



SPRINGFIELD PUBLIC SCHOOLS
ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

Springfield Public Schools
Springfield, New Jersey 07081

Honors Chemistry
Grade 10

Curriculum Guide

2026

This curriculum may be modified through varying materials, techniques, and strategies as per an individual student's IEP.

Springfield Board of Education
Approved on July 27, 2026

Springfield Public Schools

Cultivating compassionate and extraordinary learners!

EXTRACT OF THE MINUTES OF A MEETING OF
THE BOARD OF EDUCATION OF
THE TOWNSHIP OF SPRINGFIELD
COUNTY OF UNION, NEW JERSEY
AS RECORDED IN THE OFFICIAL MINUTE BOOK

Resolution: 21

Introduced By: Mrs. Gamarekian

Seconded By: Vice President Rinaldi

Adopted: July 27, 2026

Curriculum Adoption

To approve the following new and revised curriculum and courses for the 2026-2027 school year:

1. High School Courses

- a. AP Cybersecurity (new course)
- b. AP Business with Personal Finance (new course)
- c. AP Biology
- d. AP Chemistry
- e. AP Physics 1
- f. PLTW Robotics and Automation
- g. PLTW Introduction to Engineering Design
- h. PLTW Principles of Engineering
- i. Biology
- j. Biology Honors
- k. Chemistry
- l. Chemistry Honors
- m. Conceptual Physics
- n. Physics
- o. Environmental Science
- p. Forensics
- q. Human Anatomy and Physiology
- r. Oceanography
- s. Science 8
- t. Molecular Biology Research Lab (new course)

2. Middle School Courses

- a. Science 6
- b. Science 7

3. Elementary School Courses

- a. Kindergarten Science
- b. Grade 1 Science
- c. Grade 2 Science

Michelle Calas, School Business Administrator/Board Secretary

(continued)

I, Michelle Calas, School Business Administrator/ Board Secretary of the Springfield Board of Education, hereby certify that the extract from the minutes of a meeting of the Board of Education duly called and held on July 27, 2026 has been compared by me with the original minute book of said Board of Education, and is a true, complete and exact copy thereof, as far as the same relates to the subject matter to on said extract.

In WITNESS THEREOF, I have hereunto set my hand and seal of the Springfield Board of Education, this 28th day of July 2026.

SEAL

A handwritten signature in black ink, appearing to read 'M. Calas', is written over a horizontal line.

Michelle Calas
School Business Administrator/ Board Secretary



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**Springfield Public Schools
Springfield, New Jersey**

**Rachel Goldberg
Superintendent of Schools**

Curriculum Developed By:

Erica Scudero ~ Assistant Superintendent of Curriculum and Instruction

Dr. Norman Francis ~ Principal of Jonathan Dayton High School

Gregory Salmon ~ Supervisor of Mathematics and Science

Mrs. Jennifer Beal ~ Chemistry Teacher



Unit Overview Template

Content Area: Chemistry **Grade Level:** 10 **Unit Title:** Properties of Matter

Unit Summary: In this unit of study, students use investigations, simulations, and models to make sense of the substructure of atoms and to provide more mechanistic explanations of the properties of substances. Chemical reactions, including rates of reactions and energy changes, can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. Students are able to use the periodic table as a tool to explain and predict the properties of elements. Students are expected to communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Primary Interdisciplinary Connections: Mathematics

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ ICT Literacy
☐ Information Literacy ☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy

Unit Rationale: Students are expected to use the science and engineering practices to demonstrate proficiency with the core ideas.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

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

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

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

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets

Standards: HS-PS1, HS-PS2, HS-ETS1

Content Statements: Matter and Its Interactions; Motion and Stability: Forces and Interactions; Engineering Design

CPI#: **Cumulative Progress Indicator (CPI):**

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.
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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-PS1-8	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-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
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.
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.
Math.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.
Math.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 .
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.

