Hillside Township School District

Chemistry
Grade 10

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Hillside Township School District

Hillside Township School District

Table of Contents

Section		Page
District Mission Statement		2
Academic Overview		2
Affirmative Action Compliance Statement		2
Honors		3
Lesson Plan Template		4
Related NGSS Physical Science Standards		6
Units and Pacing Charts		
Unit 1:	Structure and Properties of Matter	15
Unit 2:	Periodic Table & Valence Electrons	18
Unit 3:	Chemical Bonds	21
Unit 4:	Chemical Reactions	24
Unit 5:	The Mole and Conservation of Matter	27
Unit 6:	Reaction Rate and Equilibrium	30
Unit 7:	Reaction Energy	33
Unit 8:	Nuclear Reactions	36
Modifications		39
NGSS Resources		39

Hillside Township School District

District Mission Statement

The mission of the Hillside Public Schools is to ensure that all students at all grade levels achieve the Next Generation Science Standards and make connections to real-world success. We are committed to strong parent-community school partnerships, providing a safe, engaging, and effective learning environment, and supporting a comprehensive system of academic and developmental support that meets the unique needs of each individual.

Academic Area Overview

The Hillside Township School District is committed to excellence. We believe that all children are entitled to an education that will equip them to become productive citizens of the twenty-first century. We believe that an education grounded in the fundamental principles of science will provide students with the skills and content necessary to become our future leaders.

A sound science education is grounded in the principles of inquiry and rigor. Children are actively engaged in learning as they model real-world scientific behaviors to construct knowledge. They have ample opportunities to manipulate materials in ways that are developmentally appropriate to their age. They work in an environment that encourages them to take risks, think critically, and make models, note patterns and anomalies in those patterns. Children are encouraged to ask questions, not just the "how" and the "what" of observed phenomena, but also the "why".

Our program provides teachers with cost-effective science materials that are aligned to state and national standards, incorporate instructional strategies that are research-based, and provides teachers with a deep understanding of science and the pedagogical underpinnings of science. Our teachers receive quality professional development through a partnership with nearby districts. Our K-8 kit based program encourages "hands-on science" and is endorsed by the National Science Foundation.

Equality and Equity in Curriculum

Hillside Township School District

The Hillside Township School District ensures that the district's curriculum and instruction are aligned to the Next Generation Science Standards and addresses the elimination of discrimination and the achievement gap, as identified by underperforming school-level AYP reports for State assessment, by providing equity in educational programs and by providing opportunities for students to interact positively with others regardless of race, creed, color, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, religion, disability or socioeconomic status. N.J.A.C. 6A:7-1.7(b): Section 504, Rehabilitation Act of 1973; N.J.S.A. 10:5; Title IX, Education Amendments of 197

Honors Curriculum

The content of an Honors course is organized to include more elaborate, complex, in-depth study of major ideas, problems and themes that integrate knowledge within a given academic subject. Emphasis is placed on higher-level thinking skills, creativity and excellence of performance. Students are selected for honors courses by state test data, previous course grades, and teacher recommendation. These students have been identified as being capable of above-average work. To maintain enrollment in Honor courses, students must maintain a marking period average of 'B' or above. In the event a marking period average falls under a 'B', a review process consisting of the student's counselor seeking input from the teacher regarding the placement of the student will take place. If removal from the Honor course is recommended, a parent conference with the student's counselor and teacher will be conducted.

All science department courses at Hillside High School prepares students with the knowledge and critical thinking skills necessary for study at the college level. The Honors Science courses are designed to support students seeking an additional challenge in their high school coursework, leading to the pursuit of STEM career paths. These honors courses stress the intellectual role of the student as they grapple with key concepts of science in increased depth. Emphasis will be on the analysis and application of data to make sense of major scientific concepts and principles. Students will learn by designing experiments, performing independent research, and working with models of systems at the nanoscopic, microscopic, and macroscopic levels.

To be successful in an Honors Science course, a student must be prepared to work both independently and cooperatively inside and outside of class. Students will also be required to apply more rigorous mathematical skills in Honors science, so it is recommended that students electing to take Honors Science courses have strong grades in their Math coursework. Students succeeding in Honors Science courses are prepared for success at the honors level the following year in the corresponding discipline.

- **In this document, the Honors Level components are indicated in bold purple text.**

Hillside Township School District

Science Department Lesson Plan Template

Lesson Information

Lesson Name: _____
Unit: _____
Date: _____

Lesson Data

1.	Essential Question:	
2.	NGSS:	
3.	Disciplinary Core Ideas :	*Students will know……*

4. Practices:

Students will be able to…..

