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Food Science Unit 2: The Science of Food Preparation
18 instructional days

Targeted Standards

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-PS1-5. 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-PS1-7. 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-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]

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HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include the use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

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)

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)

Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-PS3-3)

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

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 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),(HS-PS1-5)

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. (HS-PS2-6)

PS3.A: Definitions of Energy
At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3)

ETS1.A: Defining and Delimiting an Engineering Problem
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. (secondary to HS-PS3-3)

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)

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)

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)

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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)

Rationale and Transfer Goals :

A study of food science requires knowledge of the basic nature of matter. You need a mental picture of how subatomic particles fit into the structure of atoms. Matter is made up of chemical elements, which are identified in the periodic table. This information will be the basis for understanding how atoms form ionic and covalent bonds to create molecules and compounds. Students will have the opportunity to research foods and demonstrate their matter classifications to the class. As the behavior of food compounds are observed, physical and chemical changes must also be observed. Students will observe these chemical and physical changes during lab activities that highlight the occurrences. Chemical equations will then be used to record what was objectively observed. An understanding of how energy relates to food can assist in the choosing of foods preparation methods, and cookware. Understanding heat and energy and how they flow allow a good cook to know when and how to control factors in food preparation such as temperature of reactants, the surface area of the food, and the thickness of the food. Students will be able to apply not only the knowledge gained from their research on thermodynamics and food, but also apply concepts of financial literacy in finding which method of heating food is the most efficient. All topics will include the overarching theme of a STEM classroom.

Enduring Understandings:
Physical changes change the physical properties of a substance, not the chemical formula.

Chemical changes create new substances with different chemical formulas from the original substances.

The bent polarized structure of water allows for the many different advantages of water.

Chemical reactions in food can be a result of preparation or even cause the food to go bad.

Chemical equations must always be balanced

Conversions of energy allow for food to be prepared.

The water content of food affects how the food will react during preparation and storage processes.

There are certain chemical and physical properties that distinguish an acid from a base.

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Essential Questions:
If the atoms of water do not change, how is water able to exist as a gas, liquid, and solid?

How can you tell if water is soft or hard?

How can water be purified?

Why do starches from different plant sources differ in their ability to gel?

Why does an apple turn brown when you take a bite out of it and then let it sit?

Why do microwave ovens differ in the time it takes to heat the same type of food?

Why should dish towels never be used to pick up hot pans from the oven?

How are pickles made?

How do ionic and covalent bonds differ?

How do you know that a chemical equation will always have the same number of atoms of each type on each side?

What kind of energy conversion is performed by a food processor and a waffle maker?

Explain how a microwave uses all three methods of heat transfer to cook your food.

How does placing an open box of baking soda in the fridge eliminate odors and what does this tell you about the chemical make up of those compounds?

Explain why the polar nature of water makes it a good solvent.

Content/Objectives		Instructional Actions	
Content	**Skills**	**Activities/Strategies**	**Evidence (Assessments)**

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What students will know	*What students will be able to do*	*How we teach content and skills*	*How we know students have learned*

• Basic atomic structure, commonly used elements on the periodic table.
• What differentiates an ionic bond versus a covalent bond.
• How to classify pure substances and mixtures.
• Balancing chemical reactions.
• Kinetic and potential energy.
• Forms of mechanical energy in terms of food production.
• Heat and heat transfer.
• Ionization energy.
• Acids and bases.
• VSEPR Diagrams of common molecules and how they affect behavior of a compound.
• Functions of water in the body and common contaminants.
	• Describe the basic structure of atoms.
	• Identify the symbols on the periodic table commonly used in food science.
	• Define ionic and covalent bonding.
	• Explain the difference between pure substances and mixtures.
	• Compare physical and chemical reactions in laboratory experiments.
	• Balance chemical equations to illustrate simple chemical reactions.
	• Identify sources of energy as potential or kinetic.
	• Differentiate among various forms of energy.
	• Explain the relationship between heat and temperature.
	• Summarize three basic ways heat is transferred.
	• List factors affecting the rate of reaction in food preparation.
		• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
		• Provide students with multiple choices for how they can represent their understanding.
		• 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
			• Labs:
			  ○ Physical qualities of food
			  ○ Chemical Changes
			  ○ The chemical detective
			  ○ Boiling Point of Various Mixtures
			  ○ Heat Transfer of potatoes
			  ○ Freezing Cream
			  ○ Molarity of sweetened tea
			  ○ Red Cabbage as an acid-Base Indicator
			  ○ pH and Chemical leavening in muffins
			  ○ Thermometer Calibration
			  ○ Water in Hot dogs
			  ○ Water Purity
			• Unit Tests
			• Quizzes
			• Food Science Benchmark #1

	• Describe the ionization of water. • Distinguish between the characteristics of acids and the characteristics of bases. • State how the pH scale is used to identify acids and bases. • Explain the role of pH in food preservation and baking applications. • Describe how the structure of a water molecule affects water's physical characteristics. • Demonstrate a function of water in food preparation. • Explain how the water content of a food affects how the food will react during preparation and storage processes. • Identify four functions of water in the body. • List common contaminants in water.	demonstrate their understanding. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around exploring or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities.	

Spiraling for Mastery

Where does this unit spiral back to other units from this or previous years in order to ensure that students retain mastery of what they've learned?

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Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Compare physical and chemical reactions in laboratory experiments. • Balance chemical equations to illustrate simple chemical reactions. • Describe the ionization of water. • Distinguish between the characteristics of acids and the characteristics of bases. • State how the pH scale is used to identify acids and bases.	• Provide an understanding of the chemical function and properties of major food components. • Provide an understanding of the chemical interactions of food components and their effects on sensory and nutritional quality, functional properties, and safety of foods. • Provide an understanding of the chemical basis of food preservation and the effects of processing and storage on food quality.	• Balancing Equations • What's the Matter? • Matching Matter • An energetic Meal • What's the Charge • Calculating Molarity • The Universal Solvent • Understanding Water

Key resources:

"Principles of Food Science 3rd Edition" Janet Ward

"Understanding food-Principles and preparation" Amy Brown

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.

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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.

9.4.12.IML.7: Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change.

Interdisciplinary Connections/Companion Standards
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-PS2-1), (HS-PS2-6)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-5), (HS-PS2-6)

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)

NJSLS Mathematics
MP.2 Reason abstractly and quantitatively. (HS-PS1-5), (HS-PS1-7)

MP.4 Model with mathematics. (HS-PS1-4)

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-PS1-4), (HS-PS1-5), (HS-PS1-7), (HS-PS2-6)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4), (HS-PS1-7), (HS-PS2-6)

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

Companion Standards for ELA in Science and Technical Subjects: Reading
Key Ideas and Details
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
Text Types and Purposes
WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

Research to Build and Present Knowledge

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WHST.11-12.7. 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 an understanding of the subject under investigation.