Science and Engineering Practices:

Developing and Using Models

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

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



- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)

Planning and Carrying Out Investigations

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

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)

Obtaining, Evaluating, and Communicating Information

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

- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)

Using Mathematics and Computational Thinking

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

- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

Constructing Explanations and Designing Solutions

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

- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-3)

Disciplinary Core Ideas (DCIs):

PS1.A: Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1), (HS-PS1-2)



- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6)

PS1.C: Nuclear Processes

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)

PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6), (secondary to HSPS1-1), (secondary to HS-PS1-3)

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. (HS-ETS1-3)
- 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. (HS-ETS1-4)

Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1), (HS-PS1-2), (HS-PS1-3), (HS-PS1-5)

Energy and Matter

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

Structure and Function

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

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-ETS1-4)

Connections to Engineering, Technology, and Applications of Science



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

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-3)

Unit Essential Questions:

- How can a periodic table tell me about the subatomic structure of a substance?
- How can I use the periodic table to predict if I need to duck before mixing two elements?
- How can I use the properties of something (in bulk quantities) to predict what is happening with the subatomic particles?
- I want to do the right thing, what is the greener choice for grocery bags (paper or plastic/reusable vs. disposable); cold drink containers (plastic, glass, or aluminum); or hot drink containers (paper, Styrofoam, or ceramic)?

Unit Enduring Understandings:

- Different patterns may be observed at each of the scales at which a system is studied, and these patterns can provide evidence for causality in explanations of phenomena.
- Each atom has a charged substructure.
- An atom's nucleus is made of protons and neutrons and is surrounded by electrons.
- The periodic table orders elements horizontally by the number of protons in the nucleus of each element's atoms and places elements with similar chemical properties in columns.
- The repeating patterns of this table reflect patterns of outer electron states.
- Patterns of electrons in the outermost energy level of atoms can provide evidence for the relative properties of elements at different scales.
- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
- The periodic table orders elements horizontally by the number of protons in the nucleus of each element's atoms and places elements with similar chemical properties in columns.
- The repeating patterns of the periodic table reflect patterns of outer electron states.
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.
- Different patterns may be observed at each of the scales at which a system is studied, and these patterns can provide evidence for causality in explanations of phenomena.
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
- 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.
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.



- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, aesthetics, and to consider social, cultural, and environmental impacts.
- 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.
- Models (e.g., physical, mathematical, computer models) can be used to simulate why the molecular-level structure is important in the functioning of designed materials.

Unit Learning Targets:

- Use the periodic table as a model to provide evidence for relative properties of elements at different scales based on the patterns of electrons in the outermost energy level of atoms in main group elements.
- 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 in main group elements.
- Use valid and reliable evidence (obtained from students' own investigations, models, theories, simulations, and peer review) showing the outermost electron states of atoms, trends in the periodic table, and patterns of chemical properties to construct and revise an explanation for the outcome of a simple chemical reaction.
- Use the assumption that theories and laws that describe the outcome of simple chemical reactions operate today as they did in the past and will continue to do so in the future.
- Observe patterns in the outermost electron states of atoms, trends in the periodic table, and chemical properties.
- Use the conservation of atoms and the chemical properties of the elements involved to describe and predict the outcome of a chemical reaction.
- Plan and conduct an investigation individually and collaboratively to produce data that can serve as the basis for evidence for comparing the structure of substances at the bulk scale to infer the strength of electrical forces between particles. In the investigation design, decide on types, how much, and accuracy of data needed to produce reliable measurements; consider limitations on the precision of the data (e.g., number of trials, cost, risk, time); and refine the design accordingly.
- Use patterns in the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
- Communicate scientific and technical information about why the molecular - level structure is important in the functioning of designed materials.
- Evaluate a solution to a complex real-world problem based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoffs considerations to determine why the molecular level structure is important in the functioning of designed materials.
- Use mathematical models and/or computer simulations to show why the molecular level structure is important in the functioning of designed materials.
- Communicate scientific and technical information about the attractive and repulsive forces that determine the functioning of the material.