5. Crosscutting Concepts:

Students will apply…

6. Assessment:

Evidence of student learning:

7. Lesson Agenda:

Include in Lesson Outline:

- *Anticipated timing*
- *DO NOW*
- *Activities and Investigations*
- *Discussion prompts*
- *Journal writing prompts*
- *Student uses of technology*
- *Safety precautions*
- *Materials*

8. Homework

NGSS Physical Science Standards

HS-PS1 Matter and Its Interactions

Students who demonstrate understanding can:

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.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [*Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.*]
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.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [*Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.*]
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 d ebonnergies 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-PS1-6	**Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*** [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [*Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.*]
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-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.** [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [*Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.*]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Hillside Township School District

Science and Engineering Practices

Developing and Using Models

Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4),(HS-PS1-8)
- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

Planning and Carrying Out Investigations

Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- 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

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

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

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)

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),*(secondary to HS-PS2-6)*
- 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),(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)

PS1.C: 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)

PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of

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

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8)
- 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)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

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Connections to Nature of Science

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)

· 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)	matter, as well as the contact forces between material objects.*(secondary to HS-PS1-1),(secondary to HS-PS1-3)* **ETS1.C: Optimizing the Design Solution** · Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary to HS-PS1-6)*	

Connections to other DCIs in this grade-band:

HS.PS3.A (HS-PS1-4), (HS-PS1-5), (HS-PS1-8); **HS.PS3.B** (HS-PS1-4),(HS-PS1-6),(HS-PS1-7),(HS-PS1-8); **HS.PS3.C** (HS-PS1-8); **HS.PS3.D** (HS-PS1-4),(HS-PS1-8); **HS.LS1.C** (HS-PS1-1), (HS-PS1-2), (HS-PS1-4), (HS-PS1-7); **HS.LS2.B** (HS-PS1-7); **HS.ESS1.A** (HS-PS1-8); **HS.ESS1.C** (HS-PS1-8); **HS.ESS2.C**(HS-PS1-2),(HS-PS1-3)

Articulation of DCIs across grade-bands:

MS.PS1.A (HS-PS1-1),(HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8);**MS.PS1.B** (HS-PS1-1), (HS-PS1-2), (HS-PS1-4), (HS-PS1-5), (HS-PS1-6), (HS-PS1-7), (HS-PS1-8); **MS.PS2.B** (HS-PS1-3),(HS-PS1-4),(HS-PS1-5); **MS.PS3.A** (HS-PS1-5); **MS.PS3.B** (HS-PS1-5); **MS.PS3.D** (HS-PS1-4); **MS.LS1.C** (HS-PS1-4),(HS-PS1-7); **MS.LS2.B** (HS-PS1-7); **MS.ESS2.A** (HS-PS1-7),(HS-PS1-8)

Common Core State

ELA/Literacy -

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-PS1-3),(HS-PS1-5)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2),*(HS-PS1-5)*
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)
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),*(HS-PS1-6)*

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)*
Mathematics -	
MP.2	Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4	Model with mathematics. *(HS-PS1-4),(HS-PS1-8)*
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-PS1-3),(HS-PS1-4),(HS-PS1-5)*,(HS-PS1-7),(HS-PS1-8)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4),*(HS-PS1-7)*,(HS-PS1-8)
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)*

HS-PS2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

Hillside Township School District

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.*]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- 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)

Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Theories and laws provide explanations in science. (HS-PS2-1),(HS-PS2-4)
- Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-1),(HS-PS2-4)

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. (secondary to HS-PS2-6)

PS2.B: Types of Interactions

- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)
- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4),(HS-PS2-5)
- 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),*(secondary to HS-PS1-1),(secondary to HS-PS1-3)*

Crosscutting Concepts

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)

Connections to other DCIs in this grade-level:
HS.PS3.A (HS-PS2-4),(HS-PS2-5); **HS.PS3.C** (HS-PS2-1); **HS.PS4.B** (HS-PS2-5); **HS.ESS1.A** (HS-PS2-1),(HS-PS2-2),(HS-PS2-4); **HS.ESS1.B** (HS-PS2-4); **HS.ESS1.C** (HS-PS2-1), (HS-PS2-2), (HS-PS2-4);**HS.ESS2.A** (HS-PS2-5);**HS.ESS2.C** (HS-PS2-1),(HS-PS2-4); **HS.ESS3.A** (HS-PS2-4),(HS-PS2-5)

Hillside Township School District

Articulation of DCIs across grade-bands:
MS.PS1.A (HS-PS2-6); **MS.PS2.A** (HS-PS2-1),(HS-PS2-2),(HS-PS2-3); **MS.PS2.B** (HS-PS2-4),(HS-PS2-5),(HS-PS2-6); **MS.PS3.C** (HS-PS2-1),(HS-PS2-2),(HS-PS2-3); **MS.ESS1.B** (HS-PS2-4),(HS-PS2-5)

Common Core State Standards Connections:

ELA/Literacy -

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-PS2-1),(HS-PS2-6)*
WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-PS2-6)*
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-PS2-1),(HS-PS2-2),(HS-PS2-4),*(HS-PS2-5),(HS-PS2-6)*
HSN.Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. *(HS-PS2-1),(HS-PS2-2),(HS-PS2-4),(HS-PS2-5),(HS-PS2-6)*
HSN.Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS2-1),(HS-PS2-2),(HS-PS2-4),*(HS-PS2-5),(HS-PS2-6)*

Hillside Township School District

HS-PS4 Waves and their Applications in Technology for Information Transfer

Students who demonstrate understanding can:

HS-PS4-1	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [*Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.*]
HS-PS4-4	**Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [*Assessment Boundary: Assessment is limited to qualitative descriptions.*]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Using Mathematics and Computational Thinking

Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-PS4-1)

Obtaining, Evaluating, and Communicating Information

Disciplinary Core Ideas

PS4.A: Wave Properties

- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1)

PS4.B: Electromagnetic Radiation

- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS4-1)
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-4))

- -

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4)

- -

Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-PS4-3)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). (HS-PS4-5)

Influence of Engineering, Technology, and Science on Society and the Natural World

- Modern civilization depends on major technological systems. (HS-PS4-2),(HS-PS4-5)
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS4-2)

Connections to other DCIs in this grade-band:
HS.PS1.C (HS-PS4-4); **HS.PS3.A** (HS-PS4-4),(HS-PS4-5); **HS.PS3.D** (HS-PS4-3),(HS-PS4-4); **HS.LS1.C** (HS-PS4-4); **HS.ESS1.A** (HS-PS4-3); **HS.ESS2.A** (HS-PS4-1);**HS.ESS2.D** (HS-PS4-3)

Articulation of DCIs across grade-bands:
MS.PS3.D (HS-PS4-4); **MS.PS4.A** (HS-PS4-1),(HS-PS4-2),(HS-PS4-5); **MS.PS4.B** (HS-PS4-1),(HS-PS4-2),(HS-PS4-3),(HS-PS4-4),(HS-PS4-5); **MS.PS4.C** (HS-PS4-2),(HS-PS4-5); **MS.LS1.C** (HS-PS4-4); **MS.ESS2.D** (HS-PS4-4)

Common Core State Standards Connections:

ELA/Literacy -	
RST.9-10.8	Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)
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-PS4-2),(HS-PS4-3),(HS-PS4-4)*

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-PS4-1)*,(HS-PS4-4)
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-PS4-2),(HS-PS4-3),(HS-PS4-4)
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-PS4-4)
Mathematics -	
MP.2	Reason abstractly and quantitatively. (HS-PS4-1),(HS-PS4-3)
MP.4	Model with mathematics. (HS-PS4-1)
HSA-SSE.A.1	Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1),*(HS-PS4-3)*
HSA-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. *(HS-PS4-1),(HS-PS4-3)*
HSA.CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-PS4-1),(HS-PS4-3)*

UNIT 1: Structure and Properties of Matter

	Student Learning Objectives	
1	**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-PS1-3**
2	**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.*]	**HS-PS2-6**

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS

Hillside Township School District

✓ Everything is made up of matter. ✓ The structure of matter is affected by the types of atoms present and the interactions both between and within them. ✓ Atomic structure and the arrangement of the Periodic Table are the foundation for understanding matter and its interactions.	✓ What is matter and how does it behave? ✓ How does the structure of Matter affect its properties? ✓ How does the structure of matter affect its interactions?

Student Learning Objective	**Disciplinary Core Ideas with Extended Knowledge** **Students will know:**	**Practices of Science & Engineering with Additional Skills** **Students will be able to:**	**Cross Cutting Concepts** **Students will apply:**

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-PS1-3** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. **HS-PS2-6**	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. **HS-PS1.A** An atom's nucleus is made of protons and neutrons and is surrounded by electrons. Electrostatic forces can be attractive or repulsive and exist between charged particles such as protons and electrons. Nuclear forces hold the particles in the nucleus together and keep positive protons from pushing one another away in the nucleus because the attractive nuclear force is stronger than the repulsive electrostatic forces. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. **HS-PS1.A** 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.B** Models (e.g., physical, mathematical, computer models) can be used to simulate why the molecular-level structure is important in the functioning of designed materials. **Chemistry Honors will include the following assessment boundaries:** • *molecular structures of specific designed materials* **HS-PS2-6**	**Planning and Carrying Out an Investigation** Describe the phenomenon under investigation, which includes the following idea: the relationship between the measurable properties (e.g., melting point, boiling point, vapor pressure, surface tension) of a substance and the strength of the electrical forces between the particles of the substance Describe how the data will be collected, the number of trials, and the experimental set up and equipment required. **HS-PS1-3** **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 oral, graphical, textual and mathematical). Use at least two different formats (including oral, graphical, textual and mathematical) to communicate scientific and technical information, including fully describing* the structure,properties, and design of the chosen material(s). Students cite the origin of the information as appropriate. **HS-PS2-6** **Technology Design** Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials. **8.2.12.C.7**	**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** **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**

Hillside Township School District

Course Pacing Chart

TIME FRAME	UNIT	PERFORMANCE TASKS ACTIVITIES/PROJECTS ASSESSMENTS	RESOURCES/INTERDISCIPLINARY CONNECTIONS
September-October ***18 periods***	**Matter**	Chem Talk: Intermolecular Forces in Liquids, Solids, and Gasses p365 Active Chemistry " Chem Talk" p546-548 Checking Up Questions p548 Active Chemistry Chem Talk (p50)Ions Small group collaboration and input on posters or small white boards Students are encouraged to make some of their own quiz questions. Intermolecular forces and function of different molecules such as water. **Assessments:**	Active Chemistry Textbook Animation of dissolving at the molecular level BrainPOP: Matter Changing States Kinetic Molecular Theory Interactive Phases of water animation PhET: States of matter simulation Ions and building the atom: https://phet.colorado.edu/en/simulation/legacy/build-an-atom PhET: Salts and Solubility Interactive SMART Notebook Lesson: Mixtures Virtual Lab SMART Notebook Lesson: What's the Matter? You Tube: Kinetic Theory Model

