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)
- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-7)

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)

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena to support claims. (HS-PS1-7)

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)

- 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-PS1-2)

- 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)

- 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-LS1-6)

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-PS2-6)

Disciplinary Core Ideas

PS1.A: 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), (HS-PS1-2)

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS- PS1-3)

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)

- 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-PS1-2), (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. (HS-PS2-6)

LS1.C: Organization for Matter and Energy Flow in Organisms

- The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS- LS1-6)

- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS- LS1-6), (HS-LS1-7)

- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

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-PS1-1), (HS-PS1-2), (HS-PS1-3), (HS-PS1-5)

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (HS-PS1-7)

- 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), (HS-LS1-6)

- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain

stable. (HS-PS1-6)

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)

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6)

Rationale and Transfer Goals

In an effort to explain how energy is involved in all of our daily lives, this unit focuses on how chemistry is involved in the everyday activities of life. As Chemistry is the next class in the usual progression of classes for students, this last unit for the year will serve as a stepping stone into chemistry, using much of the material learned throughout the year concerning energy and applying to chemical principles in everyday life. Students will learn about the materials that make up the world around them, as well as how energy is involved in the chemical reactions that take place both inside and outside of their bodies. The focus of this section will be how chemistry, and the study of energy's involvement in chemistry, is a very practical and useful area of science which can be seen in the real world.

Enduring Understandings

- All things that exist are made of matter, which in turn is made up of atoms. To understand how materials interact, you must understand how atoms interact.
- Atoms are composed of subatomic particles- protons and neutrons inside the nucleus, and electrons forming an outer shell outside of the nucleus.
- Electrons are responsible for the attractive or repulsive forces found among atoms.
- Mass, like energy, must be conserved in a reaction
- Atoms come together to make molecules and compounds, which in turn make up the world around us.

Essential Questions

- At what point would you have to stop cutting parts of a copper penny in half? (phenomenon)

- Why does my hand stop when I touch this desk? (Phenomenon)
- What are we made of and where did it all come from? (Phenomenon)
- Can I put any two elements together and why do chemical reactions even happen in the first place? (Phenomenon)
- When a campfire goes out, the logs are reduced to ash. Where did the solid log go? (Phenomenon)
- How does an apple make it possible for me to sprint around a track? (Phenomenon)

Content - What will students know?

- All things that exist are made of matter, which in turn is made up of atoms. To understand how materials interact, you must understand how atoms interact.
- During chemical reactions both mass and energy of the system is conserved.
- The matter that makes up our bodies has existed since the Big Bang.
- The conservation of energy allows for the flow of chemical energy found in food to the kinetic energy that we expend during physical activity.

Skills - What will students be able to do?

- Explain how atoms interact with each other in terms of ionic and covalent bonds and the formation of molecules.
- Explain how both mass and energy are transferred in a chemical reaction.
- Using the conservation of mass, students will show how the atoms in our bodies have been around since the beginning of time.
- Calculate the energy required for certain physical activities and then determine how many calories from what food are required to facilitate said activity. They will also be able to determine what molecules found in food provide the most energy per gram and why.

Activities - How will we teach the content and skills?

- Students will complete Brain Pop activity on chemical bonds.
- Students will work through a virtual activity using Phet on the law of conservation of mass.

- Using this literacy activity, students will read and answer questions related to where the atoms in our body came from.
- Students will conduct a lab in which they will research exercises and physical activities and the energy required for them. This will be followed by finding what foods will be required to ingest to provide the energy for this activity.

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

- **Assessments can be reviewed for each course in this folder.**
- Students will complete this quiz on Google forms.
- Students will create and answer questions on chemical reactions concerning the conservation of both mass and energy.
- Students will provide reasoning to explain where the atoms in our body came from.
- Based on the lab activity, students will provide an explanation of the flow of energy of an athlete preparing for a big race.
- Integrated Science Unit 4 Benchmark

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Most living creatures rely on the chemical energy provided in food to help them move around. • In chemical reactions, mass and energy are conserved. • The matter that makes up our bodies has existed since the Big Bang.	• Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. • It is possible to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. • Construct an explanation of the Big Bang theory based on astronomical evidence	• Students will conduct research on how different living creatures get and expend their energy. • Students will use the flow of energy in a combustion reaction to show how both mass and energy are conserved. • Students will provide an explanation of how mass and energy are conserved in the theory of the Big Bang

	of light spectra, motion of distant galaxies, and composition of matter in the universe.	

Key Resources

Glencoe Physical Science

Phet Simulations

Google Classroom

Brain Pop

21st Century Life and Careers

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.
9.2.12.CAP.5	Assess and modify a personal plan to support current interests and post-secondary plans.

Career Readiness, Life Literacies, & Key Skills

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.
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.
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.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).
9.4.12.TL.2	Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
9.4.12.TL.4	Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).

Interdisciplinary Connections/Companion Standards

Science Standard	Math Connection	ELA Connection	Science NJSLS 2020
Patterns in rates of change and other numerical relationships can provide information about natural and human-designed systems.	Recognize and represent proportional relationships between quantities.	Close Reading of Text: Read closely to determine what the text says explicitly and make logical inferences.	MS-PS1-1, MS-LS1-1
Graphs, charts, and images can be used to identify patterns in data.	Describe qualitatively the functional relationship between two quantities by analyzing a graph.	Diverse Media and Formats: Synthesize content presented in diverse media and formats, including visually and quantitatively, as well as in words.	MS-ESS1-4
Planning and Carrying out Investigations: Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually.	Make sense of problems and persevere in solving them.	Participate Effectively: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners.	SEP.3