# Biology, Chemistry, Physics and Environmental Science Curriculum

Middle Township Public Schools
216 S. Main Street
Cape May Court House, NJ 08210

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**Acknowledgements**

| | |
|---|---|
| Dr. David Salvo | Superintendent |
| Dr. Toni Lehman | Director of Curriculum and Instruction |
| George West | Principal, Middle Township High School |

**High School Science Curriculum Work Committee**

Angela Quintana

## Introduction

This document serves to meet all requirements for curriculum as per the Middle Township Board of Education and the New Jersey Department of Education and will serve as a guide for lesson planning. Units within the curricular framework for science are designed to be taught in the order in which they are presented. Within the units, the teachers have flexibility of what order to present the standards. Suggested Science and Engineering Practice Standards and Cross-Cutting Concepts are listed in each unit to be embedded regularly in daily science instruction.

## Course Description

Biology is focused on the use of life science principles as powerful tools to make sense of the complexity, diversity, and interconnectedness of life on earth. Students engage in laboratory and authentic learning experiences that encourage the application of biological knowledge to make decisions and solve problems. Biology fulfills the New Jersey science requirements for high school graduation. Application of the Next Generation Science Standards results in a balance of the three dimensions of the standards along with a focus on the interdisciplinary nature of all science domains among one another as well as with the New Jersey Student Learning Standards for Mathematics and English Language Arts.

Scientific study involves asking questions, defining problems, investigating, analyzing and interpreting data, constructing explanations, and communicating information from gathered evidence. Biological studies will engage students in understanding their connection to the diversity of living organisms, the interaction with living and non-living environments, and the complexity of life in order to make scientifically informed decisions related to their own health and the health of planet Earth. As a fundamental science in the high school curriculum, biology students will engage in an interdisciplinary approach utilizing reading, writing, mathematical processes, and engineering solutions to solve real-world problems. The study of biology exposes students to additional college and career opportunities in science, technology, engineering and math (STEM) fields. Scientific and life skills will be nurtured and promoted to yield informed and productive 21st century citizens.

## Three Dimensions of the Next Generation Science Standards

The National Research Council's (NRC) *Framework* describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents three dimensions that will be combined to form each standard:

### Dimension 1: Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like “skills” to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC’s intent is to better explain and extend what is meant by “inquiry” in science and the range of cognitive, social, and physical practices that it requires.

Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.

## Dimension 2: Crosscutting Concepts

Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change. The Framework emphasizes that these concepts need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.**Dimension 3: Disciplinary Core Ideas**

Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have **broad importance** across multiple sciences or engineering disciplines or be a **key organizing concept** of a single discipline;
- Provide a **key tool** for understanding or investigating more complex ideas and solving problems;
- Relate to the **interests and life experiences of students** or be connected to **societal or personal concerns** that require scientific or technological knowledge;
- Be **teachable** and **learnable** over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science.

# Pacing Guide

| Content Area: Life Science | | |
|---|---|---|
| **Course Title: HS Biology** | | |
| **UNIT TITLE** | **NGSS** | **TIMEFRAME** |
| **Unit 1: Matter and Energy in Organisms and Ecosystems** | **HS-LS1-5**<br>**HS-LS1-6**<br>**HS-LS1-7**<br>**HS-LS2-3**<br>**HS-LS2-4**<br>**HS-LS2-5** | **40 days** |
| **Unit 2: Structure and Function** | **HS-LS1-1**<br>**HS-LS1-2.**<br>**HS-LS1-3** | **30 days** |
| **Unit 3: Heredity:**<br>**Inheritance & Variation of Traits** | **HS-LS1-4.**<br>**HS-LS3-1.**<br>**HS-LS3-2.**<br>**HS-LS3-3.** | **40 days** |
| **Unit 4: Natural Selection and Evolution** | **HS-LS4-1.**<br>**HS-LS4-2**<br>**HS-LS4-3**<br>**HS-LS4-4**<br>**HS-LS4-5** | **40 days** |
| **Unit 5: Ecosystems: Interactions, Energy and Dynamics** | **HS-LS2-1.**<br>**HS-LS2-2**<br>**HS-LS2-6**<br>**HS-LS2-7**<br>**HS-LS2-8**<br>**HS-LS4-6** | **30 days** |

| Content Area: | Biology | Grade(s): High School |
|---|---|---|
| Unit Plan Title: | From Molecules to Organisms: Matter and Energy In Organisms and Ecosystems | |

**Science Standards (Established Goals)**

**Disciplinary Core Ideas**

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

● The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)

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

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

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

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

● Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)

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

## Science and Engineering Practices

**Developing and Using Models**

● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)

**Planning and Carrying Out Investigations**

● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

**Constructing Explanations and Designing Solutions**

● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS- LS1-1)

## Cross-Cutting Concepts

**Systems and System Models**

● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-LS1-2)

**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-LS1-1)

**Stability and Change**

● 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-LS1-5), (HS-LS1-6)

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

## Computer Science and Design Thinking

8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs and risks, related to the use of the innovation.

Computer Science and Design Thinking Standards

● 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena,

including climate change.

● 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Career Readiness, Life Literacies, and Key Skills

**Career Readiness, Life Literacies, and Key Skills**

● 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making

● 9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g. costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

● 9.4.12.CI.1: Demonstrate the ability to reflect, analyze and use creative skills and ideas.

**Interdisciplinary Standard(s)**

**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-LS1-1)

**WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1)

**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-LS1-3)

**WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and over reliance on any one source and following a standard format for citation. (HS-LS1-3)

**WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1)

**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-LS1-2)

**Enduring Understandings:**

***Students will understand that:***

- The scientific method is a set of steps scientists can use to solve a problem
- Atoms are the building blocks of matter
- Chemical bonds hold molecules together
- Water's polarity influences its unique properties.
- Carbon produces diverse organic molecules
- Dehydration and Hydrolysis reactions are important chemical reactions in organic chemistry
- The structure and function of the four groups of macromolecules
- Potential and Kinetic energy
- Laws of thermodynamics are important to living things
- Energy is stored in molecules of ATP
- Enzymes regulate metabolic pathways
- The reactions of photosynthesis and cellular respiration represent oxidation-reduction reactions.
- Photosynthesis transforms light energy into chemical energy stored in sugars and releases oxygen.
- Cellular respiration is a series of chemical reactions which release energy that can be used to drive other chemical reactions.

**Essential Question(s) :**

- How is the scientific method used to solve a problem?
- What are atoms?
- What are chemical bonds? Explain differences between covalent, ionic, and hydrogen bonds?
- Why are the properties of water important to life?
- What is the pH scale? Distinguish between acids and bases?
- How do buffers prevent large pH changes in solutions?

- How do the properties of carbon enable it to produce diverse organic molecules?
- How are organic molecules put together and broken apart?
- What is the structure & function of carbohydrates? Lipids? Proteins? Nucleic Acids?
- What is energy and explain the difference between potential vs kinetic energy?
- How do enzymes control reaction rates inside organisms?
- How are biochemical reactions regulated by enzymes?
- What are the laws of thermodynamics and explain their importance to living things?
- What are the stages in aerobic cellular respiration and photosynthesis?
- In anaerobic conditions, how do cells generate ATP?
- What is the role of chlorophyll in photosynthesis?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| **21st Century Themes** | **21st C Century Skills** |
|---|---|
| • Global Awareness<br>• Environmental Literacy | • Critical Thinking & Problem Solving<br>• Creativity and Innovation<br>• Collaboration, Teamwork & Leadership |

| **Student Learning Goals/Objectives:** | |
|---|---|
| ***Students will know….***<br>The steps to the scientific method<br>The properties of water<br>The properties of organic molecules<br>The properties of enzymes<br>How light intensity and temperature affect photosynthesis<br>How exercise affects muscle fatigue | ***Students will be able to (do)…***<br>Apply the scientific method to solve a problem<br><br>Differentiate between cohesion and adhesion<br><br>Identify differences between carbohydrates, fats, and proteins<br><br>Explain how environmental conditions affect enzyme activity<br><br>Explain how environmental conditions affect photosynthesis<br><br>Calculate the amount of ATP produced |

**Assessment Evidence:**

***Performance Tasks:***

**Performance Tasks/Use of Technology:**

- Technology integration:
  - Gizmos: Element Builder; Dehydration Reactions; Enzymes; Cellular Respiration; Photosynthesis
  - Virtual Lab: Photo lab
  - Google Forms quizzes and test
  - Kahoot Review Games
  - YouTube Videos
    - Amoebas Sisters: Organic Molecules; Cellular respiration ; Photosynthesis

- Performance Task
  - Photosynthesis and Cellular Respiration Task board project explaining the chemical equations, inputs and outputs, locations, and importance of each reaction.

**Other Assessment Measures*:***

Formative

- Warm-ups and Ticket outs ( Atomic structure, Organic Molecules, Energy & Enzymes, Cellular Respiration and Photosynthesis)
- Graphic organizers ( Chemical Bond chart, Comparing Photosynthesis to Cellular Respiration, Organic molecule chart)
- Guided Reading Assignments
- Lab activities (suggested)
  - Organic Molecule
  - Enzyme
  - Elodea Lab
  - Muscle Fatigue Lab
- Written lab report
- Quizzes
- Class participation
- Marzano c

Summative

- Unit Test
- Laboratory Report
- Unit projects

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS

- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy

- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor

- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources | |
|---|---|
| Honors Biology : Campbell. (2015) Biology Concepts and Connections 8th Edition. New York: Pearson. ISBN 978-0321885326 | |
| Suggested Time Frame: | 40 days |

| Content Area: | Biology | Grade(s): High School |
|---|---|---|
| Unit Plan Title: | Structure and Function | |

**Science Standards (Established Goals)**

**Disciplinary Core Ideas**

**LS1.A : Structure and Function**

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)

- A ll cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS -LS1-1) (Note: This Disciplinary Core Idea is also addressed by HS -LS3-1.)

- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)

- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

## Science and Engineering Practices

**Developing and Using Models**

● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)

**Planning and Carrying Out Investigations**

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● 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-LS1-5), (HS-LS1-6)

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

## Computer Science and Design Thinking

● 8.1.12.AP.6: Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.

● 8.2.12.ETW.2: Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment.

## Career Readiness, Life Literacies, and Key Skills

● 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making

● 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.

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**Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)**

***Students will understand that:***

- Living organisms are organized and survival is based on maintaining homeostasis
- Cellular structure determines function; des
- Diffusion, Osmosis, and facilitated diffusion are types of passive transport
- Molecular pumps, endocytosis, and exocytosis are types of active transport
- Cell size relates to homeostasis
- Feedback mechanisms maintain homeostasis

**Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)**

- What are the levels of biological organization?
- How do the levels of organization apply to humans?
- What is the cell theory?
- What are the functions of organelles?
- What are the structural components of the cell membrane?
- How does the cell membrane exhibit selective permeability?
- How do proteins move molecules across the cell membrane?
- What is passive transport? What are the different types of passive transport?
- What is Active transport? What are the different types of active transport?
- How do feedback mechanisms maintain homeostasis?
- What is the difference between positive and negative feedback?

| **In this unit plan, the following 21st Century themes and skills are addressed:** | |
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| **21st Century Themes**<br>• Global Awareness<br>• Environmental Literacy | **21st C Century Skills**<br>• Critical Thinking & Problem Solving<br>• Creativity and Innovation<br>• Collaboration, Teamwork & Leadership |

| **Student Learning Goals/Objectives:** | |
|---|---|
| ***Students will know….***<br>Living organisms are dependent on feedback mechanisms to maintain homeostasis<br><br>Cell size relates to homeostasis<br><br>How to use light microscopes to identify cells and examine osmosis using a microscope | ***Students will be able to (do)…***<br>Apply data on negative and positive feedback to create a case study explaining how it maintains homeostasis.<br><br>Plan and conduct an experiment using different cells to measure the rate of osmosis<br><br>Examine differences between animal and plant cells; identify how different solutions affect tonicity |

**Assessment Evidence:**

***Performance Tasks:***

**Performance Tasks/Use of Technology:**

- Technology integration:
  - Gizmos:Cell Structure; Paramecium Homeostasis ( Osmosis); Homeostasis Stem case ( Positive and Negative feedback)
  - Google Forms quizzes and test
  - Kahoot Review Games
    YouTube Videos
    - Amoebas Sisters: Feedback; Cell transport
- Performance Task
  - Gizmo: Homeostasis Stem case ( Positive and Negative feedback); Students will interpret results and create a case study.

**Other Assessment Measures*:***

Formative

- Warm-ups and Ticket outs ( Cell structure, Cell Transport, Cell membrane structure)
- Worksheets
- Graphic organizers ( Animals vs Plant Cells Chart; Cell transport flip book; Cell membrane drawing)
- Guided Reading Assignments
- Lab activities (suggested)
  - Introduction to the Microscope lab
  - Cell Structure microscope lab
  - Diffusion lab
  - Osmosis lab
  - Active transport booklet
- Written lab report
- Quizzes
- Class participation
- Marzano scales

Summative

- Unit Test
- Laboratory Report
- Unit projects

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers
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**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
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- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a

higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery

- Engaging students in active problem-finding and problem-solving activities and research
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- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged

child's achievement level

- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

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| Suggested Time Frame: | 20 days |

| Content Area: | Biology | Grade(s): High School |
|---|---|---|
| Unit Plan Title: | Heredity | |

**Science Standards**

**Disciplinary Core Ideas**

**LS1.A: Structure Function**

- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.(HS-LS1-1)

**LS1.B: Growth and Development of Organisms**

- In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

**LS3.A: Inheritance of Traits**

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)

**LS3.B: Variation of Traits**

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic

variation.

● Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)

**Science and Engineering Practices**

**Asking Questions and Defining Problems**

● Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)

**Analyzing and Interpreting Data**

● Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS- LS3-3)

**Engaging in Argument from Evidence**

● Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS- LS3-2)

**Obtaining, Evaluating, and Communicating Information**

● Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1)

## Cross-Cutting Concepts

**Systems and System Models**

● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1- 2), (HS-LS1-4)

**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-LS1-5), (HS- LS1-6) ● Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

**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-LS1-1)

**Stability and Change**

● Feedback (negative or positive) can stabilize or destabilize a system. (HS- LS1-3)

## Computer Science and Design Thinking

8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs and risks, related to the use of the innovation.

**Career Readiness, Life Literacies, and Key Skills**

● 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making

● 9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g. costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

● 9.4.12.CI.1: Demonstrate the ability to reflect, analyze and use creative skills and ideas.

**Interdisciplinary Standard(s)**

**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-LS1-1)

**WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1)

**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-LS1-3)

**WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and over reliance on any one source and following a standard format for citation. (HS-LS1-3)

**WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1)

**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-LS1-2)

**Enduring Understandings:**

***Students will understand that:***

- All cells contain DNA
- Mitosis and Meiosis are types of cells reproduction
- Genetics is the study of heredity
- DNA contains regions that are called genes
- The sequence of genes contains instructions that code for proteins
- The central dogma of biology explains the flow of genetic information in living organisms
- Mutations are a source of genetic variations
- Groups of specialized cells (tissues) use proteins to carry out functions that are essential to the organism.

**Essential Question(s) :**

- What is the function of DNA?
- What is Mitosis?  What are the phases and explain them?
- What is Meiosis? What are the phases and explain them?
- What is genetics?
- What is probability?
- What role does DNA play in evolution?
- What impact does the environment have on the genes of an organism?
- What are mutations?
- Why is DNA important?
- How do organisms get their DNA?

| **In this unit plan, the following 21st Century themes and skills are addressed:** | |
|---|---|
| **21st Century Themes**<br>● Global Awareness<br>● Environmental Literacy | **21st C Century Skills**<br>● Critical Thinking & Problem Solving<br>● Creativity and Innovation<br>● Collaboration, Teamwork & Leadership |

| **Student Learning Goals/Objectives:** | |
|---|---|
| ***Students will know….***<br>● All cells contain DNA<br>● Mitosis and Meiosis are types of cells reproduction<br>● Genetics is the study of heredity<br>● DNA contains regions that are called genes<br>● The sequence of genes contains instructions that code for proteins<br>● Mutations are the source of genetic variations<br>● Groups of specialized cells (tissues) use proteins to carry out functions that are essential to the organism. | ***Students will be able to (do)…***<br>Identify differences between Mitosis and Meiosis<br>Construct a model of DNA<br>Identify different mutations<br>Use probability to solve genetics problems |

**Assessment Evidence:**

***Performance Tasks:***

**Performance Tasks/Use of Technology:**

- Technology integration:
  - Gizmos: Mitosis; Meiosis; Mouse genetics: Building DNA; RNA & Protein synthesis; Human Karyotyping; Google Forms quizzes and test
  - https://serendipstudio.org/exchange/bioactivities/mmfmistakes
  - Kahoot Review Games
    YouTube Videos
    - Amoebas Sisters: DNA structure; Replication; Transcription and Translation; Punnett Squares

Performance Task

- Design a species
- Genetic Disease Project

**Other Assessment Measures*:***

Formative

- Warm-ups and Ticket outs ( DNA structure; Function; Transcription; Translation
- Graphic organizers ( Mitosis vs Meiosis; DNA vs RNA structure; Types of mutations; genetic crosses
- Guided Reading Assignments
- Lab activities (suggested)
  - Onion root mitosis lab; diagrams and explanations
  - Meiosis simulation
  - DNA extraction lab
  - Mutation simulation
  - How genetics causes disease
- Reading Assignments:
  - Using DNA to track Holacust survivors
- Meiosis Review Game
- Written lab report
- Quizzes
- Class participation
- Marzano scales

Summative

- Unit Test
- Mitosis practical exam

| | |
|---|---|
| | ● Laboratory Report<br>● Unit projects |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning

- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration

- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements

- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources |
| --- |
| Honors Biology<br>Campbell. (2015) Biology Concepts and Connections 8th Edition. New York: Pearson.<br>ISBN 978-0321885326 |

| Suggested Time Frame: | 20 days |
| --- | --- |

| Content Area: | Biology | Grade(s): High School |
|---|---|---|
| Unit Plan Title: | Natural Selection and Evolution | |

**Science Standards**

**Disciplinary Core Ideas**

**LS4.A: Evidence of Common Ancestry and Diversity**

● Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)

**LS4.B: Natural Selection**

● Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation— that leads to differences in performance among individuals. (HS-LS4-2),(HS- LS4-3)

● The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)

**LS4.C: Adaptation**

● Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment**.** (HS-LS4-2)

● Natural selection leads to adaptation to a population dominated by organisms that are anatomically, behaviorally, and

physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3),(HS-LS4-4)

● Adaptation also means that the distribution of traits in a population can change when conditions change. (HS- LS4-3)

● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5),(HS-LS4-6)

● Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)

**LS4.D: Biodiversity and Humans**
● Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and

● climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6) (Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.**)**

**ETS1.B: Developing Possible Solutions**
● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-LS4-6)
● Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see

which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to HS-LS4-6) .

**Science and Engineering Practices**

**Asking Questions and Defining Problems**

● Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)

**Analyzing and Interpreting Data**

● Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS- LS3-3)

**Engaging in Argument from Evidence**

● Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS- LS3-2)

**Obtaining, Evaluating, and Communicating Information**

● Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1)

## Cross-Cutting Concepts

**Systems and System Models**

● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1- 2), (HS-LS1-4)

**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-LS1-5), (HS- LS1-6) ● Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

**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-LS1-1)

**Stability and Change**

● Feedback (negative or positive) can stabilize or destabilize a system. (HS- LS1-3)

## Computer Science and Design Thinking

●8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

● 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

## Career Readiness, Life Literacies, and Key Skills

● 9.1.12.CFR.1: Compare and contrast the role of philanthropy, volunteer service, and charities in community development and quality of life in a variety of cultures.
● 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making.
● 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
● 9.4.12.CI.1: Demonstrate the ability to reflect, analyze and use creative skills and ideas.

## Interdisciplinary Standard(s)

**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-LS4- 1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)

**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-LS4-5)

**WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)

**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-LS4-6)

**WHST.9-12.7** Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the

subject, demonstrating understanding of the subject under investigation. (HS-LS4-6)

**WHST.9-12.9** Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5)

**SL.11-12.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-LS4-1), (HS-LS4-2)

**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- ETS1-1),(HS-ETS1-3)

**RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)

**RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)

**Mathematics:**
**N.Q.A Reason abstractly and quantitatively.**

**N.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-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5 (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)
**MP.4 Model with mathematics. (HS-LS4-2),(HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)**

**Enduring Understandings:**

***Students will understand that:***

- Phylogenetic trees are used to examine groups of related organisms
- The group behavior can increase the chances for an individual and a species to survive and reproduce
- The relationship between the environment and natural selection.