		Students will design a project that reflects their understanding of molecular geometry. Quizzes Chapter Test	You Tube: Molecules in Motion *Uncovering Student Ideas in Science (USIS)* Vol.1 –Is it Matter? p79 *USIS* Vol.3 – Is It a Solid? p25 *USIS* Vol.2 –What's in the Bubbles? p65

UNIT 2: Periodic Table & Valence Electrons

	Student Learning Objectives	
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.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] *[Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]*	**HS-PS1-1**
2	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [*Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.*]	**HS-PS4-1**

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
✓ Electrons interact between atoms, depending on number and location. ✓ The Periodic Table illustrates trends in atomic reactivity.	✓ What is matter and how does it behave? ✓ What makes one atom different from another?

Student Learning Objective	Disciplinary Core Ideas with extended knowledge Students will know:	Practices of Science & Engineering with additional skills Students will be able to:	Cross Cutting Concepts Students will apply:
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-PS1-1** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. **HS-PS4-1**	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. **HS-PS1.A** According to the octet rule, atoms are in the most stable and least reactive state when they have eight valence electrons. Electrons surround the nucleus at different energy levels. The first energy level closest to the nucleus can hold 2 electrons (then 8, 18, and 32 for subsequent energy levels). Electrons fill the lower energy levels first. The elements in the same group (column) on the periodic table have the same number of valence electrons. This gives them similar chemical properties that can be used to predict how they interact with other elements (reactivity). Bohr models and Lewis dot diagrams represent the valence electron configurations in a given atom.	**Analyzing and Interpreting Data** Analyze data using a model (Periodic table) in order to make a valid scientific claim. Use the periodic table to predict the patterns of behavior of the elements based on the attraction and repulsion between electrically charged particles and the patterns of outermost electrons that determine the typical reactivity of an atom. **HS-PS1-1** **Developing and Using Models** Use a model to predict the relationships between systems or between components of a system. Students show that the product of the frequency and the wavelength of a particular type of wave in a given medium	**Patterns** The pattern of the valence electrons in the periodic table can help predict the properties of the elements Atomic radius, reactivity, electronegativity, metals and nonmetals. **HS-PS1-1** **Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **HS-PS4-1**

	The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. **HS-PS4.A** **Chemistry Honors will include the following assessment boundaries:** • *transition group elements* **HS-PS1-1** • *quantitative understanding of ionization energy beyond relative trend* **HS-PS1-1** • *algebraic relationships and describing those relationships qualitatively and quantitatively* **HS-PS4-1**	is constant, and identify this relationship as the wave speed according to the mathematical relationship $v = f\lambda$. **HS-PS4-1** **Technology Operations and Concepts** Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue **8.1.12.A.3**	

TIME FRAME	UNIT 2	PERFORMANCE TASKS ACTIVITIES/PROJECTS ASSESSMENTS	RESOURCES/INTERDISCIPLINARY CONNECTIONS
October-November ***18 Periods***	**Periodic Table & Valence Electrons**	Active Chemistry:Fun with the Periodic Table Chem Talk p50 Interactive periodic table found in the Smartboard gallery Checking Up questions p54 Active Chemistry Chapter 1 activity 7 p58 Students will use Claim, Evidence, Reasoning to support their learning. Chapter 1, Activity 5: The Electronic Behavior of Atoms Small group and large group discussions Small group collaboration	Active Chemistry Textbook youtube videos on periodic table https://www.youtube.com/watch?v=Zg6KeXsDVwY Youtube video on the valence electrons https://www.youtube.com/watch?v=yADrWdNTWEc Interactive periodic table in the smartboard gallery. Neon Light and Discharge Lamp http://phet.colorado.edu/en/simulation/legacy/discharge-lamps PhET: Build an Atom SMART Notebook Lesson: Bohr Model and Lewis Dot Diagrams SMART Notebook Lesson: Bohr Model and Lewis Dot Practice

		Chapter 1, Activity 5: The Electronic Behavior of Atoms Selected questions from checking up questions p41 Selected Chem to Go questions p43 Calculate Energy, calculate frequency, calculate wavelength. **Assessments:** Quizzes Unit test	Electromagnetic radiation on youtube video https://www.youtube.com/watch?v=cfXzwh3KadE http://group.chem.iastate.edu/Greenbowe/sections/projectfolder/flashfiles/reaction/bonding1.swf

UNIT 3: Chemical Bonds

	Student Learning Objectives	
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.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] *[Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]*	**HS-PS1-1**
2	**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-PS1-3**

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS

Hillside Township School District

✓ Everything is made up of matter. ✓ The structure of matter is affected by the types of atoms present and the interactions both between and within them. ✓ Atomic structure and the arrangement of the Periodic Table are the foundation for understanding matter and its interactions.	✓ What is matter and how does it behave? ✓ How does the structure of Matter affect its properties?