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- Use mathematical models and/or computer simulations to show the attractive and repulsive forces that determine the functioning of the material.
- Examine in detail the properties of designed materials, the structure of the components of designed materials, and the connections of the components to reveal the function.
- Use models (e.g., physical, mathematical, computer models) to simulate systems of designed materials and interactions--including energy, matter, and information flows--within and between designed materials at different scales.



Evidence of Learning

Summative Assessment: Information covered in this unit will be tested on the midterm and final examinations and as individual chapter tests in addition to the formative assessments listed below.

Equipment Needed: iPad and Software, Basic Laboratory Equipment

Teacher Resources: Chemistry textbook and online resources by Pearson.

Formative Assessments:

- Quizzes
- Tests
- Labs
- Projects
- Homework
- Activities
- Practice Problems



Lesson Plans

Lesson	Time Frame
Lesson 1 How can we learn about something we can't see?	1 day
Lesson 2 If you can't see it, how do you know it's there?	2 days
Lesson 3 Where are electrons?	1 day

Teacher Notes: This Honors Chemistry unit emphasizes laboratory investigations, scientific modeling, quantitative reasoning, data analysis, and evidence-based explanations. Students should connect observations at the macroscopic level to particle-level processes and symbolic representations while applying chemistry concepts to real-world phenomena. Opportunities for collaboration, problem-solving, communication, and the use of technology should be incorporated throughout the unit to support student understanding and scientific literacy.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

<http://phet.colorado.edu/en/simulation/build-an-atom>

http://www.mhhe.com/biosci/genbio/virtual_labs/periodic_table/main.html

<http://www.chemheritage.org/discover/online-resources/chemistry-in-history/activities/path-to-the-periodic-table.aspx>

http://www.newburyparkhighschool.net/dogancay/hchem/labs/hlabo2_mendeleev.pdf

file:///localhost/D:/Users/karenheinz/Library/Containers/com.apple.mail/Data/Library/Mail%20Downloads/BE0ACAA1-1F2C-424D-91E8-9065FE958BC9/pogil.org/uploads/media_items/classifying-types-of-chemical-reactions.original.pdf



Lesson Plan 1 Template

Content Area: Chemistry

Lesson Title: How can we learn about something we can't see?

Time Frame: 1 day

Lesson Components

21st Century Themes

- ☐ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Create a personal digital portfolio which reflects personal and academic interests, achievements, and career aspirations by using a variety of digital tools and resources.

Vernier GoDirect

Equipment Needed:

Long Grain Rice (1mm in diameter)
 Red Hots
 Pieces of PVC Pipe (10cm diameter)
 Sheet of cardboard 1m in length

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Use atoms or groups of atoms to illustrate the underlying structure of materials. • Describe in a qualitative or semi-qualitative way the relative size of atoms in comparison with macroscopic and microscopic objects. • Understand that scientists use indirect evidence to study things too small to see directly.	Lesson Sequence Anchoring Phenomenon 1. Students are shown several pieces of evidence that scientists regularly use to study things they cannot directly observe, such as X-ray images of bones, photographs of distant galaxies, and tracks left by subatomic particles in cloud chamber images.	• Discussion Questions • Activity sheet • Pair and Share • Draw what you think an atom looks like. Make sure to label your model so that anyone can understand it. • Make models • Prediction Check: Before starting, students write or share how they think scientists can study things they can't see.



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- Use models and observation to infer information about an unseen object.
- Practice making and testing hypotheses.