**Essential Question(s) :**

- What is the evidence for and causes of evolution?
- What impact do humans have on evolution?
- Why is evolution important to living things?
- How has natural selection shaped the development of the theory of evolution?
- How has Darwin influenced the theory of evolution?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| 21st Century Themes | 21st C Century Skills |
|---|---|
| • Global Awareness<br>• Environmental Literacy | • Critical Thinking & Problem Solving<br>• Creativity and Innovation<br>• Collaboration, Teamwork & Leadership |

| **Student Learning Goals/Objectives:** | |
|---|---|
| ***Students will know….***<br>● What is a phylogenetic tree?<br>● What is the evidence for and causes of evolution?<br>● What impact do humans have on evolution?<br>● Why is evolution important to living things?<br>● How has natural selection shaped the development of the theory of evolution?<br>● How has Darwin influenced the theory of evolution? | ***Students will be able to (do)…***<br>Examine a group of related organisms using a phylogenetic tree or cladogram in order to identify shared characteristics.<br><br>Apply principles of natural selection and evaluate to qualitatively and quantitatively investigate the role of natural selection in evolution. |
| **Assessment Evidence:** | |
| ***Performance Tasks:***<br><br>**Performance Tasks/Use of Technology:**<br>● Technology integration:<br>○ Gizmos: Natural and Artificial Selection; Mutation and Selection; Human Evolution; Hardy-Weinberg Equilibrium; Cladograms<br>○ Evolution Webquest<br>○ Kahoot Review Games<br>○ YouTube Videos on Darwin and Natural Selection<br>○ Amoeba sisters: Natural selection<br>○ Video: Born of Fire- Galapagos Islands<br>○ How eyes evolved | **Other Assessment Measures*:***<br>Formative<br>● Warm-ups and Ticket outs (Evolution, Natural Selection, Evidence of Evolution)<br>● Worksheets<br>● Graphic organizers (Natural Selection and Evidence of Evolution)<br>● Guided Reading Assignments<br>● Lab activities (suggested):<br>○ Phet: Natural Selection<br>○ Beak of the finch Lab<br>○ Population Genetics<br>○ Evidence of Evolution |

| | |
|---|---|
| **Performance Task**<br>○ The Biology of Skin Color<br>○ The Roots of Colorism<br>- Read and discuss the article and relate to The Biology of Skin Color Activity. | ○ Investigating Genetic Drifts<br>○ Peppered Moth Survey<br>○ Darwin Stations<br>● Reading Assignments:<br>○ POGIL: Evidence for evolution<br>○ POGIL: Evolution and selection<br>● Written lab report<br>● Quizzes<br>● Class participation<br>● Marzano scales<br>Summative<br>● Unit Test<br>● Laboratory Report<br>● Evolution Project |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions

- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension

- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources | |
|---|---|
| Honors Biology<br>Campbell. (2015) Biology Concepts and Connections 8th Edition. New York: Pearson.<br>ISBN 978-0321885326 | |
| Suggested Time Frame: | 40 days |

| **Content Area:** | **Biology** | **Grade(s): High School** |
|---|---|---|
| **Unit Plan Title:** | **Ecosystems: Interactions, Energy and Dynamics** | |

**Science Standards (Established Goals)**

**Disciplinary Core Ideas**

**LS2.A Interdependent Relationships in Ecosystems**

● Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)

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

● Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some

matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

**LS2.C Ecosystem Dynamics, Functioning and Resilience**

● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)

● Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

**LS2.D Social Interactions and Group Behavior**

● Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)
LS4.C Adaptation

● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline, and sometimes extinction, of some species (HS-LS4-5)

● Species become extinct because they can no longer survive and reproduce in their altered environment. If members

cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost (HS-LS4-5)

**LS4.D Biodiversity and Humans**

● Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)

● Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)

**ETS1.B Developing Possible Solutions**

● When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to **HS-LS2-7)**

**Science and Engineering Practices**

**Developing and Using Models**
● Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

**Using Mathematics and Computational Thinking**
● Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)
● Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS- LS2-2)
● Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)

**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, 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- LS2-3)
● Design, evaluate, and 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-LS2-7)

**Engaging in Argument from Evidence**
● Arguments may also come from current scientific or historical episodes in science.
● Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)
● Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. (HS-LS2-8)

**Connections to Nature of Science Scientific Knowledge is Open to Revision in Light of New Evidence**
● Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2- 2),(HS-LS2-3)
● Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas

and evidence that may result in revision of an explanation. (HS-LS2-6), (HS-LS2-8)

## Cross-Cutting Concepts

**Cause and Effect**

● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS- LS2-8)

**Scale, Proportion, and Quantity**

● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)

● Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

**Systems and System Models**

● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)

**Energy and Matter**

● Energy cannot be created or destroyed—it only moves between one place and another place, between objects

and/or fields, or between systems. (HS-LS2-4)

● Energy drives the cycling of matter within and between systems. (HS- LS2-3)

**Stability and Change**

● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)

**Computer Science and Design Thinking**

● 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

● 8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs and risks, related to the use of the innovation

**Career Readiness, Life Literacies, and Key Skills**

●9.1.12.CFR.1: Compare and contrast the role of philanthropy, volunteer service, and charities in community development and quality of life in a variety of cultures.

●9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g. costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

●9.4.12.GCA.1: Collaborate with individuals, analyze a variety of potential solutions to climate change effects and determine why solutions may work better than others (e.g., political. Economic, cultural).

| Interdisciplinary Standard(s) |
| --- |
| **ELA/Literacy**<br>**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-LS2-6),(HS-LS2-7),(HS-LS2-8)<br><br>**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-LS2-1),(HS-LS2-2),(HS-LS2-3),(HS-LS2-6),(HS-LS2-8)<br><br>**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- LS2-6),(HS-LS2-7),(HS-LS2-8)<br><br>**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-LS2-6),(HS-LS2-7),(HS-LS2-8)<br><br>**WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ |

experiments, or technical processes. (HS-LS2-1),(HS-LS2-2),(HS-LS2-3)

**WHST.9-12.5** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS2-3)

**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-LS2-7)

**Mathematics - Reason abstractly and quantitatively.** (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-6),(HS-LS2-7)

**Model with mathematics.** (HS-LS2-1),(HS-LS2-2),(HS-LS2-4)
**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-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)
**HSN.Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1),(HS- LS2-2),(HS-LS2-4),(HS-LS2-7)

**HSN.Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)

**HSS-ID.A.1** Represent data with plots on the real number line. (HS-LS2-6) HSS-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6)

**HSS-IC.B.6 Evaluate reports based on data.** (HS-LS2-6)

**Enduring Understandings:**

***Students will understand that:***

- Models are used to represent the cycling of matter through ecosystems
- How to calculate energy transfer through trophic levels
- How to graph J and S curves of population growth
- Population growth data is used it to present an argument for population control and the impact of overpopulation on a scarce resource.
- The availability of energy affects the ecosystem.
- Interactions that shape communities and explain how factors affect a population
- Human activities affect the biosphere, ways to decrease this disturbance and how ecosystems may or may not recover from a disturbance.
- Cycling of matter and flow of energy occurs between photosynthesis and cellular respiration.
- How the process of photosynthesis provides a vital connection between the sun and the energy needs of living systems

**Essential Question(s) :**

How do organisms interact on different scales within an ecosystem?
How does a change in an ecosystem affect the organisms that live within it?
Where does the energy and matter come from that sustains ecosystems?
When considering the models of population growth, what factors contribute to the carrying capacity of a population?
What is a community?
What is the primary source of energy on Earth?
How does a food web show energy flow in an ecosystem?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| **21st Century Themes** | **21st C Century Skills** |
|---|---|
| • Global | • Critical Thinking & Problem Solving |

| | |
|---|---|
| Awareness<br>● Environmental Literacy | ● Creativity and Innovation<br>● Collaboration, Teamwork & Leadership |

| **Student Learning Goals/Objectives:** | |
|---|---|
| ***Students will know….***<br>● That the cycling of matter occurs through ecosystems<br>● That energy is transferred through trophic levels<br>● Population growth is: exponential or logistic<br>● Overpopulation impacts habits and limits resources | ***Students will be able to (do)…***<br>Use models to represent the cycling of matter through ecosystems<br><br>Calculate energy transfer through trophic levels<br>Graph J and S curves of population growth<br><br>Analyze population growth data and use it to present an argument for population control and the impact of overpopulation on a scarce resource. |
| **Assessment Evidence:** | |

| ***Performance Tasks:*** | **Other Assessment Measures*:*** |
|---|---|
| **Performance Tasks/Use of Technology:**<br>● Technology integration:<br>○ Gizmos: Food chains, Ecosystems, GMO's and the Environment, Estimating population size<br>○ https://serendipstudio.org/exchange/bioactivities/mmfmistakes<br>○ Kahoot Review Games<br>YouTube Videos<br>- Amoebas Sisters: Autotrophs and Heterotrophs,Food Webs and Energy Pyramids ,Ecological Relationships , Carbon and Nitrogen Cycles<br>○ | Formative<br>● Warm-ups and Ticket outs ( Ecology, Food Webs, Nutrient Cycles)<br>● Worksheets<br>● Graphic organizers ( (Food Web Diagram, Nutrient Cycle Diagram)<br>● Guided Reading Assignments<br>● Lab activities (suggested):<br>○ Mark & Recapture<br>○ Random Sampling<br>○ Predator/Prey Simulations<br>○ Survivorship curves<br>○ Climatograms<br>○ Graphing Deer Populations<br>○ Human Population Growth<br>● Reading Assignments:<br>● Written lab report<br>● POGIL activities (Nutrient Cycles; Ecological Relationships; Energy Transfer; Ecological Pyramids; Population Distribution; Population Growth)<br>● Quizzes<br>● Class participation<br>● Marzano scales<br>Summative<br>● Unit Test |

| | |
|---|---|
| | ● Ecology Project<br>● Laboratory Report<br>● Unit projects |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping

- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions

- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide high interest topics/options

- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources |
| --- |
| Honors Biology<br>Campbell. (2015) Biology Concepts and Connections 8th Edition. New York: Pearson.<br>ISBN 978-0321885326 |

| Suggested Time Frame: | 20 days |
| --- | --- |

# Chemistry Course Description

Elements, substances and compounds make up our entire physical environment. Students need an understanding of Chemistry to fully appreciate the complexity and interactions present in their world. The main focuses of this course are properties of matter, changes in matter, and how energy is related to both. Upon completion of this course, students should not only understand the subject matter of chemistry, but also appreciate the interrelationship between physics, biology and chemistry. Chemistry fulfills the New Jersey science requirements for high school graduation. Students will use measurement and observation tools to refine their problem solving skills and gain experience in using mathematics as a tool in science investigations. Application of the Next Generation Science Standards results in a balance of the three dimensions of the standards along with a focus on the interdisciplinary nature of all science domains among one another as well as with the New Jersey Student Learning Standards for Mathematics and English Language Arts.

# Pacing Guide

| UNIT TITLE | ENDURING UNDERSTANDINGS | NGSS | TIMEFRAME |
|---|---|---|---|
| **Unit 1 - Introduction to Chemistry and the Atomic Theory** | • Students must follow certain procedures in order to maintain a safe environment during labs<br>• The scientific method is an established practice used to solve a problem<br>• Accuracy, precision and percent error can be used to evaluate the success of an experiment<br>• A substance can be identified by its density<br>• The current model of the atom has evolved over time based off of available technology<br>• Light can be described through the wave model and the particle model<br>• Each atom contains protons, neutrons and electrons<br>• Nuclear processes involve changes in nuclear binding energies | **HS-PS1-1 HS-PS1-8 HS-PS4-1 HS-PS4-3 HS-PS2-6** | **30 – 40 days** |
| **Unit 2 - Periodic Table** | • The Periodic Table organizes the elements based on atomic number and chemical properties.<br>• Characteristics of elements can be inferred based on the location of the element within the Periodic Table.<br>• There are trends of atomic radii, ionization energy, and electronegativity that correspond to location on the periodic table.<br>• Periodic Properties (see above) can be used to explain the chemical behavior of the elements.<br>• The valence electrons of an atom determine the chemical reactivity of the element.<br>• Electron configurations can be used to predict the chemical behavior of atoms. | **HS-PS1-1 HS-PS1-2 HS-PS4-1** | **15 days** |

| | | | |
|---|---|---|---|
| **Unit 3 - Chemical Bonding** | • The atoms of solid ionic compounds are arranged in an orderly fashion. The crystalline structure of these solids is the result of ionic bonding between atoms.<br>• Ionic bonding gives ionic compounds their unique physical properties. Molecular compounds consist of two or more nonmetallic atoms bound by a covalent bond.<br>• There are many variations of molecular compounds because of the chemical bonding found within the molecules.<br>• The Octet Rule governs how atoms are bound and arranged within a molecular compound.<br>• Molecular compounds may have an even or uneven distribution of electrons within the molecule.<br>• This distribution of electrons within the molecule determines its shape and polarity which in turn affect the physical properties of macroscopic samples of the molecular substance. | **HS-PS1-2 HS-PS1-3 HS-PS2-6** | **20 days** |
| **Unit 4 - Representing Chemical Reactions** | • Students will learn to differentiate between a physical change and a chemical change.<br>• Students will write chemical reactions using elemental symbols. These skills will be used in subsequent units.<br>• The concept of the mole enables scientists to measure the mass or volume of a substance and then to calculate the number of particles in the sample.<br>• The mole was developed as a tool to relate the number of particles of a substance to its mass and volume.<br>• Dimensional Analysis is used in order to perform these conversions.<br>• Students will learn to predict the products and write five classes of chemical reactions: synthesis reactions, decomposition reactions, combustion reactions, single replacement reactions, and double replacement reactions. | **HS-PS1-2 HS-PS1-4 HS-PS1-5HS-PS1-7** | **30 – 40 days** |

| | | | |
|---|---|---|---|
| | • Stoichiometry is the science of the quantification of matter in chemical reactions.<br>• The mole concept and Dimensional Analysis are used to quantify the substances involved in chemical reactions.<br>• In a chemical reaction, the total mass of the reactants must equal the total mass of the products.<br>• Rates of reaction are impacted by the concentration of reacting species and the temperature of the system | | |

| | | | |
|---|---|---|---|
| **Unit 5 - States of Matter** | • There is a relationship between the pressure, temperature and volume of a substance, and the gas laws can be used to calculate how these affect one another.<br>• Pressure is a result of molecular collisions and if those collisions increase, then the pressure exerted by the substance will also increase.<br>• If thermal energy is added to a substance the substance will undergo a change of phase.<br>• Phase diagrams can be used to determine the state of a matter of a sample of a substance under a particular set of conditions. | **HS-PS1-3**<br>**HS-PS2-6** | **20 – 30 days** |

| | | | |
|---|---|---|---|
| **Unit 6 - Solutions Chemistry** | • Many chemical reactions occur in aqueous solutions, therefore it is important to be able to quantify the amount of solute dissolved in a solvent.<br>• The concentration of a solute can be measured in terms of molarity, molality, percent by mass, percent by volume, and mole fraction.<br>• The amount of solute that can be dissolved in a given amount of solvent can be affected by the temperature and / or pressure of the solution. There are also factors that affect the rate at which a solute may dissolve.<br>• Dynamic Equilibrium is a state in which the rates of opposing reactions are the same.<br>• Equilibria can be forced to shift either towards reactants or products by intentional changes in conditions (P, V, T, [species]) | **HS-PS1-2 HS-PS1-3 HS-PS1-5 HS-PS1-6** | **20 - 30 days** |

| Content Area: | Chemistry | Grade(s) 10-12 |
|---|---|---|
| Unit Plan Title: | Unit 1 - Introduction to Chemistry and the Atomic Theory | |

## Overview/Rationale

Chemistry is a hands-on course. Students will first learn the safety procedures they must follow throughout this course, how to apply the scientific method to solve a problem and how to use dimensional analysis to convert between units of measure. Students will also learn how to evaluate the success of their experiments by using accuracy, precision and percent error. Finally, students will understand what density is and how it can be used to identify a substance.

Many scientists have contributed to the development of the Atomic Model. Each scientist used discoveries by their predecessors to improve the Atomic Model. The current view of the atom still contains some of the same elements of models before it. The Quantum Model of the atom describes how electrons are organized around the atom. Each atom consists of protons, neutrons, and electrons. Some atoms of the same element vary by the number of neutrons they contain. Neutral atoms have the same number of protons and electrons while ions do not. Ions are atoms with an electrical charge. The Atomic Emission Spectra of atoms helps us understand how electrons are arranged around the atom. The composition of an atom's nucleus changes during the processes of fission, fusion and radioactive decay.

## Science Standards (Established Goals)

PS1.A: structure and properties of matter
PS1.C: nuclear processes
ETS1.C: optimizing the design solution
PS2.B: types of interactions
PS4.A: wave properties
PS4.B: electromagnetic radiation

## Disciplinary Core Ideas

HS-PS1-1: use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

HS-PS1-8: develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

HS-PS4-1: use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

HS-PS4-3: evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS-PS2-6: communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials

## Science and Engineering Practices

SEP-2: Developing and using models

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

SEP-3: Planning and carrying out investigations SEP-7: Engaging In Argument from Evidence

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS- PS4-3)

SEP-8: Obtaining, evaluating and communication of information

## Cross-Cutting Concepts

CCC-1: 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)

CCC-5: Energy and Matter

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

## Computer Science & Design Thinking Standard(s) *(formerly Technology)*

**8.1.12.AP.5:** Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.

## Interdisciplinary Standard(s)

**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.9-10.8** Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-3)

**RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS2-6), (HS-PS4-3)

**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)

**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-PS4-3)

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

**Mathematics**

**MP.2** Reason abstractly and quantitatively. (HS-PS4-1),(HS-PS4-3)

**MP.4** Model with mathematics. (HS-PS4-1)

**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-PS1-8), (HS-PS2-6)

**HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-8), (HS-PS2-6)

**HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-8)

**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)

## Enduring Understandings:

***Students will understand that…***

- Students must follow certain procedures in order to maintain a safe environment during labs
- The scientific method is an established practice used to solve a problem
- Accuracy, precision and percent error can be used to evaluate the success of an experiment
- A substance can be identified by its density
- The current model of the atom has evolved over time based off of available technology
- Light can be described through the wave model and the particle model
- Each atom contains protons, neutrons and electrons
- Nuclear processes involve changes in nuclear binding energies

## Essential Question(s) :

What procedures must be followed in order to maintain a safe environment during labs?
How is the scientific method used to solve a problem?
How did the atomic theory evolve from ancient Greece to modern day, and which key scientists made which contributions?
How can one explain the structure, properties and interactions of matter?
What forces hold together and mediate nuclear processes?
What is light?

## In this unit plan, the following 21st Century, Career Readiness, Life Literacies, and Key Skills are addressed:

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
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.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

## Student Learning Goals/Objectives:

***Students will know….***
Safety procedures
The steps to the scientific method
Functional and algebraic definitions of density
How light is described
The current model of the atom
What an isotope is
The mass of an element is the average of all its isotopes
The different types of radioactive decay

***Students will be able to (do)…***
Follow safety procedures
Apply the scientific method to solve a problem
Calculate the density of a substance
Identify a substance using its density
Describe light and the importance of the double slit experiment
Determine the number of subatomic particles in an atom
Write symbols for isotopes
Calculate average atomic mass Write radiation equations

## Assessment Evidence:

**Formative**
- Observations during class
- Do now (topic relevant to each day's lesson)
- Homework/Classwork
- Class participation

**Summative**
- Quizzes:
  - Safety/Scientific Method
  - Development of Atomic Model
  - Subatomic Particles

- Student generated ideas in Venn Diagrams/Graphic Organizers
- CER (claim, evidence, reasoning) prompts
- Close Reading activities
- Various closure activities
- Online simulations
- Present student generated data to support/argue a position
- Written assignments to include graphs, tables
- Student response systems (Kahoot. socrative, plickers)

    - Isotopes
    - Radiation Equations
- Tests:
    - Foundational Skills
    - Atomic Theory
    - Nuclear Chemistry

- Lab practicals/skills based assessments using CER Framework/POGIL activitie
    - Scientific Method Lab
    - Density Lab
    - Build an Atom Webquest/Gizmo
    - Radioactive Decay Activity
    - Isotopes of Pennium Lab

**Alternative**

- Unit Portfolio
- Unit Presentations
- Projects
- Teacher-created assessment developed following 1:1 conference and/or reviev

## Teaching and Learning Actions:

*Instructional Strategies and Activities*

Direct instruction, guided and independent practice will be supplemented by student centered activities including:

Scientific method/inquiry lab

- 20-30 minutes

Density lab

- 1 class period

Higher level classes will learn how to calculate the average atomic mass of an element. Honors class will also discuss thermal energy and run a lab series. The higher level classes will also run a discovery Rutherford lab.

Build an Atom**:** This simulation allows students to create different illustrations of atoms and provides evidence that protons determine the identity of the element.