Student Learning Objective	**Disciplinary Core Ideas with extended knowledge** **Students will know:**	**Practices of Science & Engineering with additional skills** **Students will be able to:**	**Cross Cutting Concepts** **Students will apply:**
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-PS1-1** 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-PS1-3**	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.A** The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. By knowing how many electrons are being transferred to create ions and form an ionic bond, you can predict the chemical formula of the resulting binary compound. The name of this compound is two words. The first word is the name of the metal. The second word is the name of the nonmetal with the ending changed to "-ide". Atoms can interact with one another by sharing electrons to create a bond. By sharing these electrons, both atoms are able to have a full and stable octet	**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. Describe why the data about bulk properties would provide information about strength of the electrical forces between the particles of the chosen substances, including: spacing of the particles of the chosen substances can change as a result of the experimental procedure even if the identity of the particles does not change (e.g., when water is boiled the molecules are still present but further apart). **HS-PS1-3**	**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** and **HS-PS1-3**

	configuration. This is a covalent bond, which is stronger than an ionic bond. Covalent bonding occurs between two non-metals. Structural diagrams represent where covalent bonds exist between the elements in a molecule. **Chemistry Honors will include the following assessment boundaries:** • *transition group elements* **HS-PS1-1** • *quantitative understanding of ionization energy beyond relative trends* **HS-PS1-1**	**Developing and Using Models** Use a model to predict the relationships between systems or between components of a system. Predict the following patterns of properties: (1) the number and types of bonds formed (i.e. ionic, covalent, metallic) by an element and between elements; and (2) the number and charges in stable ions that form from atoms in a group of the periodic table. **HS-PS1-1**	

TIME FRAME	UNIT 3	PERFORMANCE TASKS ACTIVITIES/PROJECTS ASSESSMENTS	RESOURCES/INTERDISCIPLINARY CONNECTIONS
November-December ***18 periods***	**Chemical Bonds**	Chapter 6 Activity 3 (Chem Talk) Selected problems from the Checking Up section Selected problems from the Chem to Go section p455 1. Students will plan an investigation to select Aluminum versus Magnesium pan for baking using an acid 2. Compare the ionization energy for different atoms and relate it to the activity of the chosen metal using collected data from various resources.	Active Chemistry Textbook Youtube video on reactivity of metals https://www.youtube.com/watch?v=2MawIDT5DFU Lab Equipment and Materials Reactions of metals and metal ions simulation http://group.chem.iastate.edu/Greenbowe/sections/projectfolder/flashfiles/redox/home.html

		3. Students will plan an investigation to compare trends in the periodic table using different metals and acid 4. Students will submit lab report via Google Classroom **Assessments:** Students will use posters to demonstrate understanding of the relation between the ionization energy and element's reactivity. Quizzes Lab Report Exit Questions Unit test	Ionization energy https://www.youtube.com/watch?v=vx2RYpzCdhE

UNIT 4: Chemical Reactions

1	**Student Learning Objectives** **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.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] *[Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]*	**HS-PS1-2**

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS

✓ Atoms interact to form molecules. ✓ Atoms and their mass are conserved during chemical reactions. ✓ Many substances react chemically with other substances to form new substances with different properties.	✓ How do substances combine or change (react) to make new substances? ✓ How does one characterize and explain reactions and make predictions about them?

Student Learning Objective	**Disciplinary Core Ideas with extended knowledge** **Students will know:**	**Practices of Science & Engineering with additional skills** **Students will be able to:**	**Cross Cutting Concepts** **Students will apply:**

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-PS1-2**	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.B** In the case of ionic compounds, a highly reactive element will replace a less reactive element in a compound. The reactive metal (element A) gives electrons to the nonmetal (element C) in a binary compound (BC) and replaces the less reactive metal (element B), which then becomes separate. This is called a single replacement reaction. It can be represented by the generic formula: A + BC → AC + B In a double-replacement reaction, the cations in two compounds are switched with one another. Ionic compounds can disassociate into ions in solution and can bond to form a different type of compound (water, a gas, or a solid precipitate) that cannot split back apart into ions. Synthesis reactions build larger molecules from smaller molecules and store chemical potential energy in covalent bonds between atoms in the larger molecules. Energy must be put in for a synthesis reaction to take place. Decomposition reactions break down large molecules into smaller ones. In a chemical reaction, the same number and type of atoms that go into the reaction (reactants) have to come out of the reaction (products). Atoms do not disappear or appear during a chemical reaction. (Conservation of Matter) **Chemistry Honors will include the following assessment boundary:**	**Constructing Explanations and Designing Solutions** Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, and 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. Identify and describe the evidence to construct the explanation, including: identification of the products and reactants, including their chemical formulas and the arrangement of their outermost (valence) electrons **HS-PS1-2** **Abilities for a Technological World** Explain how material processing impacts the quality of engineered and fabricated products. **8.2.12.D.5**	**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-PS1-2**