- Students are asked how scientists can confidently describe objects and processes that cannot be seen directly and what evidence allows them to build reliable models of the unseen world.
2. Introduce the lesson with a class discussion.
 3. Set up the experiment area with the PVC pipe standing upright and the cardboard covering the top (teacher may assist).
 4. Roll long grain rice toward the covered pipe from different angles and distances.
 5. Observe how the rice bounces back — note the direction, speed, and pattern of scattering.
 6. Record observations on paper (draw or write what they notice).
 7. Form a hypothesis about what might be hidden inside the pipe based on how the rice behaves.
 8. Adjust their testing method (roll rice faster/slower, change angle or distance) to gather more evidence.
 9. Discuss findings within their group to reach a conclusion about what's inside the pipe.
 10. Sketch a model or diagram showing their inference of the "hidden contents."
 11. Compare results with other groups — see if their data matches or differs.

- Observation Notes:
- While rolling rice, students record what happens (direction, scattering, speed).
- (Assesses attention to detail and data collection.)
- Group Discussion Prompts:
Ask guiding questions during exploration:
"What patterns do you notice?" "What could cause the rice to bounce that way?"
- Hypothesis Formation:
Students write a short statement predicting what's inside the pipe based on their evidence.
- Diagram or Model Drawing:
Students sketch what they think is inside the pipe and label their reasoning.
- Exit Ticket: After the reveal, students answer brief reflection questions:
"What did you learn about how scientists study atoms?"
- Group Share or Gallery Walk: Students present their group's hypothesis and evidence to the class.
- Teacher Observation Checklist: During the activity, the teacher notes student engagement, teamwork, questioning, and use of evidence.



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| | <ol style="list-style-type: none">12. Observe the reveal when the teacher lifts the cardboard to show what's inside the pipe.13. Reflect and discuss how their indirect observations helped them infer something they couldn't see.14. Draw models using materials.15. Start investigation and answer questions on the activity sheet.16. Compare the size of important scientific objects.17. Conclude the lesson with discussion. | |
|--|--|--|

Differentiation:

While not a focus or part of the learning goals for this investigation, this is a good opportunity for students to learn about Metric units and scientific notation contextualized around learning about the sizes of important scientific objects. The materials provide some support for students on these topics if you choose to provide a review or introduce them to one or both of these ideas.

Resources Provided:

- Activity sheet
- Materials



Lesson Plan 2 Template

Content Area: Chemistry

Lesson Title: If you can't see it, how do you know it's there?

Time Frame: 2 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Google Sheets, interactive simulations, Vernier GoDirect

Equipment Needed:

1 mystery box
1 laser pointer
Projector screen or white wall
Plastic bottle of water

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Communicate the benefits and limitations of using indirect evidence for studying atomic structures. - Use historical evidence to develop and defend a model of atomic structure that explains the results of experiments done historically to better understand the nature of matter.	Lesson Sequence Anchoring Phenomenon 1. Students observe a sealed container containing a strong-smelling substance. Without opening the container, students can detect evidence that particles are moving and spreading through the air. Students are challenged to explain how scientists use indirect evidence to	- Discussion Questions - Activity sheet - Pair and Share - Observations of mystery box - Make models



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- support the existence and behavior of atoms and molecules.
2. Pre-activity: set up the mystery box and explain that atoms are so small we cannot see them.
 3. Hypothesis and Predictions: Before using the laser, students record:
 - o Their initial hypothesis about what might be inside the box and a diagram of the box predicting where objects might be located.
 4. Investigation: Shine a laser through each of the holes in the box containing an unknown object. For each location they record:
 - o Where the laser enters
 - o Where the beam exits
 - o If the beam is blocked, reflected, or scattered
 5. Observe what happens when the laser is dissected through different points in the box to collect evidence about what is inside it.
 - o Group Comparison: Groups compare maps with another group.
 6. Discussion prompts: What evidence do both groups agree on? Where do your models differ? What additional test



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would resolve the disagreement? Students revise their model if necessary.

Differentiation:

Learn more about cathode ray particles. Show and discuss simulations of the theory of atoms. Group students according to level to give tailored benchmark lessons.