Additional differentiation activities as needed include:

**English Language Learners:**

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| Thermal energy lab series (Honors)<br>- 3, 55 minute periods<br><br>Build an atom webquest/Gizmo<br>- 20-30 minutes<br><br>Radioactive decay lab<br>- 30-40 minutes<br><br>Isotopes of pennies lab<br>- 30-40 minutes<br><br>ID unknown shapes (Adv & Honors)<br>- 30 minutes | ● Teacher tutoring<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments (ex. Fewer items per page)<br>● Differentiated instruction<br>● Native language texts and native language to English dictionary<br>● Small Group Instruction<br>● Flexible Grouping<br>● Graphic Organizers for periodic table design<br>● Technology Integration<br>● Google translate for written work if needed<br>● Provide clear and specific directions<br>● Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing<br>● Provide class notes ahead of time to allow students to preview material and increase<br><br>**Special Education:**<br>● Follow all IEP modifications<br>● Audio books, Movies, and other digital media in lieu of print versions<br>● Oral instructions<br>● Record lessons instead of taking notes<br>● Outlines of lessons<br>● Multisensory Instruction / Multiple modalities<br>● Flexible Grouping<br>● Small Group Instruction<br>● Peer Buddies<br>● Graphic Organizers<br>● Chunking Information<br>● Scaffolded Questioning<br>● Manipulatives<br>● Provide clear and specific directions, orally and in writing<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide extended time<br>● Assign peer tutor<br>● Utilize visual charts/cues |

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| | **Students with 504 Plans:**<br>● Follow all 504 plan modifications<br>● Study Guide with answers<br>● Modified tests<br>● Provide extended time<br>● Graphic organizers<br>● Allow for differentiated assessment as long as it meets requirements<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide preferential seating if available and necessary<br>● Verbal and visual aides<br>● Verbal testing, if applicable<br>● Use written directions in additional to oral directions<br><br>**Gifted and Talented:**<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments<br>● Differentiated instruction<br>● Extension activities such as challenge questions or AP questions<br>● Opportunities for Critical Thinking embedded in lab activities<br>● Problem Solving/Design Challenges<br>● Technology Integration<br>● Student Choice Activities<br>● Performance task options to allow expansion on knowledge of element<br>● Enrichment Activities/Independent research<br>● Explore real world applications<br>● Act as a peer buddy<br><br>**Students At Risk of School Failure:**<br>● Response to Intervention (RTI)<br>● Give every opportunity for success<br>● Involve families in student learning<br>● Provide social/emotional support<br>● Build in more group work to encourage interaction with peers (Flexible |

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| | Grouping, Small Group Instruction, Peer Buddies)<br>• Provide immediate praise and feedback<br>• Provide road maps or outlines for difficult concepts<br>• Provide sufficient wait time before calling on any student to help keep students who may need more time engaged<br>• Provide clear, achievable expectations; do not lower academic requirements<br>• Create a nurturing environment with structured routines |
| **Resources** | |
| Chemistry<br>textbook<br>NJCTL.org<br>http://phet.colorado.edu/en/simulation/ | |
| **Suggested Time Frame:** | 30-40 days |

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| **Content Area:** | **Chemistry** | **Grade(s)** 10-12 |
| **Unit Plan Title:** | **Unit 2 - Periodic Table** | |

**Overview/Rationale**

The Periodic Table organizes the elements based on atomic number and chemical properties. Characteristics of elements can be inferred based on the location of the element within the Periodic Table. There are trends in electron configuration, atomic radius, ionization energy, and electronegativity that can be used to explain the chemical behavior of the elements.

**Science Standards (Established Goals)**

PS1.A: Structure and Properties
of Matter

PS2.B: Types of Interactions
PS4.A: wave properties
PS4.B: electromagnetic radiation
ETS1.C optimizing the design solution

## Disciplinary Core Ideas

HS-PS1-1: use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
HS-PS1-2: construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties
HS-PS4-1: use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

## Science and Engineering Practices

SEP2: Developing and using models
SEP4: Analyzing and Interpreting data
SEP5: Using mathematics and computational thinking
SEP6: Constructing explanations and designing solutions
SEP8: Obtaining, evaluating and communication of information

## Cross-Cutting Concepts

CCC1: Patterns
CCC2: Cause and Effect; Mechanism and Prediction
CCC6: Structure and Function

## Computer Science & Design Thinking Standard(s) (formerly Technology)

8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

## Interdisciplinary Standard(s)

**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.11-12.7** 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)

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

**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)

**Mathematics**

**MP.2** Reason abstractly and quantitatively. (HS-PS4-1)

**MP.4** Model with mathematics. (HS-PS4-1)

**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)

**HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS4-1)

**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)

**HSA.CED.A.4** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS4-1)

## Enduring Understandings:

- The Periodic Table organizes the elements based on atomic number and chemical properties.
- Characteristics of elements can be inferred based on the location of the element within the Periodic Table.
- There are trends of atomic radii, ionization energy, and electronegativity that correspond to location on the periodic table.
- Periodic Properties (see above) can be used to explain the chemical behavior of the elements.
- The valence electrons of an atom determine the chemical reactivity of the element.

- Electron configurations can be used to predict the chemical behavior of atoms.

## Essential Question(s) :

How is the periodic table organized?
How can location on the periodic table help predict the chemical behavior of an element?
How is an electron configuration written?

## In this unit plan, the following, 21st Century, Career Readiness, Life Literacies, and Key Skills are addressed:

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
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.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

## Student Learning Goals/Objectives:

| ***Students will know….*** | ***Students will be able to (do)…*** |
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| The contributions of scientists who gave us the organization of the periodic table<br>The trends in properties shown on the periodic table<br>What an electron configuration represents | Determine if an element is a metal, nonmetal or metalloid based on its location<br>Determine how many valence electrons an element has Write an electron configuration for an element<br>Apply the periodic trends to elements to determine the chemical behavior of said element |

## Assessment Evidence:

**Formative**

- Observations during class
- Do now (topic relevant to each day's lesson)
- Homework/Classwork
- Class participation
- Student generated ideas in Venn Diagrams/Graphic Organizers
- CER (claim, evidence, reasoning) prompts
- Close Reading activities
- Various closure activities
- Online simulations
- Written assignments to include graphs, tables
- Student response systems (Kahoot. socrative, plickers)

**Summative**

- Quizzes:
  - Electron Configurations
  - Periodic Trends
- Tests:
  - Representations of the Electron Cloud
  - Periodic Table
- Lab practicals/skills based assessments using CER Framework/POGIL activities
  - Periodic Table Lab
  - Periodic Trends Lab
  - Atomic Emission Spectra Lab
  - Flame Test Activity

**Alternative**

- Unit Portfolio
- Unit Presentations
- Projects
- Teacher-created assessment developed following 1:1 conference

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| | and/or review of student data/need |

## Teaching and Learning Actions:

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| *Instructional Strategies and Activities*<br><br>Atomic emission spectra lab<br>- 30-40 minutes<br><br>Flame test<br>- 30-55 minutes<br><br>Periodic table lab<br>- 1 class period<br><br>Periodic trends activity (honors)<br>- 2-40 minute periods | All classes will learn multiple ways to write electron configurations. Higher level classes will be expected to DESCRIBE why the periodic trends occur in terms of atomic structure. Lower level classes will be expected to IDENTIFY why the periodic trends occur in terms of atomic structure.<br><br>**Wave on a string**: Students will watch a wave on a string. Adjusting the amplitude, frequency, damping and tension will demonstrate wave properties.<br><br>**Slinky Lab**: Students will observe patterns of waves and their interactions using a slinky.<br><br>**Ripple Tank**: Students will investigate wave properties (speed in a medium, reflection, diffraction, interference) using the PhET virtual ripple tank, or use an actual ripple tank.<br><br>**Introduction to the Electromagnetic Spectrum:** NASA background resource<br><br>Periodic Table Trends**:** This is a virtual investigation of the periodic trends.<br><br>Path to Periodic Table**:** This investigation provides students with the opportunity to make sense of how and why the periodic table is organized the way that it is. Students will re-create the thought process that Dmitri Mendeleev and Julius Lothar Meyer went through to devise their early periodic tables.<br><br>Castle of Mendeleev**:** Students engage in a fantasy world that requires them to make claims, based on evidence, regarding the identity of unknown materials. |

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| | Additional differentiation activities as needed include:<br><br>**English Language Learners:**<br><br>● Teacher tutoring<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments (ex. Fewer items per page)<br>● Differentiated instruction<br>● Native language texts and native language to English dictionary<br>● Small Group Instruction<br>● Flexible Grouping<br>● Graphic Organizers for periodic table design<br>● Technology Integration<br>● Google translate for written work if needed<br>● Provide clear and specific directions<br>● Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing<br>● Provide class notes ahead of time to allow students to preview material and increase<br><br>**Special Education:**<br>● Follow all IEP modifications<br>● Audio books, Movies, and other digital media in lieu of print versions<br>● Oral instructions<br>● Record lessons instead of taking notes<br>● Outlines of lessons<br>● Multisensory Instruction / Multiple modalities<br>● Flexible Grouping<br>● Small Group Instruction<br>● Peer Buddies<br>● Graphic Organizers<br>● Chunking Information<br>● Scaffolded Questioning<br>● Manipulatives<br>● Provide clear and specific directions, orally and in writing<br>● Provide class notes ahead of time to allow students to preview material and |

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| | increase comprehension<br>● Provide extended time<br>● Assign peer tutor<br>● Utilize visual charts/cues<br><br>**Students with 504 Plans:**<br>● Follow all 504 plan modifications<br>● Study Guide with answers<br>● Modified tests<br>● Provide extended time<br>● Graphic organizers<br>● Allow for differentiated assessment as long as it meets requirements<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide preferential seating if available and necessary<br>● Verbal and visual aides<br>● Verbal testing, if applicable<br>● Use written directions in additional to oral directions<br><br>**Gifted and Talented:**<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments<br>● Differentiated instruction<br>● Extension activities such as challenge questions or AP questions<br>● Opportunities for Critical Thinking embedded in lab activities<br>● Problem Solving/Design Challenges<br>● Technology Integration<br>● Student Choice Activities<br>● Performance task options to allow expansion on knowledge of element<br>● Enrichment Activities/Independent research<br>● Explore real world applications<br>● Act as a peer buddy<br><br>**Students At Risk of School Failure:**<br>● Response to Intervention (RTI) |

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| | • Give every opportunity for success<br>• Involve families in student learning<br>• Provide social/emotional support<br>• Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)<br>• Provide immediate praise and feedback<br>• Provide road maps or outlines for difficult concepts<br>• Provide sufficient wait time before calling on any student to help keep students who may need more time engaged<br>• Provide clear, achievable expectations; do not lower academic requirements<br>• Create a nurturing environment with structured routines |
| **Resources** | |
| Chemistry<br>textbook<br>NJCTL.org<br>http://phet.colorado.edu/en/simulation/ | |
| **Suggested Time Frame:** | 15 days |

| Content Area: | Chemistry | Grade(s) 10-12 |
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| Unit Plan Title: | Unit 3 - Chemical Bonding | |

**Overview/Rationale**

Chemical bonding predicts and explains the formation of chemical compounds. Physical and chemical properties of substances are determined by the type of chemical bond that exists between the particles in a substance. Ionic bonding and covalent bonding are found among a wide array of chemical compounds.

**Science Standards (Established Goals)**

PS1.A: structure and properties
of matter PS1.B: chemical
reactions
PS2.B: types of interactions

**Disciplinary Core Ideas**

HS-PS1-2: construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties
HS-PS1-3: plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles
HS-PS2-6: communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

**Science and Engineering Practices**

SEP2: Developing and using models
SEP3: Planning and carrying out investigations
SEP4: Analyzing and Interpreting data
SEP6: Constructing explanations and designing solutions

SEP7: Engaging in argument from evidence
SEP8: Obtaining, evaluating and communication of information

## Cross-Cutting Concepts

CCC1: Patterns
CCC2: Cause and Effect; Mechanism and Prediction
CCC3: Scale, Proportion, and Quantity
CCC4: Systems and System Models
CCC6: Structure and Function

## Computer Science & Design Thinking Standard(s) *(formerly Technology)*

8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.

## Interdisciplinary Standard(s)

**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-PS1-3), (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- 2), (HS-PS2-6)

**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. (HSPS1-3)

**WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)

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

**Mathematics**

**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-PS2-6)

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

**HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-3)

## Enduring Understandings:

Students will understand that…

- The atoms of solid ionic compounds are arranged in an orderly fashion. The crystalline structure of these solids is the result of ionic bonding between atoms.
- Ionic bonding gives ionic compounds their unique physical properties. Molecular compounds consist of two or more nonmetallic atoms bound by a covalent bond.
- There are many variations of molecular compounds because of the chemical bonding found within the molecules.
- The Octet Rule governs how atoms are bound and arranged within a molecular compound.
- Molecular compounds may have an even or uneven distribution of electrons within the molecule.
- This distribution of electrons within the molecule determines its shape and polarity which in turn affect the physical properties of macroscopic samples of the molecular substance.

## Essential Question(s) :

What is the difference between an ionic and a covalent bond?
How does a chemical bond affect the physical properties of a substance?
How are formulas written?
How are substances named?
How does an atom's electronegativity affect the electron distribution within a molecule?
How can VSEPR theory be used to predict the shape of a molecule?

## In this unit plan, the following,21st Century, Career Readiness, Life Literacies, and Key Skills are addressed:

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
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.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

## Student Learning Goals/Objectives:

Students will know….

- The difference between an ionic and a covalent bond.
- The properties of ionic and covalent compounds.
- Why there are different ways to name different types of substances that molecules have predictable shapes with technical names.
- that electronegativity affects the polarity of a molecule

Students will be able to (do)…

- Determine if a substance is ionic or covalent
- Write the name for a chemical substance
- Write a formula for a chemical substance
- Predict the shape of a molecule using VSEPR
- Determine the polarity of a substance based off of its geometry and the electronegativity of its elements

## Assessment Evidence:

**Formative**

- Observations during class

**Summative**

- Quizzes:

- Do now (topic relevant to each day's lesson)
- Homework/Classwork
- Class participation
- Student generated ideas in Venn Diagrams/Graphic Organizers
- CER (claim, evidence, reasoning) prompts
- Close Reading activities
- Various closure activities
- Online simulations
- Written assignments to include tables
- Student response systems (Kahoot. socrative, plickers)

  - Type of Bonding (Ionic/Covalent)
  - Names & Formulas
  - VSEPR
- Tests:
  - Names & Formulas
  - Properties of Substances

- Lab practicals/skills based assessments using CER Framework/POGIL activities
  - Conductivity Lab (Properties of Substances)
  - VSEPR Lab

**Alternative**

- Unit Portfolio
- Unit Presentations
- Projects
- Teacher-created assessment developed following 1:1 conference and/or review of student data/need

## Teaching and Learning Actions:

*Instructional Strategies and Activities*

Conductivity lab

- 1 class period

VSEPR lab

- 1 class period

Higher level classes will have to memorize polyatomic ions, while the lower level classes will be given a list to use throughout the chapter. Higher level classes will also get into more details with VSEPR, polarity, equation writing and bonding.

Covalent Bonds Gizmo - allows students to visualize and explore covalent bonding.

Ionic Bonds Gizmo - allows students to visualize and explore ionic bonding.

Additional differentiation activities as needed include:

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| | **English Lang**uage Learners:<br><br>● Teacher tutoring<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments (ex. Fewer items per page)<br>● Differentiated instruction<br>● Native language texts and native language to English dictionary<br>● Small Group Instruction<br>● Flexible Grouping<br>● Graphic Organizers for periodic table design<br>● Technology Integration<br>● Google translate for written work if needed<br>● Provide clear and specific directions<br>● Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing<br>● Provide class notes ahead of time to allow students to preview material and increase<br><br>**Special Education:**<br>● Follow all IEP modifications<br>● Audio books, Movies, and other digital media in lieu of print versions<br>● Oral instructions<br>● Record lessons instead of taking notes<br>● Outlines of lessons<br>● Multisensory Instruction / Multiple modalities<br>● Flexible Grouping<br>● Small Group Instruction<br>● Peer Buddies<br>● Graphic Organizers<br>● Chunking Information<br>● Scaffolded Questioning<br>● Manipulatives<br>● Provide clear and specific directions, orally and in writing |

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| | ● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide extended time<br>● Assign peer tutor<br>● Utilize visual charts/cues<br><br>**Students with 504 Plans:**<br>● Follow all 504 plan modifications<br>● Study Guide with answers<br>● Modified tests<br>● Provide extended time<br>● Graphic organizers<br>● Allow for differentiated assessment as long as it meets requirements<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide preferential seating if available and necessary<br>● Verbal and visual aides<br>● Verbal testing, if applicable<br>● Use written directions in additional to oral directions<br><br>**Gifted and Talented:**<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments<br>● Differentiated instruction<br>● Extension activities such as challenge questions or AP questions<br>● Opportunities for Critical Thinking embedded in lab activities<br>● Problem Solving/Design Challenges<br>● Technology Integration<br>● Student Choice Activities<br>● Performance task options to allow expansion on knowledge of element<br>● Enrichment Activities/Independent research<br>● Explore real world applications<br>● Act as a peer buddy |

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| | **Students At Risk of School Failure:**<br>● Response to Intervention (RTI)<br>● Give every opportunity for success<br>● Involve families in student learning<br>● Provide social/emotional support<br>● Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)<br>● Provide immediate praise and feedback<br>● Provide road maps or outlines for difficult concepts<br>● Provide sufficient wait time before calling on any student to help keep students who may need more time engaged<br>● Provide clear, achievable expectations; do not lower academic requirements<br>● Create a nurturing environment with structured routines |
| **Resources** | |
| Chemistry<br>textbook<br>NJCTL.org<br>http://phet.colorado.edu/en/simulation/ | |
| **Suggested Time Frame:** | 20 days |

| Content Area: | Chemistry | Grade(s) 10-12 |
|---|---|---|
| Unit Plan Title: | Unit 4 - Representing Chemical Reactions | |

**Overview/Rationale**

Chemistry is the study of the behavior of various types of matter. Students will differentiate among the different types of matter and identify the physical and chemical changes matter goes through. The students will differentiate between a physical change in matter and a chemical change of matter. Changes in matter can be written using chemical symbols when writing chemical reactions. Students will write various types of chemical reactions using such symbols.

The concept of the mole is the basis for relating mass, volume, and the number of particles of substance. Dimensional Analysis can be used to perform these conversions. Chemistry involves predicting whether a chemical reaction will occur between two substances. In order to do so, students must learn a systematic way to identify the type of chemical reaction that may potentially occur. Being able to quantify the amount of products produced or reagents used in a chemical reaction is an important skill to master in chemistry. Students will be able to predict the amount of product that should be produced in a chemical reaction.

**Science Standards (Established Goals)**

PS1.A: structure and properties of matter
PS1.B: chemical reactions

**Disciplinary Core Ideas**

HS-PS1-2: construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties
HS-PS1-4: 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

HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing temperature or concentration of the reacting particles on the rate at which a reaction occurs.
HS-PS1-7: use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

## Science and Engineering Practices

SEP2: Developing and using models
SEP3: Planning and carrying out investigations
SEP4: Analyzing and Interpreting data
SEP5: Using mathematics and computational thinking
SEP8: Obtaining, evaluating and communication of information

## Cross-Cutting Concepts

CCC1: Patterns
CCC2: Cause and Effect; Mechanism and Prediction
CCC3: Scale, Proportion, and Quantity
CCC4: Systems and System Models
CCC5: Energy and Matter: Flows, Cycles, and Conservation
CCC7: Stability and Change

## Computer Science & Design Thinking Standard(s) *(formerly Technology)*

8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.

## Interdisciplinary Standard(s)

**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-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)
**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)
**HSN-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-2), (HS-PS1-4), (HS-PS1-5), (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)
**HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-4), (HS-PS1-5), (HS-PS1- 7)

## Enduring Understandings:

***Students will understand that…***

- Students will learn to differentiate between a physical change and a chemical change.
- Students will write chemical reactions using elemental symbols. These skills will be used in subsequent units.
- The concept of the mole enables scientists to measure the mass or volume of a substance and then to calculate the number of particles in the sample.
- The mole was developed as a tool to relate the number of particles of a substance to its mass and volume.
- Dimensional Analysis is used in order to perform these conversions.
- Students will learn to predict the products and write five classes of chemical reactions: synthesis reactions, decomposition reactions, combustion reactions, single replacement reactions, and double replacement reactions.
- Stoichiometry is the science of the quantification of matter in chemical reactions.
- The mole concept and Dimensional Analysis are used to quantify the substances involved in chemical reactions.

- In a chemical reaction, the total mass of the reactants must equal the total mass of the products.
- Rates of reaction are impacted by the concentration of reacting species and the temperature of the system

**Essential Question(s) :**

What is the difference between a chemical change and a physical change?
How is a chemical reaction represented?
What are the five general types of chemical reactions?
How can one predict the products of the five general types of chemical reactions? How is the mass of one mole of a compound calculated?
How is the mole used to calculate the number of particles and the mass of a compound?
How is the process of stoichiometry used to convert between different substances in a chemical reaction?
How is percent yield calculated?
How can I manipulate the rate of a chemical reaction?