	• *chemical reactions involving transition group elements* **HS-PS1-2**		

TIME FRAME	UNIT 4	PERFORMANCE TASKS ACTIVITIES/PROJECTS ASSESSMENTS	RESOURCES/INTERDISCIPLINARY CONNECTIONS
December-January ***17 periods***	**Chemical Reactions**	Chapter 3 Activity 3 Checking Up questions p198 Selected Chem to Go questions p200 Handling chemicals, lab equipment, and following safety rules Chem Talk p393-396 "Types of Chemical Reactions" Chapter 6 Activity 6 p477 Checking UP questions p481 Selected Chem to Go questions p483 **Assessments:** Quizzes Unit test Lab Report submitted on google classroom	Active Chemistry Textbook Reaction of Metals Simulation: http://group.chem.iastate.edu/Greenbowe/sections/projectfolder/flashfiles/redox/home.html SMART Notebook Lesson: Matter and Photosynthesis http://express.smarttech.com/?url=http://exchangedownloads.smarttech.com/public/content/15/1500bf3c-ddb4-408c-b5d1-d1de08366d4b/photosynthesis.notebook Flame Test Lab https://www.youtube.com/watch?v=1EXr_L7Ojqg Reaction Rate Lab: The Iodine Clock (with safety rules) https://www.youtube.com/watch?v=KWJpKNQfXWo

Hillside Township School District

UNIT 5: The Mole and Conservation of Matter

	Student Learning Objectives	
1	**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-PS1-7**

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
✓ Atoms and their mass are conserved during chemical reactions. ✓ The mole concept simplifies calculations involving very large numbers of atoms.	✓ Are the types and mass of atoms conserved in a chemical reaction? ✓ What is the mole concept used for?

Hillside Township School District

Student Learning Objective	Disciplinary Core Ideas with extended knowledge Students will know:	Practices of Science & Engineering with additional skills Students will be able to:	Cross Cutting Concepts Students will apply:
Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. **HS-PS1-7**	The fact that atoms are conserved, together with the knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. **PS1.** Atoms and their mass are conserved during a chemical reaction. (Conservation of Matter) One mole of a substance consists of 6.02×10^{23} particles. One mole of an element has the same mass in grams as one atom of that element has in AMUs. This can be used to calculate how many particles are present in a known mass, or the mass of a known number. **Chemistry Honors will include the following assessment boundary:** ● *single replacement, double replacement, synthesis, and decomposition chemical reactions* **HS-PS1-7**	**Using Mathematics and Computational Thinking**. Use mathematical representations of phenomena to support claims. Identify and describe the relevant components in the mathematical representations: (1) quantities of reactants and products of a chemical reaction in terms of atoms, moles, and mass; (2) molar mass of all components of the reaction;(3) use of balanced chemical equation(s); and (4) identification of the claim that atoms, and therefore mass, are conserved during a chemical reaction. Use the mole to convert between the atomic and macroscopic scale in the analysis. Given a chemical reaction, use the mathematical representations to predict the relative number of atoms in the reactants versus the products at the atomic molecular scale; and calculate the mass of any component of a reaction, given any other component. **HS-PS1-7** **Technology Operations and Concepts** Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. **HS-PS1-7** Scale, Proportions, and and Quantity. Change the mass of reactants result in a change of the mass of products.

		mathematical or logical functions, charts and data from all worksheets to convey the results. **8.1.12.A.4**	

TIME FRAME	UNIT 5	PERFORMANCE TASKS ACTIVITIES/PROJECTS ASSESSMENTS	RESOURCES/INTERDISCIPLINARY CONNECTIONS
January-February ***12 periods in January*** **Mid Term Exam** ***14 periods in February***	**The Mole and Conservation of Matter**	Chapter 4, Activity 2: Balancing Chemical Equations p265 Chem Talk: Law of Conservation of Matter Chapter 1, Activity 3: Atoms and Their Masses p15 Chem Talk: Atomic Mass Chapter 4 Activity 3: How Much Gas is Produced? p274 Chem Talk: Stoichiometry ChemTalk The Chemistry Way of Counting – Moles p215-217 Balancing level 3 chemical equations on Phet simulations. Balance combustion reactions. Name the type of chemical reaction and balance it. **Assessments:** Quizzes Quia (exit quiz) https://www.quia.com/quiz/3373113.html small poster that reflects at least 10 household products and their chemical formula.	Active Chemistry Textbook BrainPOP: Chemical Equations BrainPOP: Moles Chembalancer Game Molar Mass interactive PhET: Balancing Chemical Equations interactive PhET: Reactants, Products, and Leftovers simulation SMART Notebook Lesson: Balancing Chemical Equations SMART Notebook Lesson: Balancing Chemical Equations SMART Notebook Lesson: Balancing Equations with Molecules SMART Notebook Lesson: Solutions review with molarity PhET: Balancing Chemical Equations interactive level 3

		Unit test	

UNIT 6: Reaction Rate and Equilibrium

	Student Learning Objectives	
1	**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-PS1-5**
2	**Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.** [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] *[Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]*	**HS-PS1-6**

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
✓ External conditions affect the rate of a chemical reaction. ✓ If the forward and reverse reaction rates are equal, this is chemical equilibrium.	✓ How do you change the rate of a reaction? ✓ When does equilibrium occur in a chemical reaction?