Resources Provided:

- Activity sheet
- Materials



Lesson Plan 3 Template

Content Area: Chemistry Lesson Title: Where are electrons? Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Google Sheets, interactive simulations, Vernier GoDirect

Equipment Needed:

Pencils, Paper with target on it, Vernier system

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: Create a model of the atom that includes modern thinking regarding the role, location, and behavior of electrons.	Lesson Sequence Anchoring Phenomenon 1. Students observe demonstrations of static electricity, such as a charged balloon attracting small pieces of paper or bending a stream of water. Although electrons cannot be seen directly, their effects are clearly visible. Students are asked how scientists determine where electrons are likely to be found and how electron behavior explains observable chemical and physical properties.	- Discussion Questions - Activity sheet - Pair and Share - Observations of mystery box - Make models



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2. Review of Atomic History
 - Briefly revisit the progression of atomic models. Students complete a quick model comparison chart.
3. Describe probability, including precision versus accuracy. Ask students: Can you predict exactly where a dropped pencil will land?
 - What if you dropped it 50 times?
4. Take a piece of paper and draw a target symbol on it
5. Place the paper on a table, desk, or floor
6. Hold a pencil about 1 foot directly over the center of the circle with the point facing downward.
7. Drop the pencil trying to get it so that the tip will land right in the center of the X.
8. Repeat this step 20 to 30 times or more
9. Data Analysis
 - Students examine the pattern created.
 - Guiding questions:
 - Where are most of the marks?
 - Are they evenly distributed?
 - Do more points appear near the center or edges?
 - What pattern appears after many trials?



10. Combine results from the entire class on one large target.
11. Connect to Electron Location in Atoms
 - Explain that electrons behave similarly.
12. Show students a diagram of an electron cloud. Compare it to their pencil-drop pattern
13. Conclusion discussion questions: Why can't scientists determine the exact location of an electron? How does repeating random events help scientists understand patterns? How does the pencil drop model represent electron probability? What part of the activity represents uncertainty? How is the electron cloud model different from the Niels Bohr orbit model?
14. Reflection Exit Ticket

Differentiation:

- Note the variety and ask students what they think about the different ones.
- Be sure to make connections with the model and probe students for evidence from the simulation. It would be useful to have the simulation projected.
- If some seem confusing ask if anyone thinks they can explain it (or if students are willing to have names attached to their models ask the author of the model to explain it)
- Add a few model images to the DQ board selected by the class.

Resources Provided:

- Activity sheet
- Materials



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Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging Strongly and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☐	☒	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☐	☒	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☐	☒	☐
Are differentiated based on student needs	☐	☒	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☐	☒	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science

Grade Level: 10

Unit Title: Properties of Matter

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Chemistry **Grade Level:** 10 **Unit Title:** Inter and Intramolecular Forces

Unit Summary: In this unit, students will learn the intermolecular and intramolecular forces between atoms and compounds. The students begin to develop the concept of intermolecular forces by creating their own models for each type of force, observing physical properties of different liquids, and observing what happens when a phase change occurs. Naming compounds, acids, and bases will also be explored and analyzed.

Primary Interdisciplinary Connections: Engineering and mathematics

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ ICT Literacy
☒ Information Literacy ☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy

Unit Rationale: All interactions can be described by multiple types of forces, but the relative impact of these forces change with scale. On the nanoscale, a range of electrical forces with varying strengths tend to dominate the interactions between objects.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

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

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

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

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets

Standards: HS-PS1, HS-PS2, HS-PS3, HS-ESS2

Content Statements: Matter and Its Interactions; Motion and Stability: Forces and Interactions; Energy; Earth's Systems

CPI#:	Cumulative Progress Indicator (CPI):
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.



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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.
HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
Math.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.
Math.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 .
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.