**In this unit plan, the following, 21st Century, Career Readiness, Life Literacies, and Key Skills are addressed:**

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
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.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

**Student Learning Goals/Objectives:**

Students will know….

- The differences between chemical and physical changes
- The symbols used in a chemical equation
- The generic forms for five general types of reactions
- That mass is conserved in a chemical reaction
- The relationships between moles, particles, and mass
- Definitions for limiting reactant, excess reactant, yield, theoretical yield, actual yield, percent yield
- That external factors can impact the rate of a chemical reaction
- The tenets of the Kinetic Molecular Theory

Students will be able to (do)…

- Distinguish between a chemical change and a physical change
- Write a chemical equation
- Classify a chemical reaction
- Predict the products of a chemical reaction
- Balance a chemical reaction
- Calculate the number of particles, moles, and mass of a substance Calculate relative masses of substances involved in a chemical reaction by using stoichiometry
- Calculate the percent yield of a reaction
- Describe, qualitatively, how temperature and concentration can affect the rate of reaction using kinetic molecular theory

**Assessment Evidence:**

**Formative**

- Observations during class
- Do now (topic relevant to each day's lesson)
- Homework/Classwork
- Class participation
- Student generated ideas in Venn Diagrams/Graphic Organizers
- CER (claim, evidence, reasoning) prompts
- Close Reading activities
- Various closure activities
- Online simulations

**Summative**

- Quizzes:
  - Physical & Chemical Changes
  - Reaction Types
  - Balancing
  - Moles
  - Reaction Rate
- Tests:
  - Chemical Reactions

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| • Present student generated data to support/argue a position<br>• Written assignments to include graphs, tables<br>• Student response systems (Kahoot. socrative, plickers) | ○ Stoichiometry<br><br>• Lab practicals/skills based assessments using CER Framework/POGIL activities<br>○ Conservation of Mass Lab<br>○ Chemical Reactions Lab<br>○ Stoichiometry Lab<br><br>**Alternative**<br>• Unit Portfolio<br>• Unit Presentations<br>• Projects<br>• Teacher-created assessment developed following 1:1 conference and/or review of student data/need |
| **Teaching and Learning Actions:** | |
| *Instructional Strategies and Activities*<br><br>Chemical vs. physical change videos<br>- half a class period<br><br>Conservation of mass activity<br>- 1 class period<br><br>Balancing equations activity<br>- half a class period<br><br>Chemical reactions labs<br>- 2-3 class periods<br><br>Stoichiometry labs | Higher level classes will learn how to apply the conservation of mass to an equation, while the lower level classes will learn about this concept and not do the math. Higher level classes will do more involved problems/equations dealing with balancing, predicting products and stoichiometry.<br><br>Balancing Chemical Equations Gizmo - helps students to visualize, at the particle level, what happens during a chemical reaction and apply that knowledge to balancing chemical equations.<br><br>Limiting Reactants Gizmo - encourages students to visualize the concept of a limiting reactant at the particulate level.<br><br>Additional differentiation activities as needed include: |

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| - 1-2 class periods | **English Language Learners:**<br><br>● Teacher tutoring<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments (ex. Fewer items per page)<br>● Differentiated instruction<br>● Native language texts and native language to English dictionary<br>● Small Group Instruction<br>● Flexible Grouping<br>● Graphic Organizers for periodic table design<br>● Technology Integration<br>● Google translate for written work if needed<br>● Provide clear and specific directions<br>● Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing<br>● Provide class notes ahead of time to allow students to preview material and increase<br><br>**Special Education:**<br>● Follow all IEP modifications<br>● Audio books, Movies, and other digital media in lieu of print versions<br>● Oral instructions<br>● Record lessons instead of taking notes<br>● Outlines of lessons<br>● Multisensory Instruction / Multiple modalities<br>● Flexible Grouping<br>● Small Group Instruction<br>● Peer Buddies<br>● Graphic Organizers<br>● Chunking Information<br>● Scaffolded Questioning<br>● Manipulatives<br>● Provide clear and specific directions, orally and in writing<br>● Provide class notes ahead of time to allow students to preview |

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| | material and increase comprehension<br>● Provide extended time<br>● Assign peer tutor<br>● Utilize visual charts/cues<br><br>**Students with 504 Plans:**<br>● Follow all 504 plan modifications<br>● Study Guide with answers<br>● Modified tests<br>● Provide extended time<br>● Graphic organizers<br>● Allow for differentiated assessment as long as it meets requirements<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide preferential seating if available and necessary<br>● Verbal and visual aides<br>● Verbal testing, if applicable<br>● Use written directions in additional to oral directions<br><br>**Gifted and Talented:**<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments<br>● Differentiated instruction<br>● Extension activities such as challenge questions or AP questions<br>● Opportunities for Critical Thinking embedded in lab activities<br>● Problem Solving/Design Challenges<br>● Technology Integration<br>● Student Choice Activities<br>● Performance task options to allow expansion on knowledge of element<br>● Enrichment Activities/Independent research<br>● Explore real world applications<br>● Act as a peer buddy |

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|---|---|
| | **Students At Risk of School Failure:**<br>● Response to Intervention (RTI)<br>● Give every opportunity for success<br>● Involve families in student learning<br>● Provide social/emotional support<br>● Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)<br>● Provide immediate praise and feedback<br>● Provide road maps or outlines for difficult concepts<br>● Provide sufficient wait time before calling on any student to help keep students who may need more time engaged<br>● Provide clear, achievable expectations; do not lower academic requirements<br>● Create a nurturing environment with structured routines |
| **Resources** | |
| Chemistry Book<br>Various websites/Youtube for videos<br>NJCTL.org<br>http://phet.colorado.edu/en/simulation/ | |
| **Suggested Time Frame:** | 30-40 days |

## Acknowledgements

| | |
|---|---|
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| George West | Principal, Middle Township High School |

## High School Physics Curriculum Work Committee

Kristina Ortman


# Introduction

This document serves to meet all requirements for curriculum as per the Middle Township Board of Education and the New Jersey Department of Education and will serve as a guide for lesson planning. Units within the curricular framework for science are designed to be taught in the order in which they are presented. Within the units, the teachers have flexibility of what order to present the standards.
Suggested Science and Engineering Practice Standards and Cross-Cutting Concepts are listed in each unit to be embedded regularly in daily science instruction.

# Course Description

Physics is defined as the science that involves the study of energy, matter and how they are related. Students will investigate and explore sound, light, energy, forces, motion, Newton's Laws, gravity, electricity, and nuclear physics. Upon completion of this course, students should not only understand the subject matter of physics, but also appreciate the interrelationship between physics, biology and chemistry. Physics fulfills the New Jersey science requirements for high school graduation. Application of the Next Generation Science Standards results in a balance of the three dimensions of the standards along with a focus on the interdisciplinary nature of all science domains among one another as well as with the New Jersey Student Learning Standards for Mathematics and English Language Arts.

# Three Dimensions of the Next Generation Science Standards

The National Research Council's (NRC) *Framework* describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents three dimensions that will be combined to form each standard:

## Dimension 1: Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like "skills" to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC's intent is to better explain and extend what is meant by "inquiry" in science and the range of cognitive, social, and physical practices that it requires.

Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.

## Dimension 2: Crosscutting Concepts

Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change. The Framework emphasizes that these concepts need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.

## Dimension 3: Disciplinary Core Ideas

Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have **broad importance** across multiple sciences or engineering disciplines or be a **key organizing concept** of a single discipline;
- Provide a **key tool** for understanding or investigating more complex ideas and solving problems;
- Relate to the **interests and life experiences of students** or be connected to **societal or personal concerns** that require scientific or technological knowledge;
- Be **teachable** and **learnable** over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science.

# Pacing Guide

| UNIT TITLE | ENDURING UNDERSTANDINGS | NGSS | TIMEFRAME |
|---|---|---|---|
| **Unit 1 - Introduction to Physics, Forces and Motion** | • There are certain procedures they must follow in order to maintain a safe environment during labs<br>• The scientific method is a set of steps scientists can use to solve a problem<br>• Principles of measurement<br>• How to interpret the motion of an on object (kinematics, graphs, free-fall and projectile motion)<br>• How a force moves an object (including circular motion and periodic motion)<br>• Newton's laws<br>• Friction<br>• What happens when objects collide<br>• How momentum is conserved during a collision | **HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-ETS1-2 HS-ETS1-3** | **25 – 35 days**<br>**SPED: 55-65 days** |
| **Unit 2 - Fundamental Forces** | • Newton's law of Universal Gravitation<br>• Coulomb's law<br>• Centripetal Force | **HS-PS2-4** | **10 days** |
| **Unit 3 - Kepler's Laws** | • Use mathematical or computational representations to predict the motion of orbiting objects in the solar system | **HS-ESS1-4** | **15 days** |
| **Unit 4 - Energy** | • Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter<br>• Energy and work are related through the work-energy theorem<br>• The total change of energy in a system is equal to the total energy transferred into and out of the system<br>• Power is determined by the rate at which work is being done | **HS-PS3-1 HS-PS3-2 HS-PS3-3 HS-ETS1-1,2,3, 4** | **30 days** |

| | | | |
|---|---|---|---|
| **Unit 5 - Fluids** | • Thermal energy is transferred using several different methods<br>• The state of matter of an object can be determined by the amount of energy it absorbs/releases | **HS-PS2-6**<br>**HS-PS3-2,4** | **15 days** |
| **Unit 6- Wave Properties** | • The fundamental measures of a wave are related to one another<br>• Interactions of waves affect the properties of waves<br>• How sound waves are different from light waves | **HS-PS4-1** | **20 days** |
| **Unit 7 – Electromagnetic Radiation** | • Electromagnetic radiation is both a wave and a particle<br>• How astronauts communicate with people on the ground<br>• Why digital technology has replaced analog technology<br>• How ray diagrams can be used to determine information | **HS-PS4-2: HS-PS4-3 HS-PS4-4 HS-PS4-5 HS-ETS1-1 HS-ETS1-3** | **30 days** |
| **Unit 8 - Electricity and Magnetism** | • Magnets or electric currents cause magnetic fields and that electric charges or changing magnetic fields cause electric fields<br>• When two objects interacting through a field change relative position, the energy stored in the field is changed<br>• How electric and magnetic fields are related | **HS-PS2-5 HS-PS3-5** | **15 days** |

| Content Area: | Physics | Grade(s) 11 - 12 |
|---|---|---|
| Unit Plan Title: | Unit 1 - Introduction to Physics, Forces and Motion | |

**Overview/Rationale**

Physics is a hands-on class. Students will first learn the safety procedures they must follow throughout this course, how to apply the scientific method to solve a problem and how to use dimensional analysis to convert between units of measure.

Students will develop an understanding of ideas related to why some objects keep moving and some objects fall to the ground. They will also build an understanding of forces and Newton's laws, develop an understanding that the total momentum of a system of objects is conserved when there is no net force on the system, and have an understanding of collisions.

**Science Standards (Established Goals)**

**HS-PS2-1**: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

**HS-PS2-2**: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.

**HS-PS2-3**: Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

**HS-ETS1-2**: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

**HS-ETS1-3**: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural and environmental impacts.

**Disciplinary Core Ideas**

**PS2.A**: Forces and motion

- Newton's second law accurately predicts changes in the motion of macroscopic objects
- Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object
- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system

**ETS1.A**: Defining and delimiting an engineer 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

**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

**Science and Engineering Practices**

**Analyzing and Interpreting Data Analyzing**

● Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

**Using Mathematics and Computational Thinking**

● Use mathematical representations of phenomena to describe explanations. Constructing Explanations and Designing Solutions

● Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects.

● Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.

● Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.

**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.

**Cross-Cutting Concepts**

Patterns:

- Different pattern may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena

Cause and effect:

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS- PS2-1)
- Systems can be designed to cause a desired effect. (HS-PS2-3)

Systems and systems models:

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. (HS-PS2-2)

**Primary Interdisciplinary Connections**

**Infused within the unit are connections to the NJSLS for Mathematics, Language Arts Literacy**

**English Language Arts**

NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.
NJSLSA.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
NJSLSA.SL1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
NJSLSA.SL2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
NJSLSA.SL5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

**Mathematics**

N.Q.A. Reason quantitatively and use units to solve problems.
N.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.
N.Q.A.2. Define appropriate quantities for the purpose of descriptive modeling.

N.Q.A.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

*Vector and Matrix Quantities*

N.VM.A. Represent and model with vector quantities.

N.VM.A.1. Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).

N.VM.A.2. Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N.VM.A.3. Solve problems involving velocity and other quantities that can be represented by vectors.

N.VM.A.B. Perform operations on vectors.

N.VM.A.4. Add and subtract vectors.

a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum

*Creating Equations*

A.CED.A. Create equations that describe numbers or relationships

A.CED.A.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A.CED.A.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A.CED.A.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

A.CED.A.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

*Reasoning with Equations and Inequalities*

A.REI.A. Understand solving equations as a process of reasoning and explain the reasoning

A.REI.A.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A.REI.A.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

A.REI.A.B. Solve equations and inequalities in one variable

A.REI.A.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.A.C. Solve systems of equations
A.REI.A.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A.REI.A.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

*Interpreting Functions*
F.IF.B. Interpret functions that arise in applications in terms of the context
F.IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
F.IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
F.IF.B.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
F.IF.C. Analyze functions using different representations
F.IF.C.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

*Building Functions*
F.BF.A. Build a function that models a relationship between two quantities
F.BF.A.1. Write a function that describes a relationship between two quantities.

*Linear and Exponential Models*
F.LE.A. Construct and compare linear and exponential models and solve problems
F.LE.A.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Computer Science and Design Thinking Standards**

- 8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
- 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
- 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

**Career Readiness, Life Literacies, and Key Skills**

● 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making.
● 9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
● 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities and utility for accomplishing a specified task.
● 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

**Enduring Understandings:**

***Students will understand that…***

The scientific method is a set of steps scientists can use to solve a problem
The metric system is used to take measurements and solve
equations All objects have the same acceleration due to gravity
Motion can be interpreted through graphs and mathematical
equations How a force moves an object
Newton's laws
How friction impacts the motion of an object
What happens when objects
collide
How momentum is conserved during a collision

**Essential Question(s) :**

How is the scientific method used to solve a problem?
How are metric prefixes converted?
What is the difference between distance and displacement?
Why do some objects keep moving while others fall to the ground? How do Newton's laws pertain to an object in periodic motion?
How does a force affect the motion of an object?
How can motion be represented graphically?
What happens when objects collide?
What happens to the motion of an object when there is friction?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| 21st Century Themes | 21st Century Skills |
| --- | --- |
| • **Global Awareness** | • **Critical Thinking and Problem Solving**<br>• **Creativity and Innovation**<br>• **Collaboration, Teamwork & Leadership** |

**Student Learning Goals/Objectives:**

| ***Students will know….*** | ***Students will be able to (do)…*** |
|---|---|
| The steps to the scientific method<br>The difference between vector quantities and scalar quantities<br>How to apply kinematics equations to solve problems Newton's laws<br>How Newton's laws affect an object in periodic motion How a force affects an object<br>How to determine if an object is accelerating<br>How to represent motion by using graphs<br>How friction impacts the motion of an object<br>How momentum is conserved during a collision<br>How external forces affect the overall momentum of a system | Apply the scientific method to solve a problem<br>Differentiate between scalar and vector quantities<br>Apply the principles of measurement<br>Solve problems involving motion (algebraically and graphically) 1-dimension and 2-dimension<br>Apply Newton's laws to everyday situations<br>Interpret motion diagrams<br>Analyze data to support Newton's laws of motion<br>Calculate the force of friction |
| **Assessment Evidence:** | |
| ***Performance Tasks:***<br>● Technology Integration<br>○ Google Forms<br>○ Google Docs/Slide for individual topics<br>○ Vernier software<br>○ PhET simulations<br>○ Gizmos - Friction, Forces<br>● Performance Task<br>○ Newton's Laws Project: Students will create a comic strip or cartoon representing each of Newton's 3 laws. This will show the student's understanding of Newton's laws and how it applies to everyday situations | **Other Assessment Measures*:***<br>● Formative<br>○ Observations of student progress during class<br>○ Warm-Ups and Ticket-Outs<br>○ Homework to reinforce concepts<br>○ Lab activities<br>○ Class participation<br>○ Quizzes on individual topics<br>● Summative<br>○ Tests: 1D, 2D, momentum/collisions<br>○ Lab reports<br>○ Projects<br>● Benchmark<br>○ NJSLA assessment<br>○ SGO assessments |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time

- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support

● Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
● Provide immediate praise and feedback
● Provide high interest topics/options
● Provide road maps or outlines for difficult concepts
● Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
● Provide clear, achievable expectations; do not lower academic requirements
● Create a nurturing environment with structured routines
● Teach study skills
● Allow for alternative assignments
● Provide visuals
● Assign peer tutor
● Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
● Create a familial atmosphere by using inclusive and affiliative language
● Provide needed academic resources (if an issue) such as paper, pencils, calculators
● Help students with goal-setting skills
● Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources | |
|---|---|
| Physics Book, NJCTL.org , Sciencespot.com, pHet.com, Vernier.com, physlab.com, Explorelearning.com | |
| Suggested Time Frame: | 25-35 days (55-65 days for SPED) |

| Content Area: | Physics | Grade(s) 11 |
|---|---|---|
| Unit Plan Title: | Unit 2 - Fundamental Forces | |

**Overview/Rationale**

Make sense of Newton's law of gravitation and Coulomb's law

**Science Standards (Established Goals)**

**HS-PS2-4**: Use mathematical representations of Newton's law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

**Disciplinary Core Ideas**

**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.
- 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.

**Science and Engineering Practices**

**Using Mathematics and Computational Thinking**

- Use mathematical representations of phenomena to describe explanations.

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

- Theories and laws provide explanations in science.
- Laws are statements or descriptions of the relationships among observable phenomena.

**Cross-Cutting 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-PS2-4)

**Primary Interdisciplinary Connections**

**Infused within the unit are connections to the NJSLS for Mathematics, Language Arts Literacy**

**English Language Arts**

NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. NJSLSA.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.

NJSLSA.SL1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

NJSLSA.SL2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

NJSLSA.SL5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

**Mathematics**

*Quantities*

N.Q.A. Reason quantitatively and use units to solve problems.

N.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.

N.Q.A.2. Define appropriate quantities for the purpose of descriptive modeling.

N.Q.A.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

*Creating Equations*

A.CED.A. Create equations that describe numbers or relationships

A.CED.A.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A.CED.A.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A.CED.A.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
A.CED.A.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

*Reasoning with Equations and Inequalities*
A.REI.A. Understand solving equations as a process of reasoning and explain the reasoning
A.REI.A.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A.REI.A.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
A.REI.B. Solve equations and inequalities in one variable
A.REI.B.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.C. Solve systems of equations
A.REI.C.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A.REI.C.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

*Interpreting Functions*
F.IF.B. Interpret functions that arise in applications in terms of the context
F.IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
F.IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
F.IF.B.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
F.IF.C. Analyze functions using different representations
F.IF.C.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

*Building Functions*
F.BF.A. Build a function that models a relationship between two quantities
F.BF.A.1. Write a function that describes a relationship between two quantities.

*Linear and Exponential Models*

F.LE.A. Construct and compare linear and exponential models and solve problems

F.LE.A.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Computer Science and Design Thinking Standards**

- 8.1.12.DA.2: Describe the tradeoffs in how and where data is organized and stored.
- 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
- 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

**Career Readiness, Life Literacies, and Key Skills**

- 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making.
- 9.2.12.CAP.12: Analyze how the economic, social, and political conditions of a time period can affect the labor market.
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.

**Enduring Understandings:**

***Students will understand that…***

Gravitational and electrostatic forces change between objects according to Newton and Coulomb's law Newton's laws can be applied to objects in uniform circular motion

There are different types of fundamental forces

There are different factors that go into determining the gravitational force between objects

The electric force between two charges is inversely proportional to the square of the distance between the two charges

**Essential Question(s) :**

How are the gravitational and electrostatic forces between two objects determined? How is Newton's law of gravitation applied to objects in uniform circular motion?

What are the four fundamental forces?