Student Learning Objective	Disciplinary Core Ideas with extended knowledge Students will know:	Practices of Science & Engineering with additional skills Students will be able to:	Cross Cutting Concepts Students will apply:

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-PS1-5** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. **HS-PS1-6**	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. **PS1.B** 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. **PS1.B** Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. Chemical reactions occur at different rates. Factors such as temperature, mixing, concentration, particle size, and surface area affect the rates of chemical reactions. 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. **Chemistry Honors will include the following assessment boundaries:** • *complex reactions in which there are more than two reactants* **HS-PS1-5** • *quantitative relationships between rate and temperature* **HS-PS1-5** • *specifying the change in more than one variable at a time* **HS-PS1-6** • *calculating equilibrium constants and concentrations* **HS-PS1-6**	**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. Construct an explanation that includes the idea that as the kinetic energy of colliding particles increases and the number of collisions increases, the reaction rate increases. **HS-PS1-5** **Constructing Explanations and Designing Solutions** Refine a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. Identify and describe potential changes in a component of the given chemical reaction system that will increase the amounts of particular species at equilibrium. Use evidence to describe the relative quantities of a product before and after changes to a given chemical reaction system (e.g., concentration increases, decreases, or stays the same), and will explicitly use Le Chatelier's principle **HS-PS1-6** **Technology and Society** Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review. **8.2.12.B.1**	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. **HS-PS1-6**

Hillside Township School District

TIME FRAME	UNIT 6	PERFORMANCE TASKS ACTIVITIES/PROJECTS ASSESSMENTS	RESOURCES/INTERDISCIPLINARY CONNECTIONS
March-April *20 periods*	**Reaction Rate and Equilibrium**	Chapter 11 Activity 4 Chem Talk p884-887 Selected Checking Up questions and Chem to Go questions p886-889 **Assessments:** Design and carry out an investigation to study the effect of temperature on equilibrium. Quizzes Unit test	Active Chemistry Book Dynamic Equilibrium youtube video: https://www.youtube.com/watch?v=JsoawKguU6A&feature=youtu.be&t=5s Effect of temerature on Equilibrium youtube video https://www.youtube.com/watch?v=0XQVXFL4uoo&feature=youtu.be&t=15s Blue Bottle experiment as a demo for equilibrium. https://www.youtube.com/watch?v=kGSPAkOgN3U Effect of Pressure and Temperature http://www.freezeray.com/flashFiles/ammoniaConditions.htm Reactant concentration over time http://employees.oneonta.edu/viningwj/sims/equilibrium_state_s.html Disturbing a Chemcial Equilibrium http://employees.oneonta.edu/viningwj/sims/disturbing_a_chemical_equilibrium_s.html Le Chatelier's principal Crash Course Chemistry #28 youtube video https://www.youtube.com/watch?v=g5wNg_dKsYY Equilibrium Constant (K_{eq}) http://employees.oneonta.edu/viningwj/sims/equilibrium_constant_s.html

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Unit 7: Reaction Energy

	Student Learning Objectives	
1	**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-PS1-4**

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
✓ Atoms interact to form molecules as a result of a chemical reaction. ✓ Energy and entropy drive chemical reactions. ✓ External conditions affect the rate of a chemical reaction.	✓ What is matter and how does it behave? ✓ Where does energy go?

Student Learning Objective	Disciplinary Core Ideas with extended knowledge Students will know:	Practices of Science & Engineering with additional skills Students will be able to:	Cross Cutting Concepts Students will apply:

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. **HS-PS1-4**	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.B** The driving forces of chemical reactions are energy and entropy. Energy is the ability to do work. Entropy is a measure of disorder and randomness. Energy is conserved. It may change locations or forms, but does not leave our finite universe. (Law of Conservation of Energy, First Law of Thermodynamics) Every time energy changes forms, some of it doesn't go into useful energy but is instead given off as heat, light, sound, etc. As useful energy decreases, the amount of disorder and randomness (entropy) increases. (Second Law of Thermodynamics) Chemical reactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic). The change in heat energy is called enthalpy. Enthalpy (ΔH) is negative in an exothermic reaction and positive in an endothermic reaction. All chemical reactions require activation energy to begin. A catalyst lowers the activation energy necessary for a reaction. **Chemistry Honors will include the following assessment boundary:** ● *calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products* **HS-PS1-4**	**Developing and Using Models** Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Use the developed model to illustrate: (1) the energy change within the system is accounted for by the change in the bond energies of the reactants and products; (2)breaking bonds requires an input of energy from the system or surroundings, and forming bonds releases energy to the system and the surroundings; (3) the energy transfer between systems and surroundings is the difference in energy between the bond energies of the reactants and the products; (4) the overall energy of the system and surroundings is unchanged (conserved) during the reaction; (4) energy transfer occurs during molecular collisions; and (5) the relative total potential energies of the reactants and products can be accounted for by the changes in bond energy. **HS-PS1-4**	**Energy and Matter** 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**