Science and Engineering Practices:

Planning and Carrying Out Investigations

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

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3), (HS-ESS2-5)

Obtaining, Evaluating, and Communicating Information

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

- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)

Developing and Using Models



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

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-5)

Disciplinary Core Ideas (DCIs):

PS1.A: Structure and Properties of Matter

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3), (secondary to HS-PS2-6)

PS2.B: Types of Interactions

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6), (secondary to HS-PS1-3)

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. (HS-PS3-5)

ESS2.C: The Roles of Water in Earth's Surface Processes

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5)

Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-3)

Structure and Function

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

Cause and Effect



- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5)

Unit Essential Questions:

- What underlying forces explain the variety of interactions observed?
- How are ionic compounds formed?
- How does metallic bonding affect the properties of metals?
- How is the bonding in molecular compounds different from the bonding in ionic compounds?
- How do electrons affect the shape of a molecule?
- What factors affect molecular properties?
- How does the periodic table help you determine the names and formulas of ions and compounds?
- What is the difference between an ionic and a molecular compound?

Unit Enduring Understandings:

- To find the number of valence electrons in an atom of a representative element, simply look at its group number.
- Although they are composed of ions, ionic compounds are electrically neutral.
- The valence electrons of atoms in a pure metal can be modeled as a sea of electrons.
- Alloys are important because their properties are often superior to those of their component elements.
- A molecular formula shows how many atoms of each element a substance contains.
- In covalent bonds, electron sharing occurs so that atoms attain the configurations of noble gases.
- Just as an atomic orbital belongs to a particular atom, a molecular orbital belongs to a molecule as a whole.
- Intermolecular attractions are weaker than either an ionic or covalent bond.
- A polyatomic ion is composed of more than one atom that behaves as a unit and carries a charge.
- To write formulas for compounds with polyatomic ions, write the symbol for the cation followed by the symbol for the anion. Then balance the charges. To name a compound containing a polyatomic ion, state the cation name followed by the anion name.
- An -ide ending usually indicates a binary compound. An -ite or -ate ending indicates a polyatomic ion with oxygen. Prefixes usually indicate a molecular compound. A roman numeral after the name of a cation shows the ionic charge of the cation.

Unit Learning Targets:

Students will....

- Develop and use models to illustrate properties of substances based on interactions between particles.



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- Plan and conduct an investigation to gather evidence to explain properties based on the interactions between particles.
- Communicate information about the relationship between observations at the bulk scale to particle interactions at the microscopic scale.
- Describe three properties of ionic compounds.
- Describe how cations and anions form.
- Identify the information a molecular formula provides.
- Explain the result of electron sharing in covalent bonds.
- Describe the relationship between atomic and molecular orbitals.
- Explain how polyatomic ions differ from and are similar to monatomic ions.
- Apply the rules for naming and writing formulas for binary ionic compounds and compounds with polyatomic ions.
- Determine the name and formula of an acid and a base.
- List general guidelines that can help you write the name and formula of a chemical compound.



Evidence of Learning

Summative Assessment: Information covered in this unit will be tested on the midterm and final examinations and as individual chapter tests in addition to the formative assessments listed below.

Equipment Needed: iPad and Software, Basic Laboratory Equipment

Teacher Resources: Chemistry textbook and online resources by Pearson.

Formative Assessments:

- Quizzes
- Tests
- Labs
- Projects
- Homework
- Activities
- Practice Problems



Lesson Plans

Lesson	Time Frame
Lesson 1 How do wood frogs survive extreme cold during the winter?	1 day
Lesson 2 VSEPR Model Making	2 days
Lesson 3 Sweet 16 Chemical Formulas Tournament	1 day

Teacher Notes: This Honors Chemistry unit emphasizes laboratory investigations, scientific modeling, quantitative reasoning, data analysis, and evidence-based explanations. Students should connect observations at the macroscopic level to particle-level processes and symbolic representations while applying chemistry concepts to real-world phenomena. Opportunities for collaboration, problem-solving, communication, and the use of technology should be incorporated throughout the unit to support student understanding and scientific literacy.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

<https://ngsschemistry.wordpress.com/unit-2-atomic-structure/>

<http://www.nextgenscience.org/topic-arrangement/hschemical-reactions>



Lesson Plan 1 Template

Content Area: Chemistry
 winter?