What factors affect the gravitational force between objects?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| 21st Century Themes | 21st Century Skills |
|---|---|
| • **Global Awareness** | • **Critical Thinking & Problem Solving**<br>• **Collaboration, Teamwork & Leadership** |

**Student Learning Goals/Objectives:**

| ***Students will know….*** | ***Students will be able to (do)…*** |
|---|---|
| The gravitational force between two bodies is inversely proportional to the square of the distance between the two bodies.<br>Apply Newton's universal law of gravitation to find the gravitational force between two masses.<br>The electric force between two charges is inversely proportional to the square of the distance between the two charges.<br>The force of gravity is an attractive force.<br>How to make sense of Newtons' laws, Newton's law of gravitation and Coulomb's law<br>How to apply Newton's law of gravity to objects in uniform circular motion | Plan and conduct investigations and apply scientific ideas to make sense of Newton's law of gravitation and Coulomb's law<br><br>Apply these laws to describe and predict the gravitational and electrostatic forces between objects.<br><br>Determine how forces move objects |

| **Assessment Evidence:** | |
|---|---|
| ***Performance Tasks:***<br>● Technology Integration<br>○ Google Forms<br>○ Google Docs/Slide for individual topics<br>○ Vernier software<br>○ PhET simulations<br>○ Gizmos - Universal Gravitation, Centripetal Motion<br>● Performance Task<br>○ Using Gizmos to test how different factors affect the gravitational force between two objects | **Other Assessment Measures*:***<br>● Formative<br>○ Observations of student progress during class<br>○ Warm-Ups and Ticket-Outs<br>○ Homework to reinforce concepts<br>○ Lab activities<br>○ Class participation<br>○ Quizzes on individual topics<br>● Summative<br>○ Tests: Universal Gravitation, Centripetal Motion, Forces<br>○ Lab reports<br>○ Projects<br>● Benchmark<br>○ NJSLA assessment<br>○ SGO assessments |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing

- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions

- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills

- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources | |
|---|---|
| Physics Book, NJCTL.org , Sciencespot.com, pHet.com, Vernier.com, physlab.com, Explorelearning.com | |
| Suggested Time Frame: | 20 days |

| Content Area: | Physics | Grade(s) 11 |
|---|---|---|
| Unit Plan Title: | Unit 3 - Kepler's Laws | |

**Overview/Rationale**

Examine the processes governing the workings of the solar system and universe

**Science Standards (Established Goals)**

**HS-ESS1-4:** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system

**Disciplinary Core Ideas**

**ESS1.B:** Earth and the Solar System.
Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system

**Science and Engineering Practices**

Using mathematics and computational thinking

- Use mathematical or computational representations of phenomena to describe explanations.

**Cross-Cutting Concepts**

Scale, Proportion, and Quantity:
● Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Interdependence of Science, Engineering, and Technology:
● Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

**Primary Interdisciplinary Connections**

**Infused within the unit are connections to the NJSLS for Mathematics, Language Arts Literacy**

**English Language Arts**

NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. NJSLSA.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
NJSLSA.SL1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
NJSLSA.SL2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
NJSLSA.SL5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

**Mathematics**

*Quantities*

N.Q.A. Reason quantitatively and use units to solve problems.
N.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.
N.Q.A.2. Define appropriate quantities for the purpose of descriptive modeling.
N.Q.A.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

*Creating Equations*

A.CED.A. Create equations that describe numbers or relationships
A.CED.A.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
A.CED.A.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A.CED.A.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
A.CED.A.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

*Reasoning with Equations and Inequalities*
A.REI.A. Understand solving equations as a process of reasoning and explain the reasoning
A.REI.A.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A.REI.A.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
A.REI.B. Solve equations and inequalities in one variable
A.REI.B.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.C. Solve systems of equations
A.REI.C.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A.REI.C.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

*Interpreting Functions*
F.IF.B. Interpret functions that arise in applications in terms of the context
F.IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
F.IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
F.IF.B.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
F.IF.C. Analyze functions using different representations
F.IF.C.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

*Building Functions*
F.BF.A. Build a function that models a relationship between two quantities
F.BF.A.1. Write a function that describes a relationship between two quantities.

*Linear and Exponential Models*
F.LE.A. Construct and compare linear and exponential models and solve problems
F.LE.A.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Computer Science and Design Thinking Standards**

- 8.1.12.DA.2: Describe the tradeoffs in how and where data is organized and stored.
- 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

- 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

**Career Readiness, Life Literacies, and Key Skills**

- 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making.
- 9.2.12.CAP.12: Analyze how the economic, social, and political conditions of a time period can affect the labor market.
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.

**Enduring Understandings:**

***Students will understand that…***

Use mathematical or computational representations to predict the motion of orbiting objects in the solar system

**Essential Question(s) :**

How does gravity affect motion in the solar system?
What are Kepler's three laws and how do they pertain to space?
How do satellites stay in orbit rather than colliding with the Earth?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| **21st Century Themes** | **21st Century Skills** |
|---|---|
| • Global Awareness | • Critical Thinking & Problem Solving<br>• Collaboration, Teamwork & Leadership |

**Student Learning Goals/Objectives:**

| ***Students will know….*** | ***Students will be able to (do)…*** |
|---|---|
| Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.<br>Kepler's Laws of Planetary Motion can predict the orbital period and velocity of planets, and both man-made and natural satellites. | Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.<br><br>Use mathematical and computational representations of Newtonian gravitational laws governing orbital motion that apply to moons and human-made satellites.<br><br>Use algebraic thinking to examine scientific data and predict the motion of orbiting objects in the solar system. |

**Assessment Evidence:**

| ***Performance Tasks:*** | **Other Assessment Measures*:*** |
|---|---|
| ● Technology Integration<br>○ Google Forms<br>○ Google Docs/Slide for individual topics<br>○ PhET simulations<br>○ Gizmos - Kepler's Laws<br>● Performance Task<br>○ Gravity and Orbits - PhET or Gizmo simulation to identify Kepler's 3 laws of planetary motion | ● Formative<br>○ Observations of student progress during class<br>○ Warm-Ups and Ticket-Outs<br>○ Homework to reinforce concepts<br>○ Lab activities<br>○ Class participation<br>○ Quizzes on individual topics<br>● Summative<br>○ Tests: Kepler's Laws<br>○ Lab reports<br>● Benchmark<br>○ NJSLA assessment<br>○ SGO assessments |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction

- Peer Buddies
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension

- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback

- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources | |
|---|---|
| Physics Book, NJCTL.org , Sciencespot.com, pHet.com, Vernier.com, physlab.com, Explorelearning.com | |
| Suggested Time Frame: | 15 days |

| Content Area: | Physics | Grade(s) 11 |
|---|---|---|
| Unit Plan Title: | Unit 4 – Work and Energy | |

**Overview/Rationale**

Students will be able to differentiate between different types of energy, understand how energy is conserved and transferred, and the relationship between energy and forces.

**Science Standards (Established Goals)**

**HS-PS3-1:** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

**HS-PS3-2:** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects)

**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

**HS-ETS1-1:** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants

**HS-ETS1-2:** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering

**HS-ETS1-3**: Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

**HS-ETS1-4:** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

**Disciplinary Core Ideas**

PS3.A: Definitions of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

PS3.B: Conservation of Energy and Energy Transfer

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
- The availability of energy limits what can occur in any system.

PS3.D: Energy in Chemical Processes

- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.

ETS1.A: Defining and Delimiting Engineering Problems

- 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.

**Science and Engineering Practices**

**Developing and Using Models**
● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

**Using Mathematics and Computational Thinking**
● Create a computational model or simulation of a phenomenon, designed device, process, or system.

**Constructing Explanations and Designing Solutions**
● 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.

**Cross-Cutting Concepts**

Systems and system models:

- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4)

Energy and matter:

- 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-PS3-3)
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)

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

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

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.

**Primary Interdisciplinary Connections**

**Infused within the unit are connections to the NJSLS for Mathematics, Language Arts Literacy**

**English Language Arts**

NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. NJSLSA.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
NJSLSA.SL1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
NJSLSA.SL2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
NJSLSA.SL5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

**Mathematics**

*Quantities*

N.Q.A. Reason quantitatively and use units to solve problems.
N.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.
N.Q.A.2. Define appropriate quantities for the purpose of descriptive modeling.
N.Q.A.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

*Creating Equations*

A.CED.A. Create equations that describe numbers or relationships
A.CED.A.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
A.CED.A.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A.CED.A.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

A.CED.A.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

*Reasoning with Equations and Inequalities*
A.REI.A. Understand solving equations as a process of reasoning and explain the reasoning
A.REI.A.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A.REI.A.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
A.REI.B. Solve equations and inequalities in one variable
A.REI.B.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.C. Solve systems of equations
A.REI.C.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A.REI.C.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

*Interpreting Functions*
F.IF.B. Interpret functions that arise in applications in terms of the context
F.IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
F.IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
F.IF.B.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
F.IF.C. Analyze functions using different representations
F.IF.C.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

*Building Functions*
F.BF.A. Build a function that models a relationship between two quantities
F.BF.A.1. Write a function that describes a relationship between two quantities.

*Linear and Exponential Models*
F.LE.A. Construct and compare linear and exponential models and solve problems
F.LE.A.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Career Readiness, Life Literacies, and Key Skills**

- 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making.
- 9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities and utility for accomplishing a specified task.
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

**Enduring Understandings:**

***Students will understand that…***

Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter The total change of energy in a system is equal to the total energy transferred into and out of the system
There is a relationship between rotational motion and linear motion

**Essential Question(s) :**

What is work and how is it calculated?
How are work and energy related?
What are the two main types of energy and what are some examples of each?
How is energy transferred and conserved? How are changes in energy calculated?
What is power and how is it calculated?

| **In this unit plan, the following 21st Century themes and skills are addressed:** | |
|---|---|
| **21st Century Themes**<br><br>● Global Awareness<br>● Environmental Literacy | **21st Century Skills**<br><br>● Critical Thinking & Problem Solving<br>● Collaboration, Teamwork & Leadership |

| **Student Learning Goals/Objectives:** | |
|---|---|
| ***Students will know….***<br>The differences in the types of energy and be able to state examples of each<br>How work and power are related to<br>energy What conservation means<br>That energy can't be created or destroyed<br>Energy is a quantitative property of a system that depends on the motion and interactions of matter within that system | ***Students will be able to (do)…***<br>Calculate changes in kinetic energy and potential energy of a system<br>Differentiate between the different types of potential energy<br>- gravitational vs elastic<br>Calculate the amount of work/power in a system<br>Identify the various types of energy within a system<br>Apply the conservation of energy to real-world problems |

**Assessment Evidence:**

***Performance Tasks:***

Technology Integration
- Google Forms
- Google Docs/Slide for individual topics
- PhET simulations
- Gizmos - Work

- Performance Task: Engineering and Energy Transfer
  - Students will engineer a product that allows them to study energy transfer, specifically looking at PE and KE. Options could include a Rube Goldberg, mouse trap cars, roller coasters, nerf guns, catapults. Students will argue the effectiveness of their product.

**Other Assessment Measures*:***

- Formative
  - Observations of student progress during class
  - Warm-Ups and Ticket-Outs
  - Homework to reinforce concepts
  - Lab activities
  - Class participation
  - Quizzes on individual topics
- Summative
  - Tests: Work and Energy
  - Lab reports
- Benchmark
  - NJSLA assessment
  - SGO assessments

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities

- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element

- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language

- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources |
|---|

| | |
|---|---|
| Physics Book, NJCTL.org , Sciencespot.com, pHet.com, Vernier.com, physlab.com, Explorelearning.com | |
| Suggested Time Frame: | 30 days |

| | | | |
|---|---|---|---|
| **Content Area:** | **Physics** | **Grade(s)** | 11 |
| **Unit Plan Title:** | **Unit 5 - Fluids** | | |

**Overview/Rationale**

Students will be able to differentiate between fluid statics and fluid dynamics.
Students will understand how energy affects the state of matter a substance is in.
Students will be able to calculate the amount of energy it takes for a substance to go through a phase change.

**Science Standards (Established Goals)**

**HS-PS3-1:** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
**HS-PS3-4:** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperatures are combined within a closed system results in a more uniform energy distribution among the components in the system
**HS-ETS1-2:** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering

**Disciplinary Core Ideas**

PS3.A: Definitions of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

PS3.B: Conservation of Energy and Energy Transfer

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
- The availability of energy limits what can occur in any system.

PS3.D: Energy in Chemical Processes

- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.

ETS1.A: Defining and Delimiting Engineering Problems

- 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.

**Science and Engineering Practices**

**Developing and Using Models**

● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

**Using Mathematics and Computational Thinking**

● Create a computational model or simulation of a phenomenon, designed device, process, or system.

**Constructing Explanations and Designing Solutions**

● 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.

**Cross-Cutting Concepts**

Systems and system models:

- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4)

Energy and matter:

- 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-PS3-3)
- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems. (HS-PS3-2)

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

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

Scientific Knowledge Assumes an Order and Consistency in Natural Systems:

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*Quantities*

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*Interpreting Functions*
F.IF.B. Interpret functions that arise in applications in terms of the context
F.IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
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F.BF.A. Build a function that models a relationship between two quantities
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*Linear and Exponential Models*
F.LE.A. Construct and compare linear and exponential models and solve problems
F.LE.A.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Career Readiness, Life Literacies, and Key Skills**

● 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making.
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● 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities and utility for accomplishing a specified task.
● 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

**Enduring Understandings:**

***Students will understand that…***

Thermal energy is transferred using several different methods

The state of matter of an object can be determined by the amount of energy it absorbs/releases

**Essential Question(s) :**

What is thermal energy?

How can thermal energy be transferred? What is specific heat?

What is the difference between fluid statics and fluid dynamics?

How does the buoyant force determine if an object will float or sink?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| 21st Century Themes | 21st Century Skills |
| --- | --- |
| • Global Awareness<br>• Environmental Literary | • Critical Thinking & Problem Solving<br>• Creativity and Innovation<br>• Collaboration, Teamwork and Leadership |

| **Student Learning Goals/Objectives:** | |
|---|---|
| ***Students will know….*** | ***Students will be able to (do)…*** |
| How thermal energy is transferred between objects<br>How to calculate the specific heat of a substance<br>How the amount of energy affects the state of matter a substance is in The difference between fluid statics and fluid dynamics | Calculate specific heat<br>Apply the idea of calorimetry to two substances Apply Pascal's principle<br>Calculate the buoyant force on an object<br>Apply Archimede's and Bernoulli's principles to an object |
| **Assessment Evidence:** | |
| ***Performance Tasks:*** | **Other Assessment Measures*:*** |
| ● Technology Integration<br>○ Google Forms<br>○ Google Docs/Slide for individual topics<br>○ PhET simulations<br>○ Gizmos - Archimedes' Principle<br>● Performance Task: Engineering and Fluids<br>○ Students will engineer a paper airplane using principles discussed in this unit. They will fly their airplanes in a contest then discuss what made their airplane fly. | ● Formative<br>○ Observations of student progress during class<br>○ Warm-Ups and Ticket-Outs<br>○ Homework to reinforce concepts<br>○ Lab activities<br>○ Class participation<br>○ Quizzes on individual topics<br>● Summative<br>○ Tests: Fluids<br>○ Lab reports<br>○ Projects<br>● Benchmark<br>○ NJSLA assessment<br>○ SGO assessments |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping

- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

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- Provide clear and specific directions, orally and in writing
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- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides

- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
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- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
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- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources | |
|---|---|
| Physics Book, NJCTL.org , Sciencespot.com, pHet.com, Vernier.com, physlab.com, Explorelearning.com | |
| Suggested Time Frame: | 15 days |

| Content Area: | Physics | Grade(s) 11 |
|---|---|---|
| Unit Plan Title: | Unit 6- Wave Properties | |

**Overview/Rationale**

Students will apply their understanding of how wave properties can be used to transfer information across long distances, store information, and investigate nature on many scales.
Students will also understand the difference between types of waves.

**Science Standards (Established Goals)**

**HS-PS4-1:** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

**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.

**Science and Engineering Practices**

**Using Mathematics and Computational Thinking**
- Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.

**Cross-Cutting 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)

**Primary Interdisciplinary Connections**
**Infused within the unit are connections to the NJSLS for Mathematics, Language Arts Literacy**

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**Mathematics**

*Quantities*

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A.CED.A.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
A.CED.A.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.
*Reasoning with Equations and Inequalities*
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A.REI.A.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
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A.REI.A.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.A.C. Solve systems of equations
A.REI.A.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A.REI.A.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

*Interpreting Functions*
F.IF.B. Interpret functions that arise in applications in terms of the context
F.IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
F.IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
F.IF.B.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
F.IF.C. Analyze functions using different representations
F.IF.C.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

*Building Functions*
F.BF.A. Build a function that models a relationship between two quantities
F.BF.A.1. Write a function that describes a relationship between two quantities.

*Linear and Exponential Models*

F.LE.A. Construct and compare linear and exponential models and solve problems

F.LE.A.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Computer Science and Design Thinking Standards**

- 8.1.12.DA.2: Describe the tradeoffs in how and where data is organized and stored.
- 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
- 8.2.12.ETW.2: Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment.

**Career Readiness, Life Literacies, and Key Skills**

- 9.1.12.CFR.1: Compare and contrast the role of philanthropy, volunteer service, and charities in community development and quality of life in a variety of cultures.
- 9.2.12.CAP.22: Identify different ways to obtain capital for starting a business.
- 9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.

**Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)**

***Students will understand that…***

There are different types of waves and how they are similar/different from one another

The fundamental measures of a wave are related to one another Interactions of waves affect the properties of waves

How sound waves are different from light waves

**Essential Question(s) :**

What are waves and how do they transfer energy?

What are the similarities/differences between mechanical and electromagnetic waves?

What are the fundamental measures of a wave, and how are they related to one another? What happens when waves interfere with each other?

What is the Principle of Superposition and how does it affect the interference of waves?

What is the difference between sound waves and light waves?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| **21st Century Themes** | **21st Century Skills** |
| --- | --- |
| ● Global Awareness<br>● Environmental Literacy | ● Critical Thinking & Problem Solving<br>● Creativity and Innovation<br>● Collaboration, Teamwork & Leadership |

**Student Learning Goals/Objectives:**

| ***Students will know….*** | ***Students will be able to (do)…*** |
|---|---|
| The differences between types of waves<br>How frequency, speed and velocity of a wave are related<br>How a sound wave changes by adjusting the frequency of the wave<br>What happens when waves interfere with each other<br>How the Doppler Shift works<br>How a wave refracts, reflects and diffracts How Snell's Law works | Differentiate between types of waves<br>Calculate the speed, velocity and frequency of a waves by using the wave equation<br>Apply the Doppler Shift to real-world scenarios<br>Trace the course of different light rays and calculate the angle of incidence and to apply Snell's Law<br>Predict what will happen to the properties of a wave when it crosses a boundary<br>Predict what will happen to waves when they interfere with one another |

**Assessment Evidence:**

| ***Performance Tasks:*** | **Other Assessment Measures*:*** |
|---|---|
| ● Technology integration:<br>● Vernier Software & Technology<br>● Google Forms quizzes<br>● Docs/Slides/Sites creation for each individual topic<br>● PhET Simulations of waves<br>● The Physics Classroom simulations<br>● Performance Tasks:<br>○ Doppler Effect: Students will research how sound and light waves display the doppler effect. They will then make an argument for how the Doppler effect might be used as evidence for the expansion of our Universe and the Big Bang theory | ● Formative<br>○ Homework assignments to reinforce understanding of wave behavior, calculations and interactions<br>○ Warm-ups and ticket outs<br>○ Labs on each topic<br>○ Quizzes<br>○ PhET simulations<br>● Summative<br>○ Unit Test - Waves<br>○ Laboratory Reports |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success

- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources | |
|---|---|
| Physics Book, NJCTL.org , Sciencespot.com, pHet.com, Vernier.com, physlab.com, Explorelearning.com | |
| Suggested Time Frame: | 20 days |

| Content Area: | Physics | Grade(s) 11 |
|---|---|---|
| Unit Plan Title: | Unit 7 - Electromagnetic Radiation | |

**Overview/Rationale**

Students will apply their understanding of wave properties to make sense of how electromagnetic radiation can be used to transfer information across long distances, store information, and be used to investigate nature on many scales.

**Science Standards (Established Goals)**

**HS-PS4-2**. Evaluate questions about the advantages of using digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]

**HS-PS4-3.** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]

**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.]

**HS-PS4-5.** Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]

**HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

**HS-ETS1-3.** Evaluate a solution to a complex real world problem based on prioritized criteria and trade offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts

**Disciplinary Core Ideas**

PS3.D: Energy in Chemical Processes
● Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy.

PS4.A: Wave Properties
● Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.

PS4.B: Electromagnetic Radiation
● Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.
● 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.
● Photoelectric materials emit electrons when they absorb light of a high-enough frequency.

PS4.C: Information Technologies and Instrumentation Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.

**Science and Engineering Practices**

Asking Questions and Defining Problems:

● Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

Engaging in Argument from Evidence:

● Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

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.

● Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

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.

**Cross-Cutting Concepts**

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.

● Systems can be designed to cause a desired effect.

Systems and System Models:

● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (HS-PS4-3)

Stability and Change:

● Systems can be designed for greater or lesser stability. Interdependence of Science, Engineering, and Technology

● Science and engineering complement each other in the cycle known as research and development (R&D).