Hillside Township School District

TIME FRAME	UNIT 7	PERFORMANCE TASKS ACTIVITIES/PROJECTS ASSESSMENTS	RESOURCES/INTERDISCIPLINARY CONNECTIONS
April-May ***22 periods***	**Reaction Energy**	Chapter 4, Activity 1: Alternative Pathways p255 Chem Talk: Energy and Entropy Changes in Chemical Reactions Chapter 4, Activity 7: Reactions that Produce Heat p318 Chem Talk: Thermodynamics Chapter 6, Activity 5: Chemical Energy p468 Chem Talk: Endothermic and Exothermic Processes Chapter 6, Activity 6 Reaction Rate Lab p477 Chem Talk: Factors Affecting the Rate of a Reaction **Assessments:** Quizzes Unit test	Active Chemistry Textbook Catalysts Graph Animation PhET: Reactions and rates simulation PhET: Reversible reactions simulation Reaction Rate and Concentration Animation Reaction Rate and Temperature Interactive SMART Notebook Lesson: Catalysts SMART Notebook Lesson: Effect of Pressure on Rate of Reaction SMART Notebook Lessons: Combustion YouTube: Entropy Video Bond Energy and ΔH_{rxn} http://employees.oneonta.edu/viningwj/sims/bond_energy_dh_reaction_s.html Hess's Law http://employees.oneonta.edu/viningwj/sims/hess_law_s.html

Hillside Township School District

UNIT 8: Nuclear Reactions

	Student Learning Objectives	
1	**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.** [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] *[Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]*	**HS-PS1-8**
2	**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 in the form of radiation.** [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [*Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.]*	**HS-ESS1-1**
3	**Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] *[Assessment Boundary: Assessment is limited to qualitative descriptions.]*	**HS-PS4-4**

ENDURING UNDERSTANDINGS	ESSENTIAL QUESTIONS
✓ Energy is exchanged or transformed in all chemical reactions and physical changes of matter.	✓ How does conservation play a role in chemical reactions?

Student Learning Objective	Disciplinary Core Ideas with extended knowledge Students will know:	Practices of Science & Engineering with additional skills Students will be able to:	Cross Cutting Concepts Students will apply:
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-PS1-8** 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 in the form of radiation. **HS-ESS1-1** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of	Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve changes in nuclear binding energies. The total number of neutrons plus protons does not change in any nuclear process. **HS-PS1.C** When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. **HS-PS4-4** Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). Atoms of an element whose nuclei have different numbers of neutrons are called isotopes. The atomic mass given on the periodic table for an element is an average of all the isotopes of that element relative to their abundance on earth. **Chemistry Honors will include the following assessment boundaries:**	**Obtaining, Evaluating, and Communicating Information** Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. Students obtain at least two claims proposed in published material (using at least two sources per claim) regarding the effect of electromagnetic radiation that is absorbed by matter. One of these claims deals with the effect of electromagnetic radiation on living tissue. **HS-PS4-4** **Developing and Using Models** Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Students develop five distinct models to illustrate the relationships between components underlying the nuclear processes of 1) fission, 2) fusion and 3) three distinct types of radioactive decay. **HS-PS1-8** Students use the model to explicitly identify that chemical processes are unable to produce the amount of energy flowing out of the sun over long periods of time, thus requiring fusion	**Energy and Matter** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. **HS-PS1-8** **Cause and Effect** Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. **HS-PS4-4** **Scale, Proportion, and Quantity**

electromagnetic radiation have when absorbed by matter. **HS-PS4-4**	• *quantitative calculation of energy released.* **HS-PS1-8** • *details of the atomic and sub-atomic processes involved with the sun's nuclear fusion* **HS-ESS1-1** • *quantitative descriptions* **HS-PS4-4**	processes as the mechanism for energy release in the sun. **HS-ESS1-1** **Design** Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). 8.2.12.C.3	The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. **HS-ES1-1**

TIME FRAME	UNIT 8	PERFORMANCE TASKS ACTIVITIES/PROJECTS ASSESSMENTS	RESOURCES/INTERDISCIPLINARY CONNECTIONS
May-June *12 periods* **Final Exam**	**Nuclear Reactions**	Chapter 1 Activity 9: What determines and limits an atom's mass? p77 ChemTalk Unstable Atoms Debate on the use of nuclear energy Quizzes using google docs on google classroom. Equation on the nuclear reaction in the sun Balancing nuclear reactions Calculation of E=mc2 **Assessments:** Quizzes Unit test	Active Chemistry Textbook BrainPOP: Isotopes BrainPOP: Radioactivity Isotope calculator PhET: Alpha decay simulation PhET: Beta decay simulation PhET: Nuclear fission simulation PhET: Radioactive dating game Radioactive decay animation Radioactive decay interactive Radioactive Decay graph

			http://employees.oneonta.edu/viningwj/sims/radioactive_decay_s.html

Modifications

Note: Teachers identify the modifications they will use in each unit.
• Restructure lessons using Universal Design for Learning (UDL) principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA) • 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 understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide English Language Learners students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities.

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NGSS Resources

https://ngsschemistry.wordpress.com/

http://ngss.nsta.org/

http://concord.org/ngss/

http://www.bozemanscience.com/ngss/

Appendix F Science & Engineering Practices

Appendix G Crosscutting Concepts