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

● Modern civilization depends on major technological systems.
● Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

**Primary Interdisciplinary Connections**
**Infused within the unit are connections to the NJSLS for Mathematics, Language Arts Literacy**

**English Language Arts**
NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. NJSLSA.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
NJSLSA.SL1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
NJSLSA.SL2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
NJSLSA.SL5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

**Mathematics**
*Quantities*
N.Q.A. Reason quantitatively and use units to solve problems.
N.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.
N.Q.A.2. Define appropriate quantities for the purpose of descriptive modeling.
N.Q.A.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

*Creating Equations*
A.CED.A. Create equations that describe numbers or relationships
A.CED.A.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A.CED.A.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A.CED.A.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
A.CED.A.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

*Reasoning with Equations and Inequalities*
A.REI.A. Understand solving equations as a process of reasoning and explain the reasoning
A.REI.A.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A.REI.A.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
A.REI.B. Solve equations and inequalities in one variable
A.REI.B.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.C. Solve systems of equations
A.REI.C.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A.REI.C.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

*Interpreting Functions*
F.IF.B. Interpret functions that arise in applications in terms of the context
F.IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
F.IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
F.IF.B.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
F.IF.C. Analyze functions using different representations
F.IF.C.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

*Building Functions*
F.BF.A. Build a function that models a relationship between two quantities
F.BF.A.1. Write a function that describes a relationship between two quantities.

*Linear and Exponential Models*
F.LE.A. Construct and compare linear and exponential models and solve problems
F.LE.A.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Computer Science and Design Thinking Standards**

- **8.1.12.DA.2: Describe the tradeoffs in how and where data is organized and stored.**
- **8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.**
- **8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.**
- **8.2.12.EC.3: Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual.**

**Career Readiness, Life Literacies, and Key Skills**

- **9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making.**
- **9.2.12.CAP.12: Analyze how the economic, social, and political conditions of a time period can affect the labor market.**
- **9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.**
- **9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.**

**Enduring Understandings:**

***Students will understand that…***

Electromagnetic radiation can be modeled as a wave of changing electric and magnetic fields or as particles

Electromagnetic radiation can be used to transfer information across long distance

How electromagnetic radiation is used to store information

How electromagnetic radiation can be used to investigate nature on many scales

**Essential Question(s) :**

How is electromagnetic radiation used to transfer information across long distances?
How is electromagnetic radiation used to store information?
How can electromagnetic radiation be used to investigate nature on many scales?

**In this unit plan, the following 21st Century themes and skills are addressed:**

| 21st Century Themes | 21st Century Skills |
| --- | --- |
| ● Global Awareness<br>● Environmental Literacy | ● Critical Thinking & Problem Solving<br>● Creativity and Innovation<br>● Cross-Cultural and Interpersonal Communication |

**Student Learning Goals/Objectives:**

| ***Students will know….*** | ***Students will be able to (do)…*** |
|---|---|
| Models of electromagnetic radiation as both a wave of changing electrical and magnetic fields or as particles are developed and used.<br>There are 5 types of electromagnetic radiation<br>Electromagnetic radiation is a way of transferring information across distances and storing information.<br>That light is the visible portion of the electromagnetic spectrum.<br>Describe the ray model of light.<br>The Law of Reflection.<br>How to calculate the index of refraction in a given medium | Identify the different types of electromagnetic radiation<br>Demonstrate the principle of superposition Draw ray diagrams for light rays<br>Apply the additive/subtractive color processes<br>Present information about how technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. |

**Assessment Evidence:**

| ***Performance Tasks:*** | **Other Assessment Measures*:*** |
|---|---|
| **Performance Tasks/Use of Technology:**<br>● Technology integration:<br>○ Google Forms quizzes on electromagnetic radiation properties<br>○ Various internet search engines to research how electromagnetic radiation is used<br>○ Google Docs/Slides/Sites creation for each individual topic<br>○ PhET simulations and Gizmo labs<br><br>● Performance Task:<br>Electromagnetic Effects on the Human Body: Students will work in collaborative teams to research information about different frequencies of electromagnetic waves to determine wavelength, usage in society, and effects on the human body (dangerous vs not dangerous) then share their findings. Students should then make a claim about which wavelength/frequency is the most useful and/or the most dangerous to humans. | ● Formative<br>○ Homework assignments to reinforce understanding of wave behavior, calculations and interactions<br>○ Warm-ups and ticket outs<br>○ Class participation<br>○ Labs on each topic<br>○ Quizzes<br>○ PhET simulations<br><br>● Summative<br>○ Unit Test - EM Radiation<br>○ Laboratory Reports - ray diagrams, polarization activity<br>○ SGO |

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements

- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback

- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child's achievement level
- Create a familial atmosphere by using inclusive and affiliative language
- Provide needed academic resources (if an issue) such as paper, pencils, calculators
- Help students with goal-setting skills
- Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration

| Resources | |
|---|---|
| Physics Book, NJCTL.org , Sciencespot.com, pHet.com, Vernier.com, physlab.com, Explorelearning.com | |
| Suggested Time Frame: | 30 days |

| Content Area: | Physics | Grade(s) 11 |
|---|---|---|
| Unit Plan Title: | Unit 8 - Electricity and Magnetism | |

**Overview/Rationale**

Students will have an understanding of how forces at a distance can be explained by fields, why some materials are attracted to each other while others are not, how magnets or electric currents cause magnetic fields, and how charges or changing magnetic fields cause electric fields.

**Science Standards (Established Goals)**

HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.]

HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]

**Disciplinary Core Ideas**

PS2.B: Types of Interactions

- 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.

PS3.C: Relationship Between Energy and Forces When two objects interacting through a field change relative position, the energy stored in the field is changed.

**Science and Engineering Practices**

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.

Developing and Using Models

● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

**Cross-Cutting Concepts**

Cause and Effect

● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

● 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.

**Primary Interdisciplinary Connections**
**Infused within the unit are connections to the NJSLS for Mathematics, Language Arts Literacy**

**English Language Arts**

NJSLSA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.
NJSLSA.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
NJSLSA.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. NJSLSA.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
NJSLSA.SL1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
NJSLSA.SL2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
NJSLSA.SL5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

**Mathematics**

*Quantities*

N.Q.A. Reason quantitatively and use units to solve problems.
N.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.
N.Q.A.2. Define appropriate quantities for the purpose of descriptive modeling.
N.Q.A.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

*Creating Equations*
A.CED.A. Create equations that describe numbers or relationships
A.CED.A.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
A.CED.A.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A.CED.A.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.
A.CED.A.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

*Reasoning with Equations and Inequalities*
A.REI.A. Understand solving equations as a process of reasoning and explain the reasoning
A.REI.A.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
A.REI.A.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
A.REI.B. Solve equations and inequalities in one variable
A.REI.B. 3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.C. Solve systems of equations
A.REI.C.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
A.REI.C.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

*Interpreting Functions*
F.IF.B. Interpret functions that arise in applications in terms of the context

F.IF.B.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
F.IF.B.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
F.IF.B.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval.
F.IF.C. Analyze functions using different representations
F.IF.C.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

*Building Functions*
F.BF.A. Build a function that models a relationship between two quantities
F.BF.A.1. Write a function that describes a relationship between two quantities.

*Linear and Exponential Models*
F.LE.A. Construct and compare linear and exponential models and solve problems
F.LE.A.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

**Computer Science and Design Thinking Standards**

- 8.1.12.DA.2: Describe the tradeoffs in how and where data is organized and stored.
- 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
- 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

**Career Readiness, Life Literacies, and Key Skills**

- 9.1.12.FP.5: Evaluate how behavioral bias (e.g., overconfidence, confirmation, recency, loss aversion, etc.) affects decision making.
- 9.2.12.CAP.12: Analyze how the economic, social, and political conditions of a time period can affect the labor market.
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.

**Enduring Understandings:**

***Students will understand that…***

Like charges repel and opposite charges attract.
Coulomb's Law describes the force between charges.
Magnets or electric currents cause magnetic fields and that electric charges or changing magnetic fields cause electric fields When two objects interacting through a field change relative position, the energy stored in the field is changed
Components of circuits can be arranged in series and/or parallel.
Current through a circuit is dependent on the applied voltage and net resistance.
How electric and magnetic fields are related

**Essential Question(s) :**

How did the study of the photoelectric effect lead to a better understanding of the dual nature of light?
What are some common examples of electric and magnetic forces at work?
What is Coulomb's law, and how can it be used to describe the relationship between attractive and repulsive forces?
How are electromagnetic waves generated?
How do electricity and magnetism relate to the more general phenomenon of electromagnetism?

| **21st Century Themes** | **21st Century Skills** |
|---|---|
| ● Global Awareness<br>● Environmental Literacy | ● Critical Thinking & Problem Solving<br>● Creativity and Innovation<br>● Cross-Cultural and Interpersonal Communication |

**Student Learning Goals/Objectives:**

| ***Students will know….*** | ***Students will be able to (do)…*** |
| --- | --- |
| Like charges repel and opposite charges attract.<br>Ground is the reference point for voltage measurements. Voltage is an electric potential difference between two points.<br>Coulomb's Law describes the force between charges.<br>Charge is conserved.<br>Charges attract proportionally to their magnitude but inversely proportional to the squared distance between them.<br>Current is a flow of charges.<br>Components of circuits can be arranged in series and/or parallel.<br>Current through a circuit is dependent on the applied voltage and net resistance. Electrical schematic drawings are essential in designing and building circuits. Difference in behavior of components in series versus parallel circuits.<br>How to calculate equivalent resistance.<br>The relationship between power, current and voltage. | Demonstrate how an electric current can produce a magnetic field<br><br>Develop and use an evidence-based model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction<br><br>An electric current produces a magnetic field and that a changing magnetic field produces an electric current.<br><br>Students measure and record electric currents and magnetic fields. |
| **Assessment Evidence:** | |

***Performance Tasks:***

**Performance Tasks/Use of Technology:**

- Technology integration:
  - Vernier Software & Technology (available options)
    - Ohm's Law
    - Series and Parallel Circuits
  - PhET Simulations
  - Gizmos
- Performance Tasks:
  - Conductivity of Different Materials Lab: Students will plan and carry out an investigation and complete a circuit using various materials of different conductive properties. They analyze and argue how the resistance of different materials affects the current (qualitatively and/or quantitatively).

**Other Assessment Measures*:***

Formative

- Homework assignments to reinforce series vs. parallel, calculations for both and magnetic fields
- Warm-ups and Ticket outs on electricity and magnetism
- Lab activities (suggested)
  - Series, Parallel, and Complex Circuit Lab
  - Magnetic Field Lab
- Written lab report
- Quizzes on electricity calculations
- PhET simulations
- Class participation

Summative

- Electricity & Magnetism Unit Test
- Laboratory Report
- Unit projects

***Suggested Options for Differentiation***

**English Language Learners:**

- Small Group Instruction
- Peer Buddies
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension

**Special Education:**

- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Allow for differentiated assessment as long as it meets requirements / demonstrates proficiency of NJSLS
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration

- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy
- Activities must be restructured to be more intellectually demanding. For example: questions that require a higher level of response or by open-ended questions that stimulate inquiry, active exploration, and discovery
- Engaging students in active problem-finding and problem-solving activities and research
- Providing students opportunities for making connections within and across systems of knowledge by focusing on issues, themes, and ideas
- Include more elaborate, complex, and in-depth study of major ideas, problems, and themes
- Integrate knowledge within and across systems of thought

**Students At Risk of School Failure:**

- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide high interest topics/options
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines
- Teach study skills
- Allow for alternative assignments
- Provide visuals
- Assign peer tutor
- Offer teacher tutoring: thirty to forty minutes a few times a week can drastically increase a disadvantaged child’s achievement level
- Create a familial atmosphere by using inclusive and affiliative language

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| ● Provide needed academic resources (if an issue) such as paper, pencils, calculators<br>● Help students with goal-setting skills<br>● Build supportive relationships, provide positive guidance, foster hope and optimism and take time for affirmation and celebration |

| Resources | |
|---|---|
| Physics Book, NJCTL.org , Sciencespot.com, pHet.com, Vernier.com, physlab.com, Explorelearning.com | |
| Suggested Time Frame: | 15 days |

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|---|---|---|
| **Content Area:** | **Chemistry** | **Grade(s)** 10-12 |
| **Unit Plan Title:** | **Unit 5 - States of Matter** | |

**Overview/Rationale**

States and properties of matter determine the behavior of substances. Students should be familiar with the relationship between properties of matter at the molecular level and their relationship to behavior of matter on the macroscopic scale. This relationship will

be explored regarding solids, liquids, and gasses, with special attention paid to the role of intermolecular forces in determining the state of matter of a pure substance.

Students are generally less familiar with and therefore have more misconceptions regarding gasses (than solids or liquids). For this reason more time will be spent exploring the properties of gasses than liquids or solids. Special attention will be paid to pressure as most students haven't considered its existence, let alone its causes or the effects it can have on our daily lives.

**Science Standards (Established Goals)**

PS1.A: structure and properties of matter
PS2.B: types of interactions

**Disciplinary Core Ideas**

HS-PS1-3: plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles
HS-PS2-6: communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials

**Science and Engineering Practices**

SEP2: Developing and using models
SEP3: Planning and carrying out investigations
SEP4: Analyzing and Interpreting data
SEP7: Engaging in argument from evidence

**Cross-Cutting Concepts**

CCC1: Patterns
CCC2: Cause and Effect; Mechanism and Prediction
CCC4: Systems and System Models
CCC6: Structure and Function
CCC7: Stability and Change

**Computer Science & Design Thinking Standard(s)** *(formerly Technology)*

8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

**Interdisciplinary Standard(s)**

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-PS1-3),(HS-PS2-6)

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

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HSPS1-3)

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)

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

Mathematics

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-3), (HS-PS2-6)

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

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

**Enduring Understandings:**

Students will understand that…

- There is a relationship between the pressure, temperature and volume of a substance, and the gas laws can be used to calculate how these affect one another.
- Pressure is a result of molecular collisions and if those collisions increase, then the pressure exerted by the substance will also increase.
- If thermal energy is added to a substance the substance will undergo a change of phase.
- Phase diagrams can be used to determine the state of a matter of a sample of a substance under a particular set of conditions.

**Essential Question(s) :**

How do intermolecular forces affect the boiling point of a substance?
How are the gas laws used to calculate the pressure, temperature and/or volume of a substance?
What is pressure and how can it be measured?
What happens to a substance if its temperature and/or pressure changes?

**In this unit plan, the following 21st Century, Career Readiness, Life Literacies, and Key Skills are addressed:**

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
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.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

**Student Learning Goals/Objectives:**

| ***Students will know….*** | ***Students will be able to (do)…*** |
| --- | --- |

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|---|---|
| Temperature, pressure and volume of a substance are related to each other.<br>That phase diagrams show the relationship between pressure, temperature, and states of matter for a substance.<br>How a manometer and barometer measure pressure<br>The types of intermolecular forces | Use the gas laws to calculate the temperature, pressure or volume of a substance<br>Interpret a phase diagram<br>Explain how a manometer and barometer work<br>Predict the type of intermolecular force within a substance |

## Assessment Evidence:

**Formative**

- Observations during class
- Do now (topic relevant to each day's lesson)
- Homework/Classwork
- Class participation
- Student generated ideas in Venn Diagrams/Graphic Organizers
- CER (claim, evidence, reasoning) prompts
- Close Reading activities
- Various closure activities
- Online simulations
- Present student generated data to support/argue a position
- Written assignments to include graphs, tables
- Student response systems (Kahoot. socrative, plickers)

**Summative**

- Quizzes:
  - pressure unit conversion
  - gas laws
  - phase diagrams
- Test:
  - State of Matter
- Lab practicals/skills based assessments using CER Framework/POGIL activities
  - Gas Laws Lab
  - Phase Diagrams Graphing Activity
  - Intermolecular Forces Lab

**Alternative**

- Unit Portfolio
- Unit Presentations
- Projects
- Teacher-created assessment developed following 1:1 conference and/or review of student data/need

## Teaching and Learning Actions:

| *Instructional Strategies and Activities* | Higher level classes will learn how to calculate the pressure of a gas from a manometer, while the lower level classes will only learn how a manometer works. Higher level classes will get more involved with the gas laws.<br><br>Intermolecular Forces Gizmo - helps students to visualize polarity of molecules and its impact on the interactions between those molecules.<br><br>Additional differentiation activities as needed include:<br><br>**English Language Learners:**<br><br>● Teacher tutoring<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments (ex. Fewer items per page)<br>● Differentiated instruction<br>● Native language texts and native language to English dictionary<br>● Small Group Instruction<br>● Flexible Grouping<br>● Graphic Organizers for periodic table design<br>● Technology Integration<br>● Google translate for written work if needed<br>● Provide clear and specific directions<br>● Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing<br>● Provide class notes ahead of time to allow students to preview material and increase<br><br>**Special Education:**<br>● Follow all IEP modifications<br>● Audio books, Movies, and other digital media in lieu of print versions<br>● Oral instructions<br>● Record lessons instead of taking notes<br>● Outlines of lessons |
|---|---|
| Gas Laws Lab<br>- 1 class period<br><br>Phase Diagrams Graphing Activity<br>- 1 class period<br><br>Intermolecular Forces Lab<br>- 1 class period | |

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| | ● Multisensory Instruction / Multiple modalities<br>● Flexible Grouping<br>● Small Group Instruction<br>● Peer Buddies<br>● Graphic Organizers<br>● Chunking Information<br>● Scaffolded Questioning<br>● Manipulatives<br>● Provide clear and specific directions, orally and in writing<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide extended time<br>● Assign peer tutor<br>● Utilize visual charts/cues<br><br>**Students with 504 Plans:**<br>● Follow all 504 plan modifications<br>● Study Guide with answers<br>● Modified tests<br>● Provide extended time<br>● Graphic organizers<br>● Allow for differentiated assessment as long as it meets requirements<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide preferential seating if available and necessary<br>● Verbal and visual aides<br>● Verbal testing, if applicable<br>● Use written directions in additional to oral directions<br><br>**Gifted and Talented:**<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments<br>● Differentiated instruction<br>● Extension activities such as challenge questions or AP questions<br>● Opportunities for Critical Thinking embedded in lab activities<br>● Problem Solving/Design Challenges |

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|---|---|
| | • Technology Integration<br>• Student Choice Activities<br>• Performance task options to allow expansion on knowledge of element<br>• Enrichment Activities/Independent research<br>• Explore real world applications<br>• Act as a peer buddy<br><br>**Students At Risk of School Failure:**<br>• Response to Intervention (RTI)<br>• Give every opportunity for success<br>• Involve families in student learning<br>• Provide social/emotional support<br>• Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)<br>• Provide immediate praise and feedback<br>• Provide road maps or outlines for difficult concepts<br>• Provide sufficient wait time before calling on any student to help keep students who may need more time engaged<br>• Provide clear, achievable expectations; do not lower academic requirements<br>• Create a nurturing environment with structured routines |
| **Resources** | |
| Chemistry<br>textbook<br>NJCTL.org<br>http://phet.colorado.edu/en/simulation/ | |
| **Suggested Time Frame:** | 20-30 days |

| Content Area: | Chemistry | Grade(s) 10-12 |
|---|---|---|
| Unit Plan Title: | Unit 6 - Solutions Chemistry | |

**Overview/Rationale**

It is important to be able to quantify the amount of solute that can dissolve in a given amount of solvent. The concentration of dissolved substances in water can be expressed as molarity, molality, percent by mass, percent by volume, and mole fraction. Expressing concentration in units of molarity is an important skill students must master when dealing with the concept of equilibrium and acid/base chemistry. Most chemical reactions do not go to completion but rather establish a dynamic equilibrium between the forward and reverse reactions. Equilibria can be manipulated by changes in temperature, pressure, or the concentration of a reactant or product.

**Science Standards (Established Goals)**

PS1.A: structure and properties of matter
PS1.B: chemical reactions
PS2: B: types of interactions
ETS1.C: optimizing the design solution

**Disciplinary Core Ideas**

HS-PS1-2: construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties
HS-PS1-3: plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles
HS-PS1-5: apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs
HS-PS1-6: refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

## Science and Engineering Practices

SEP1: Asking questions and defining problems
SEP2: Developing and using models
SEP3: Planning and carrying out investigations
SEP4: Analyzing and Interpreting data
SEP5: Using mathematics and computational thinking
SEP6: Constructing explanations and designing solutions
SEP7: Engaging in argument from evidence
SEP8: Obtaining, evaluating and communication of information

## Cross-Cutting Concepts

CCC1: Patterns
CCC2: Cause and Effect; Mechanism and Prediction
CCC3: Scale, Proportion, and Quantity
CCC4: Systems and System Models
CCC5: Energy and Matter: Flows, Cycles, and Conservation
CCC6: Structure and Function
CCC7: Stability and Change

## Computer Science & Design Thinking Standard(s) *(formerly Technology)*

8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

## Interdisciplinary Standard(s)

**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-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. (HSPS1-3),(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)

**Mathematics**
**MP.2** Reason abstractly and quantitatively. (HS-PS1-5)
**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-PS1-5)
**HSN-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-3), (HS-PS1-5)

## Enduring Understandings:

***Students will understand that…***

- Many chemical reactions occur in aqueous solutions, therefore it is important to be able to quantify the amount of solute dissolved in a solvent.
- The concentration of a solute can be measured in terms of molarity, molality, percent by mass, percent by volume, and mole fraction.
- The amount of solute that can be dissolved in a given amount of solvent can be affected by the temperature and / or pressure of the solution. There are also factors that affect the rate at which a solute may dissolve.
- Dynamic Equilibrium is a state in which the rates of opposing reactions are the same.
- Equilibria can be forced to shift either towards reactants or products by intentional changes in conditions (P, V, T, [species])

## Essential Question(s) :

Which factors determine the extent to which a solute dissolves in a solvent?
How is the solubility of a substance measured?
How can the concentration of a substance be measured in a solution?
What effect does diluting a solution have on the concentration of the substance?
What is a colligative property?
How do solvated particles affect the colligative properties of a solution?
How is the freezing point and boiling point of a solution related to its molality?
What is the difference between an acid and a base?
What is equilibrium?
How can equilibria be manipulated physically?

## In this unit plan, the following, 21st Century, Career Readiness, Life Literacies, and Key Skills are addressed:

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
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.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

## Student Learning Goals/Objectives:

***Students will know….***

- Temperature, pressure, solute, surface area, and agitation affect the rate at which a substance may dissolve.

***Students will be able to (do)…***

- Calculate the concentration of a solution
- Calculate the boiling point and freezing point of a solution
- Calculate the solubility of a solute

- Molarity, molality, percent by mass, percent by volume, and mole fraction are units of concentration.
- The solubility of a substance is measured in the mass of the solute per mass of solvent or volume of solution.
- The concentration of a substance is lowered when water is added to a solution. Colligative properties are physical properties of a solution that are affected by the number of dissolved solute particles.
- An increase in the number of solvated particles in a solution will increase the boiling point, lower the freezing point, and lower the vapor pressure of the pure solvent.
- As the molality of a solution increases, the boiling point of a solution increases and the freezing point of a solution decreases
- The difference between an acid and a base
- How the equilibrium constant is determined
- Le Chatelier's Principle

- Determine if a solution is an acid or a base
- Calculate the equilibrium constant for a reaction
- Predict shifts in equilibria using Le Chatelier's Principle

## Assessment Evidence:

**Formative**

- Observations during class
- Do now (topic relevant to each day's lesson)
- Homework/Classwork
- Class participation
- Student generated ideas in Venn Diagrams/Graphic Organizers
- CER (claim, evidence, reasoning) prompts
- Close Reading activities
- Various closure activities
- Online simulations

**Summative**

- Quizzes:
  - Concentration Units
  - Colligative Properties
  - Acid/Base Introduction
  - Equilibrium
- Tests:
  - Solutions

- Lab practicals/skills based assessments using CER Framework/POGIL activities

| | |
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| ● Present student generated data to support/argue a position<br>● Written assignments to include graphs, tables<br>● Student response systems (Kahoot. socrative, plickers) | ○ Solutions Lab<br>○ Colligative Properties Lab<br><br>**Alternative**<br>● Unit Portfolio<br>● Unit Presentations<br>● Projects<br>● Teacher-created assessment developed following 1:1 conference and/or review of student data/need |

| **Teaching and Learning Actions:** | |
|---|---|
| *Instructional Strategies and Activities*<br><br>Solutions lab<br>- 1 class period<br><br>Colligative properties activity<br>- 1 class period | Higher level classes will get more involved with the math in this chapter, while the lower level classes will stick with more concepts instead of the math.<br><br>Colligative Properties Gizmo - allows students to visualize the effect of a solute on colligative properties at the particle level.<br><br>Additional differentiation activities as needed include:<br><br>**English Language Learners:**<br><br>● Teacher tutoring<br>● Peer tutoring<br>● Cooperative learning groups<br>● Modified assignments (ex. Fewer items per page)<br>● Differentiated instruction<br>● Native language texts and native language to English dictionary<br>● Small Group Instruction<br>● Flexible Grouping<br>● Graphic Organizers for periodic table design<br>● Technology Integration<br>● Google translate for written work if needed<br>● Provide clear and specific directions |

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| | ● Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing<br>● Provide class notes ahead of time to allow students to preview material and increase<br><br>**Special Education:**<br>● Follow all IEP modifications<br>● Audio books, Movies, and other digital media in lieu of print versions<br>● Oral instructions<br>● Record lessons instead of taking notes<br>● Outlines of lessons<br>● Multisensory Instruction / Multiple modalities<br>● Flexible Grouping<br>● Small Group Instruction<br>● Peer Buddies<br>● Graphic Organizers<br>● Chunking Information<br>● Scaffolded Questioning<br>● Manipulatives<br>● Provide clear and specific directions, orally and in writing<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide extended time<br>● Assign peer tutor<br>● Utilize visual charts/cues<br><br>**Students with 504 Plans:**<br>● Follow all 504 plan modifications<br>● Study Guide with answers<br>● Modified tests<br>● Provide extended time<br>● Graphic organizers<br>● Allow for differentiated assessment as long as it meets requirements<br>● Provide class notes ahead of time to allow students to preview material and increase comprehension<br>● Provide preferential seating if available and necessary<br>● Verbal and visual aides<br>● Verbal testing, if applicable |

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| | • Use written directions in additional to oral directions<br><br>**Gifted and Talented:**<br>• Peer tutoring<br>• Cooperative learning groups<br>• Modified assignments<br>• Differentiated instruction<br>• Extension activities such as challenge questions or AP questions<br>• Opportunities for Critical Thinking embedded in lab activities<br>• Problem Solving/Design Challenges<br>• Technology Integration<br>• Student Choice Activities<br>• Performance task options to allow expansion on knowledge of element<br>• Enrichment Activities/Independent research<br>• Explore real world applications<br>• Act as a peer buddy<br><br>**Students At Risk of School Failure:**<br>• Response to Intervention (RTI)<br>• Give every opportunity for success<br>• Involve families in student learning<br>• Provide social/emotional support<br>• Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)<br>• Provide immediate praise and feedback<br>• Provide road maps or outlines for difficult concepts<br>• Provide sufficient wait time before calling on any student to help keep students who may need more time engaged<br>• Provide clear, achievable expectations; do not lower academic requirements<br>• Create a nurturing environment with structured routines |
| **Resources** | |
| Chemistry textbook NJCTL.org<br>http://phet.colorado.edu/en/simulation/ | |
| **Suggested Time Frame:** | 20-30 days |

| Content Area: | Environmental Science | Grade(s): High School |
|---|---|---|
| Unit Plan Title: | Ecosystem Dynamics | |

**Science Standards**

**Disciplinary Core Ideas**

**LS2.A Interdependent Relationships in Ecosystems**

● Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1),(HS-LS2-2)

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

● Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

**LS2.C Ecosystem Dynamics, Functioning and Resilience**

● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)

● Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

**LS2.D Social Interactions and Group Behavior**

● Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

**LS4.C Adaptation**

● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline, and sometimes extinction, of some species (HS-LS4-5)

● Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost (HS-LS4-5)

**ETS1.B Developing Possible Solutions**

● When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HS-LS2-7)

**ESS3.A Natural Resources**

● Resource availability has guided the development of human society. (HSESS3-1)

● All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

**ESS3.C Human Impacts on Earth Systems**

● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

**Science and Engineering Practices**

**Using Mathematics and Computational Thinking**

● Use mathematical and/or computational representations of phenomena or design solutions to support explanations.

● Use mathematical representations of phenomena or design solutions to support and revise explanations.

● Use mathematical representations of phenomena or design solutions to support claims.

**Constructing Explanations and Designing Solutions**

● Design, evaluate, and refine a solution to a complex, real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.

**Engaging in Argument from Evidence**

● Evaluate the claims, evidence and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

● Evaluate the evidence behind currently accepted explanations to determine the merits of arguments.

**Cross-Cutting Concepts**

**Patterns**

● Patterns of performance of designed systems can be analyzed and interpreted to re-engineer and improve the system. **Cause and Effect: Mechanism and Prediction**

● 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.

● Changes in systems may have various causes that may not have equal effects

**Systems & System Models**

● Models (e.g. physical, mathematical, computer models) can be used to simulate systems and interactions- including energy, matter, information flows - within and between systems at different scales.

● Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

**Computer Science and Design Thinking**

8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs and risks, related to the use of the innovation.

**Interdisciplinary Standard(s)**

**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.
- 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.
- 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.
- 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.
- WHST.9-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- 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.

**Mathematics -**

● MP.2- Reason abstractly and quantitatively.
● MP.4 - Model with mathematics.
● 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. ● HSN -Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.

● HSN -Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
● HSS-ID.A.1- Represent data with plots on the real number line (dot plots, histograms, and box plots).
● HSS-IC.A.1- Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
● HSS-IC.B.6- Evaluate reports based on data.

**Enduring Understandings:**

*Students will know…*

● Comparison of relationships among interdependent factors including boundaries, resources, climate, and competition
● Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.
● Biomass being passed between trophic levels from one level to another
● Matter and energy are conserved as matter cycles and energy flows through ecosystems
● Atoms such as Carbon, Oxygen, Hydrogen, and Nitrogen are being conserved as they move through the ecosystem
● Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales
● Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem

● Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

● Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity

● Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

● Urbanization, Building Dams,
Dissemination of Invasive Species
impact the environment and biodiversity
● Distinguish between group and individual behavior
● Identifying evidence supporting the
outcomes of group behavior
● Developing logical and reasonable
arguments based on evidence
● Group behaviors:
● Flocking, Schooling, Herding, cooperative behaviors,
hunting, migrating swarming

**Essential Question(s) :**

*Students will be able to…*

● Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

● What are the patterns for energy flow in functioning ecosystems?

● What goods and services do people receive from the non-human environment—other living things, soil, water, sunlight, atmosphere, water, fossil fuels?

● What is the role of the major bio-geo-chemical cycles in the health and survival of living organisms and their habitats?

● How do the processes of photosynthesis and respiration work together to allow continuation of life on earth?

● In what ways are human activities putting stress on ecosystems?

● In what ways do human activities help ecosystems function?

| *Teaching and Learning Actions:* | |
|---|---|
| *Instructional Strategies and Activities* | **LS2-1**<br>Students will use calculation, estimation, and graphing to explore factors that influence change in two populations of different scales: lions in the Ngorongoro Crater of Tanzania, Africa, and bacteria within a petri dish. At the end, students are asked to use what they have learned to predict human population growth.<br>African Lions: Modeling Populations<br><br>**LS2-2**<br>Students will use online tools as an introduction to ecological fieldwork and data collection. At the end of the activity students will be able to:<br>Resources for **on-grade** students:<br>● Graphic Organizers<br>● Interactive Notebooks<br>Resources for students **approaching** grade level expectations:<br>● Quizlet vocabulary review<br>● Amoeba Sisters Videos- Ecology Series<br><br>Resources for students **exceeding** grade level expectations: ● AP Biology/ Environmental Science Questions ● POGIL Activities<br><br>Useful links / online resources:<br>● Newsela<br>● https://edu.symbaloo.com/mix/ls4d-biodiversityus1<br>● Define ecosystem and biodiversity<br>● Design and carry out standardized protocols for conducting biological surveys<br>● Use a simple dichotomous key to identify organisms<br>● Graph data and interpret results<br>Bug Lyphe! A Next Generation-linked observational study in biodiversity |

**LS2-4**
Students engage in an argumentation cycle based on a scenario of a farm family trying to survive a dust bowl winter with limited food and water resources. The family has a bull, a cow, and limited amounts of water and wheat. Students are presented with four options that include various combinations of eating or keeping the animals alive and eating the wheat. Students are provided with data on nutritional requirements of cows and humans, along with nutritional contents of wheat, milk, and beef. Students will use this data to construct an argument for the best strategy to allow their family to survive. As they construct this argument, students build and apply knowledge of food chains, trophic levels, interdependence among organisms, and energy transfers within ecosystems.
Surviving Winter in the Dust Bowl (Food Chains and Trophic Levels)

**LS2-6**
Is our saltwater fish population declining? If so, what policies would be most effective in slowing that decline? This lesson is constrained to data from the coastal waters of Florida. The focus of the lesson is on the human impact through both commercial and recreational fishing on six identified fish populations and the ecosystems in which they live. Data and information concerning these fish species found along both Florida coasts (Gulf and Atlantic) is provided. Using a template to construct an argument, students are guided to design and carry out an investigation that will allow them to collect evidence needed to construct an argument defending their claims. As they construct this argument, students build and apply knowledge of interdependent relationships in ecosystems.
Decline in Saltwater Fish Populations (Chapter 7)
- All NGSS activities

**Suggested Options for Differentiation**

**English Language Learners:**

- Teacher tutoring
- Peer tutoring
- Cooperative learning groups
- Modified assignments (ex. Fewer items per page)
- Differentiated instruction
- Native language texts and native language to English dictionary
- Small Group Instruction
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase

**Special Education:**

- Follow all IEP modifications
- Audio books, Movies, and other digital media in lieu of print versions
- Oral instructions
- Record lessons instead of taking notes
- Outlines of lessons
- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing

- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Follow all 504 plan modifications
- Study Guide with answers
- Modified tests
- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Peer tutoring
- Cooperative learning groups
- Modified assignments
- Differentiated instruction
- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications

- Act as a peer buddy

**Students At Risk of School Failure:**

- Response to Intervention (RTI)
- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines

**Assessment Evidence**

**Formative**

- Observations during class
- Laboratory Activities (Carrying Capacity, Predator Prey)
- Class participation
- Venn Diagrams/Graphic Organizers (Ecosystems)
- Ecosystem Dynamics CER (claim, evidence, reasoning) ● Close Reading activities, annotation
- Various closure activities
- Quiz (Nutrient Cycles, Ecosystems, Populations Dynamics)
- Online simulations
- Use models to represent the cycling of matter through ecosystems
- Calculate energy transfer through trophic levels
- Graph J and S curves of population growth

- Analyze population growth data and use it to present an argument for population control and the impact of overpopulation on a scarce resource.
- Online simulations
- Present student generated data to support/argue a position(decline of coastal fish populations)
- Develop a plan to manage a finite resource
- Written assignments to include graphs, tables
- Do now & exit tickets
- Student response systems (Kahoot. socrative, plickers)
- Lab Practicals/Skills assessments
- Unit projects
- NGSS Performance tasks

**Summative**

- Laboratory Report using CER framework
- Unit Assessments

**Alternative**

- Unit Portfolio
- Unit Presentations- Atoms
- POGIL activities (Nutrient Cycles; Ecological Relationships; Energy Transfer; Ecological Pyramids; Population Distribution; Population Growth)
- Projects
- Portfolios
- Teacher-created assessment developed following 1:1 conference and/or review of student data/needs

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| Suggested Time Frame: | 25 Days |

| Content Area: | Environmental Science | Grade(s): High School |
|---|---|---|
| Unit Plan Title: | Human Sustainability | |

**Science Standards (Established Goals)**

**Disciplinary Core Ideas**

**HS-ESS3-1:** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.

**HS-ESS3-2:** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

**HS-ESS3-3:** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

**Science and Engineering Practices**

**Using Mathematics and Computational Thinking**

● Use mathematical and/or computational representations of phenomena or design solutions to support explanations.

● Use mathematical representations of phenomena or design solutions to support and revise explanations.

● Use mathematical representations of phenomena or design solutions to support claims.

**Constructing Explanations and Designing Solutions**

● Design, evaluate, and refine a solution to a complex, real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.

**Engaging in Argument from Evidence**

● Evaluate the claims, evidence and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

● Evaluate the evidence behind currently accepted explanations to determine the merits of arguments.

**Cross-Cutting Concepts**

**Cause and Effect: Mechanisms and Prediction**

● Changes in systems may have various causes that may not have equal effects.

● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

**Scale, Proportion and Quantity**

● Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another(e.g. linear growth vs exponential growth)

**Systems & System Models**

● Models (e.g. physical, mathematical, computer models) can be used to simulate systems and interactions- including energy, matter, information flows - within and between systems at different scales.

● Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

**Energy and Matter:Flows, Cycles and Conservation**

● Energy cannot be created or destroyed - it only moves between one place and another place, between objects and/or fields, or between systems

**Stability and Change**

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

**Computer Science and Design Thinking**

● 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.

● 8.2.12.ITH.1: Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.

**Interdisciplinary Standard(s)**

**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.

● 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.

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● 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.

**Mathematics -**

- MP.2 - Reason abstractly and quantitatively.
- MP.4 - Model with mathematics.
- 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.
- HSN -Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.
- HSN -Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quant.

**Enduring Understandings:**

*Students will know…*

- Natural Resources:
  - Freshwater
  - Minerals
  - Fossil Fuels
- Natural Resources and natural hazards (Earthquakes, volcanic eruptions, severe storms, and droughts) results in changes in climate that can affect populations or drive mass migrations
- Recycling Minerals and Metals
- Minimizing impacts where it is not recycled
- How the hydrosphere, atmosphere, cryosphere, geosphere, and biosphere are affected by impacts of human activity
- Increase in CO2 levels results in an increase in photosynthetic biomass on land and an increase in ocean acidification
- Management of natural resources includes the cost of extraction and waste management per capita

consumption and development of new technologies

- Human sustainability is affected by:
    - agricultural efficiency, levels of conservation, and urban planning
- Examples of data on the impacts of human activities could include:
    - Quantities and types of pollutants released,
      changes to biomass and species diversity, or areal changes in land surface use (such as for urban relationships among Earth systems and how those relationships are being modified due to human activity.

**Essential Question(s) :**

*Students will be able to…*

- Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- Develop best practices for developing soil use and for mining things like coal, tar, sand, oil shales, petroleum, and natural gasses

| *Teaching and Learning Actions:* | |
|---|---|
| *Instructional Strategies and Activities* | **ESS3-2**<br>Students will explore the economic and environmental tradeoffs associated with growing different bioenergy crops (corn, switchgrass, miscanthus, and native grassland). Through a simulation game they explore a range of environmental issues and ecological interactions related to climate change mitigation, biodiversity conservation, water quality and sustainable agriculture. The goal of the simulation is to plant and manage a farm so as to make money and create positive environmental impacts while respecting chosen values and goals.<br>Bioenergy Farm Game<br><br>**ESS3-3**<br>Students will create a physical model of an aquifer, which will be changed to simulate pollution and its impact on the local population.<br>● NGSS Hub Land and People<br>Finding a Balance<br>**ESS3-4**<br>Students will work in teams as part of the UN Climate Council to identify and address the major factors of climate change. They will identify three major factors of climate change through research, then identify ways to help reduce the impact these factors have on climate change keeping in mind social, economic, and environmental impacts of those solutions.<br>Earth's Dynamically Changing Climate<br>E-Waste regulation activity |

| | |
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| | **ESS3-6**<br>Students use maps to identify patterns of human population and their impact on the environment. Students will learn about the Pacific Ocean garbage patch by collecting their recyclable trash for one week and use it to extrapolate additional data. They will learn how increasing human populations take their toll on natural resources.<br>National Geographic Human Footprint<br>Students will use NOAA data to answer the question, Will there be enough freshwater?<br><br>Black Scientists and Conservationists in the United States<br>Students will read this article discussing the advancements of black conservationists. Students will research other black scientists and their advancements in the field. |

**Suggested Options for Differentiation**

**English Language Learners:**

- Teacher tutoring
- Peer tutoring
- Cooperative learning groups
- Modified assignments (ex. Fewer items per page)
- Differentiated instruction
- Native language texts and native language to English dictionary
- Small Group Instruction
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed

- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase

**Special Education:**

- Follow all IEP modifications
- Audio books, Movies, and other digital media in lieu of print versions
- Oral instructions
- Record lessons instead of taking notes
- Outlines of lessons
- Multisensory Instruction / Multiple modalities
- Flexible Grouping
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- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Follow all 504 plan modifications
- Study Guide with answers
- Modified tests
- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension

- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Peer tutoring
- Cooperative learning groups
- Modified assignments
- Differentiated instruction
- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
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- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
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- Explore real world applications
- Act as a peer buddy

**Students At Risk of School Failure:**

- Response to Intervention (RTI)
- Give every opportunity for success
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- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged

- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines

**Assessment Evidence**

**Formative**

- Observations during class
- Do now (Science Starters on Human Sustainability)
- Homework on Human Sustainability
- Laboratory Activities
- Class participation
- Venn Diagrams/Graphic Organizers
- CER (claim, evidence, reasoning)
- Close Reading activities, annotation
- Various closure activities
- Sustainability Quiz
- Online simulations
- Research human population growth in a specific area and the impact on the local environment
- Written assignments to include graphs, tables
- Do now & exit tickets
- Student response systems (Kahoot. socrative, plickers)

**Summative**

- Position papers on climate change
- POGIL activities (Population Distribution; Population Growth
- Laboratory Report using CER framework
- Unit Assessments
- Midterm & final exams
- Benchmark assessments
- Lab Practicals/Skills assessments

- Unit projects
- NGSS Performance tasks
- State Standardized Assessments (NJSLA)
- SGO Assessments

**Alternative**
- Projects
- Portfolios
- Teacher-created assessment developed following 1:1 conference and/or review of student data/needs

| | |
|---|---|
| Suggested Time Frame: | 25 Days |

| | | |
|---|---|---|
| **Content Area:** | **Environmental Science** | **Grade(s): High School** |
| **Unit Plan Title:** | **Weather & Climate** | |

**Science Standards**

**Disciplinary Core Ideas**

**HS-ESS2-4:** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]

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

**HS-ESS3-5:** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs,

are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of climate change and its associated impacts.]

**Science and Engineering Practices**

**Developing and using Models**

● Use a model to provide mechanistic accounts of phenomena (HS-ESS2-4)

● Develop a model based on evidence to illustrate the relationships between systems or between components of systems.

**Analyzing and Interpreting Data**

● Analyze data using computational models in order to make valid and reliable scientific claims.

● Analyze data using tools, technologies and/or models(computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

**Cross-Cutting Concepts**

**Patterns**

● Empirical evidence is needed to identify patterns

**Cause and Effect: Mechanism and Prediction**

● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

**Scale, Proportion and Quantity**

● Some systems can only be studied indirectly because they are too small, too large, too fast or too slow to observe directly. **Systems and System Models**

● Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

**Stability and Change**

● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

**Computer Science and Design Thinking**

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

8.2.12.ED.4: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.

**Interdisciplinary Standard(s)**

**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.
- RST.11-12.2- Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- RST.11-12.7
- SL.11-12.5- Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

**Mathematics -**

- MP.2- Reason abstractly and quantitatively.
- MP.4- Model with mathematics.
- 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.
- HSN -Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.
- HSN -Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

**Enduring Understandings:**

*Students will know…*

- Interpretation of weather and climate
  - Temperature, Pressure, Wind, Moisture Content
  - Air Masses
- Weather and climate are affected by latitude, distribution of land and water, general circulation of the atmosphere, ocean currents, altitude, topographic barriers, and storms
- Things that cause Earth's Climate change over different time scales including:
  - 1-10 Years: Large volcanic eruptions and ocean circulations
  - 10-100's of Years: Changes in human activity, ocean circulation, solar output
  - 10-100's of thousands of years: changes of Earth's orbit and the orientation of its axis
  - 10-100's of millions of years: Long Term changes of atmospheric composition
- Carbon Dioxide and Oxygen Cycle
  - How it cycles through the ocean, atmosphere, soil, and biosphere
- Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).

**Essential Question(s) :**

*Students will be able to…*

- Construct scientific arguments using data to support claims that spatial and temporal patterns in weather and climate found around the Earth are created by complex global, regional, and local interactions involving sunlight, and all of the Earth's spheres.
- Use a model to describe how variations in the flow of energy into and out of Earth's systems result in

changes in climate.
● Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere as it relates to our climate system.
● Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

| *Teaching and Learning Actions:* | |
|---|---|
| *Instructional Strategies and Activities* | **ESS2-6**<br>Students will use online data to support or disprove a simple hypothesis about increased levels of $CO_2$ and the health of the oceans. They will use online tools to recreate climate change models and scenarios and examine the effect of elevated $CO_2$ on ocean acidity. Students will use data graphs of ocean pH, sea surface temperature and $CO_2$ data to determine the driving factor behind ocean acidification and its impact on climate.<br>Carbon Pollution:Costs and Cures<br>NOAA data in the classroom<br>Khan Academy- AP Environmental Science<br>NOAA Carbon Tracker<br><br>**ESS3-5**<br>Students will use data graphs of ocean pH, sea surface temperature and $CO_2$ data to determine the driving factor behind ocean acidification and its impact on climate.<br>Nasa Climate<br>Measuring and modeling climate change<br>MIT greenhouse gas simulator<br><br>**Additional Activities**<br>http://dataintheclassroom.noaa.gov/DataInTheClassRoom/node<br>https://www.climate.gov/climate-and-energy-topics/climate-system |

| | |
|---|---|
| | http://ngss.nsta.org/classroom-resources-results.aspx?CoreIdea=10<br><br>NGSS Performance Task<br><br>Analyzing Floods<br><br>Teachers may wish to include activities on calculation of carbon footprints to connect students to the broader implications for climate change.<br><br>Weather & Climate lab |

**Suggested Options for Differentiation**

**English Language Learners:**

- Teacher tutoring
- Peer tutoring
- Cooperative learning groups
- Modified assignments (ex. Fewer items per page)
- Differentiated instruction
- Native language texts and native language to English dictionary
- Small Group Instruction
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase

**Special Education:**

- Follow all IEP modifications
- Audio books, Movies, and other digital media in lieu of print versions
- Oral instructions
- Record lessons instead of taking notes
- Outlines of lessons
- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Follow all 504 plan modifications
- Study Guide with answers
- Modified tests
- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable

- Use written directions in additional to oral directions

**Gifted and Talented:**

- Peer tutoring
- Cooperative learning groups
- Modified assignments
- Differentiated instruction
- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy

**Students At Risk of School Failure:**

- Response to Intervention (RTI)
- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines

| Assessment Evidence |
| --- |
| **Formative**<br>● Observations during class<br>● Do now (Science Starters on Human Sustainability)<br>● Homework on Human Sustainability<br>● Laboratory Activities<br>● Class participation<br>● Venn Diagrams/Graphic Organizers<br>● CER (claim, evidence, reasoning)<br>● Close Reading activities, annotation<br>● Various closure activities<br>● Sustainability Quiz<br>● Online simulations<br>● Research human population growth in a specific area and the impact on the local environment<br>● Written assignments to include graphs, tables<br>● Do now & exit tickets<br>● Student response systems (Kahoot. socrative, plickers)<br>**Summative**<br>● Position papers on climate change<br>● POGIL activities (Population Distribution; Population Growth<br>● Laboratory Report using CER framework<br>● Unit Assessments<br>● Midterm & final exams<br>● Benchmark assessments<br>● Lab Practicals/Skills assessments<br>● Unit projects<br>● NGSS Performance tasks<br>● State Standardized Assessments (NJSLA)<br>● SGO Assessments |

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| Suggested Time Frame: | 45 Days |

| Content Area: | Environmental Science | Grade(s): High School |
|---|---|---|
| Unit Plan Title: | Earth's Systems | |

**Science Standards**

**Disciplinary Core Ideas**

**HS-ESS2-2:** Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems. [Clarification Statement: Examples should include climate feedback, such as how an increase in greenhouse gasses causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.

**HS-ESS2-3:** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.

**Science and Engineering Practices**

**Analyzing and Interpreting Data**

● Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

● Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2)

**Developing and Using Models**

● Modeling in 9–12 builds on K–8 experiences 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 world(s).

● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS ESS2-3)

**Cross-Cutting Concepts**

**Scale, Proportion & Quantity**

● Some systems can only be studied indirectly because they are too small, too large, too fast, or too slow to observe directly.

**Systems & System Models**

● Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

**Cause and Effect**

●Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

**Patterns**

● Empirical evidence is needed to identify patterns.

**Stability & Change**

● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible

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

**Computer Science and Design Thinking**

- 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
- 8.2.12.ETW.3: Identify a complex, global environmental or climate change issue, develop a systematic plan of investigation, and propose an innovative sustainable solution.

**Interdisciplinary Standard(s)**

**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.
- RST.11-12.2- Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- WHST.9-12.1- Draw evidence from informational texts to support analysis, reflection, and research.
- 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.
- SL.11-12.5- Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

**Mathematics -**

- MP.2- Reason abstractly and quantitatively.
- MP.4- Model with mathematics.
- 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.
- HSN -Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.
- HSN -Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

**Enduring Understandings:**

*Students will know…*

- Climate feedbacks
- Increase in greenhouse gases causes rise in global temperatures that melt glacial ice
- Melting glacial ice reduces the amount of sunlight reflected from Earth's surface
- Deforestation causes increased water runoff and soil erosion
- Dammed rivers decrease sediment transport and increase soil erosion
- Loss of wetlands causes a decrease in local humidity that further reduces wetland extent
- Layers of the Earth
- Composition of the Earth's layers
- Convection currents in the Mantle
- Earth's interior obtained through seismic waves
- Rate of change of Earth's magnetic field
- Water Cycle
- Rock Cycle
- Nitrogen Cycle
- Stream transport and deposition
- Weathering and Erosion
- Frost Wedging
- Carbon Dioxide and Oxygen Cycle
- How it cycles through the ocean, atmosphere, soil, and biosphere
- Causes, Effects, and Feedbacks between biosphere and other factors and how they allow for the evolution of animal and microbial life on land which increased the formation of soil which allow for the evolution of land plants and coral reefs.

**Essential Question(s) :**

*Students will be able to…*

- Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems
- Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
- Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface

processes.
● Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
● Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth

| *Teaching and Learning Actions:* | |
|---|---|
| *Instructional Strategies and Activities* | **ESS2-3**<br>Students will create models and perform laboratory experiments to demonstrate the effect of convection currents on the Earth's mantle. Students will use the principles of density to explain the layers of the Earth.<br>Resources for **on-grade** students:<br>● Graphic Organizers<br>● Earth's Systems Quizizz<br><br>● All NGSS related ESS2 activities<br><br>Resources for students **approaching** grade level expectations:<br>Students will use data to show changes in the Earth's magnetic field.<br><br>IRIS Seismic monitor<br>IRIS determining Earth's internal Structure<br>IRIS seismic wave simulator<br><br>**ESS2-5**<br>Students will demonstrate the connections between the hydrologic cycle and the rock cycle. they will plan and carry out investigations to show the effects of water on Earth's materials, specifically rock.<br><br>Making a Cave |

**ESS2-6**
Students will use real time data to monitor carbon levels in the ocean.

NOAA Carbon tracker activity
IRIS Rapid Earthquake Viewer

Global warming, the environment and the causes of genocide Students will read article and discuss how natural resources were used to justify the Holocaust.

- PBS Learning Media
- ESS2A - Earth Materials and Systems
- Symbaloo Earth's Systems
- Bozeman Science
    - Atmosphere

Resources for students **exceeding** grade level expectations: ● Bozeman Science- AP Environmental Science Playlist ● Khan Academy- AP Environmental Science

Useful links / online resources:

- Newsela
- Quizizz

**Suggested Options for Differentiation**

**English Language Learners:**

- Teacher tutoring
- Peer tutoring
- Cooperative learning groups
- Modified assignments (ex. Fewer items per page)

- Differentiated instruction
- Native language texts and native language to English dictionary
- Small Group Instruction
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase

**Special Education:**

- Follow all IEP modifications
- Audio books, Movies, and other digital media in lieu of print versions
- Oral instructions
- Record lessons instead of taking notes
- Outlines of lessons
- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives
- Provide clear and specific directions, orally and in writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Follow all 504 plan modifications

- Study Guide with answers
- Modified tests
- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Peer tutoring
- Cooperative learning groups
- Modified assignments
- Differentiated instruction
- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research
- Explore real world applications
- Act as a peer buddy

**Students At Risk of School Failure:**

- Response to Intervention (RTI)
- Give every opportunity for success

- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines

**Assessment Evidence**

**Formative**

- Observations during class
- Do now (Science Starters on the history of the earth, plate tectonics, Age of the Earth)
- Homework on the History of the Earth
- Laboratory Activities (Plate Tectonics, History of the Earth, Earthquake)
- Class participation
- Venn Diagrams/Graphic Organizers (Formation of Solar System, History of the Earth)
- CER (claim, evidence, reasoning)
- Close Reading activities, annotation on the History of the Earth
- Various closure activities
- Plate Tectonics Quiz
- Plate Tectonics Online simulations
- Use fossil record data to support the idea of environmental change
- Present student generated data to support/argue a position
- Written assignments to include graphs, tables

- Do now & exit tickets on the History of the Earth
- Student response systems (Kahoot. socrative, plickers)
- Relative dating using popcorn

**Summative**

- History of the Earth projects
- Lab practicals/skills based assessments
- NGSS performance tasks
- Laboratory Report using CER framework
- History of the Earth Assessment
- History of the Earth Unit projects
- POGIL activities

**Alternative**

- History of Earth Unit Portfolio
- Unit Presentations- Solar System Project
- History of Earth Projects
- Teacher-created assessment developed following 1:1 conference and/or review of student data/needs

| | |
|---|---|
| Suggested Time Frame: | 40 Days |

| Content Area: | Environmental Science | Grade(s): High School |
|---|---|---|
| Unit Plan Title: | History of Earth | |

**Science Standards**

**Disciplinary Core Ideas**

**ESS1.C**: **The History of Planet Earth:** Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5) Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6)

**ESS2.B**: **Plate Tectonics and Large-Scale System Interactions:** Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. (ESS2-1) Plate movements are responsible for most continental and ocean floor features and for the distribution of most rocks and minerals within Earth's crust.

**HS-ESS2-7:** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [*Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.*]

**HS-LS4-5:** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

**Science and Engineering Practices**

**Engaging in Argument from Evidence**

● Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

● Construct an oral and written argument or counter-arguments based on data and evidence. (HS- ESS2-7)

● Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)

**Disciplinary Core Ideas**

● Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-7)

● Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3)

**Cross-Cutting Concepts**

**Patterns**:

● Empirical evidence is needed to identify patterns. (HS-ESS1-5)

**Stability and Change**:

● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6, HS-ESS2-7)

● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS2-1)

**Cause and Effect**:

● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-5)

**Computer Science and Design Thinking**

● 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.

● 8.2.12.ED.4: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.

**Interdisciplinary Standard(s)**

**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.
- 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.
- WHST.9 -12.1 - Draw evidence from informational texts to support analysis, reflection, and research. ● WHST.9 -12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- SL.11 -12.5 - Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.
- WHST.9 -12.9 - Write arguments focused on discipline-specific content.

**Mathematics:**

- MP.2 - Reason abstractly and quantitatively.
- MP.4 - Model with mathematics.
- 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.

● HSN -Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.

● HSN -Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

● HSF -IF.B.5 - Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

● HSS -ID.B.6 - Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

**Enduring Understandings:**

*Students will know…*

● What are the main causes of earthquakes and what are their effects?
● Why is life on earth confined to such a narrow layer near the earth's surface?
● What is the composition of the earth?
● How has the Earth's structure and composition changed its geological features over time?
● How do people reconstruct and date events in Earth's planetary history?
● Why do the continents move, and what causes surface processes operate at different spatial and temporal
● How can we use the past to help understand the present state of the environment?

**Essential Question(s) :**

*Students will be able to…*

● Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history.

● Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks

● Develop a model to illustrate how Earth’s internal and scales to form continental and ocean-floor features

● Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth

● Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and

(3) the extinction of other species.
● Develop and use models to demonstrate the process of seafloor spreading
● Model the destructive process of coastal erosion
● Research/use new articles on coastal erosion in the local area to show the destructive force of nature and the permanent change to earth's surfaces
● Use hotspot data to calculate the rate of movement of tectonic plates

| *Teaching and Learning Actions:* | |
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| *Instructional Strategies and Activities* | Prior to the start of the unit, students will complete the lesson "What is a Scientist?" Many students come into class with many misunderstandings about what a scientist is or looks like. In this lesson students will discover the many misconceptions regarding scientists' identity. Students will learn about scientists from every race, culture, gender, ethnicity, and background. Specifically, I will introduce students to scientists of the LGBTQ community through this lesson. To counteract the stereotypes and ensure a more equitable future for STEM, we need more classrooms and resources that celebrate the incredible range of personalities, interests, backgrounds, and pursuits that drive discovery and progress. Because **every student** deserves a chance to see themselves in science.<br>Vision<br>Scientists<br>6 Important Scientists that represent the LGBTQ community More Scientists that represent the LGBTQ community<br>● **ESS1-5**<br>Students will use data, including relative aging of rocks, to explain the concept of seafloor spreading from mid ocean ridges. AASG dating popcorn<br>Mapping the seafloor<br><br>● **ESS2-1**<br>Students will create models to demonstrate the principles of plate tectonics and how these processes have resulted in the formation of key landforms such as volcanoes, ocean trenches, mountain building.<br>Students will use models to demonstrate the destructive forces of nature including aspects of weathering and erosion and its impact on shorelines due to coastal erosion. |

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| | USGS A Model of Three Faults lesson<br>Constructive forces of mountain building<br><br>● **ESS2-7**<br>Students will use evidence from the fossil record as the basis to construct explanations for how the Earth's surface has changed over time. This will include explanations for changing environments as evidenced by the life forms found in the fossil record.<br><br>Exploring the fossil record and geologic time<br>Developing a model of events in Earth's geologic history<br><br>● **LS4-5**<br>Using information from PE ESS2-7 which connects life forms in the fossil record to changes in environmental conditions, students will extend this thinking and use the fossil record to explain why changing environmental conditions over geologic time may have resulted in lifeform extinction and speciation.<br>Compare and contrast mass extinctions with environmental conditions<br><br>NGSS Performance Task<br>Unraveling Earth's Early History<br>Full list of 9-12 suggested activities from NGSS |

**Suggested Options for Differentiation**

**English Language Learners:**

- Teacher tutoring
- Peer tutoring
- Cooperative learning groups
- Modified assignments (ex. Fewer items per page)
- Differentiated instruction
- Native language texts and native language to English dictionary
- Small Group Instruction
- Flexible Grouping
- Graphic Organizers for periodic table design
- Technology Integration
- Google translate for written work if needed
- Provide clear and specific directions
- Allow for alternate forms of responses- drawing or speaking instead of writing to demonstrate knowledge when you are not specifically assessing writing
- Provide class notes ahead of time to allow students to preview material and increase

**Special Education:**

- Follow all IEP modifications
- Audio books, Movies, and other digital media in lieu of print versions
- Oral instructions
- Record lessons instead of taking notes
- Outlines of lessons
- Multisensory Instruction / Multiple modalities
- Flexible Grouping
- Small Group Instruction
- Peer Buddies
- Graphic Organizers
- Chunking Information
- Scaffolded Questioning
- Manipulatives

- Provide clear and specific directions, orally and in writing
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide extended time
- Assign peer tutor
- Utilize visual charts/cues

**Students with 504 Plans:**

- Follow all 504 plan modifications
- Study Guide with answers
- Modified tests
- Provide extended time
- Graphic organizers
- Allow for differentiated assessment as long as it meets requirements
- Provide class notes ahead of time to allow students to preview material and increase comprehension
- Provide preferential seating if available and necessary
- Verbal and visual aides
- Verbal testing, if applicable
- Use written directions in additional to oral directions

**Gifted and Talented:**

- Peer tutoring
- Cooperative learning groups
- Modified assignments
- Differentiated instruction
- Extension activities such as challenge questions or AP questions
- Opportunities for Critical Thinking embedded in lab activities
- Problem Solving/Design Challenges
- Technology Integration
- Student Choice Activities
- Performance task options to allow expansion on knowledge of element
- Enrichment Activities/Independent research

- Explore real world applications
- Act as a peer buddy

**Students At Risk of School Failure:**

- Response to Intervention (RTI)
- Give every opportunity for success
- Involve families in student learning
- Provide social/emotional support
- Build in more group work to encourage interaction with peers (Flexible Grouping, Small Group Instruction, Peer Buddies)
- Provide immediate praise and feedback
- Provide road maps or outlines for difficult concepts
- Provide sufficient wait time before calling on any student to help keep students who may need more time engaged
- Provide clear, achievable expectations; do not lower academic requirements
- Create a nurturing environment with structured routines

**Assessment Evidence**

**Formative**

- Observations during class
- Do now (Science Starters on the history of the earth,plate tectonics, Age of the Earth)
- Homework on the History of the Earth
- Laboratory Activities (Plate Tectonics, History of the Earth, Earthquake)
- Class participation
- Venn Diagrams/Graphic Organizers (Formation of Solar System, History of the Earth)
- CER (claim, evidence, reasoning)
- Close Reading activities, annotation on the History of the Earth

- Various closure activities
- Plate Tectonics Quiz
- Plate Tectonics Online simulations
- Use fossil record data to support the idea of environmental change
- Present student generated data to support/argue a position
- Written assignments to include graphs, tables
- Do now & exit tickets on the History of the Earth
- Student response systems (Kahoot. socrative, plickers)
- Relative dating using popcorn

**Summative**

- History of the Earth projects
- Lab practicals/skills based assessments
- NGSS performance tasks
- Laboratory Report using CER framework
- History of the Earth Assessment
- History of the Earth Unit projects
- POGIL activities

**Alternative**

- History of Earth Unit Portfolio
- Unit Presentations- Solar System Project
- History of Earth Projects
- Teacher-created assessment developed following 1:1 conference and/or review of student data/need

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| Suggested Time Frame: | 35 Days |