Lesson Title: How do wood frogs survive extreme cold during the
 Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Genetics, Mathematics

Integration of Technology:

Vernier GoDirect

Equipment Needed:

- Activity sheet
- Videos
- Articles
- De-icing agents
- Beakers
- Test tubes with holders
- Ice
- Digital Thermometers
- Scoops

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Explain how wood frogs survive extreme cold during the winter. • Analyze whether de-icing agents met their claims about their effective lowest temperatures. • Determine whether de-icing agents are more effective than generic ones.	Lesson Sequence Anchoring Phenomenon 1. Show images or short clips of winter roads covered in salt. Ask students: Why does salt melt ice? Why do cities sometimes use different chemicals instead of regular salt? Why do products advertise	• Video • Claim, Evidence, and Reasoning for Investigation



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- “works to -25°F ”?
Explain that many de-icing products contain chemicals like:
- Sodium chloride (rock salt)
 - Calcium chloride
 - Magnesium chloride
2. Student Experimental Design Challenge:
 3. Design an investigation to determine the answers to the guiding questions. What will be their independent variable? What will be their dependent variable? What variables must be controlled?
 4. Discuss Possible measurable outcomes: Time to melt ice. The amount of ice melted. Temperature at which melting stops
 5. Students conduct their experiment and record a video explaining their investigation.
 6. The video should include:
 - Introduction, Procedures, Data Collection, and Observations.
 7. Evaluate Product Claims: Do commercial de-icing agents meet their claims about their effective lowest temperatures?
 8. Are brand name de-icing agents more effective than generic ones?
 9. Combine data from all groups. Create a class dataset. This allows discussion of: experimental variation,



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reliability, scientific consensus. Students see how larger sample sizes improve confidence.

Differentiation:

Guided help with investigation and more handouts with explanations.
Incorporate videos into lab reports.

Resources Provided:

- <http://www.rsc.org/chemistryworld/2014/02/ice-core-antifreeze-protein-inner-workings-flou-nder-clathrate>
- <https://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/articlesbytopic/solutions/chemmatters-feb2006-salting-roads.pdf>
- <http://youtu.be/UvCdOXG2rPo?list=PL79OOLERPwb7RoXUsZU4pToY-KahkCztJ> (Watch up to 1:20)
- <http://youtu.be/TYJv-wxwvLw>; <http://news.nationalgeographic.com/news/2007/02/070220-frog-antifreeze.html>



Lesson Plan 2 Template

Content Area: Chemistry

Lesson Title: VSEPR Model Making

Time Frame: 2 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

iPads for 3-D modeling examples and G-suite applications

Equipment Needed:

- Molecular Model Kit
- Molecule Geometric Handouts
- iPads with Google Slides

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Construct at least six models of VSEPR molecular geometries from using molecular model kits	Lesson Sequence Anchoring Phenomenon 1. Students compare molecular models of carbon dioxide, water, methane, and ammonia. Despite having similar numbers of atoms, the molecules have dramatically different shapes and properties. Students are challenged to explain why molecules arrange themselves in specific three-dimensional structures and how	• Grade shapes made. • Pre-lab questions. • Post lab questions.



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- molecular shape influences behavior.
2. Engage Students: Why Shape Matters
 - Show examples of molecules and ask: Why do molecules have shapes? Why does shape affect properties like smell, reactivity, or polarity?
 3. Scaffolding Review: Drawing Lewis Structures
 4. Electron Groups and Geometry . Explain that geometry depends on the number of electron groups around the central atom.
 5. Model Kit Investigation
 6. Pre-Lab Planning.
Students receive a list of molecules to model.
Students first:
 - Draw the Lewis structure
 - Predict molecular geometry
 - Predict bond angle
 7. Students use model kits to build molecules.
 - For each molecule they must:
 - Construct the 3D model
 - Observe bond angles
 - Compare with predicted geometry
 8. Photographing Models
 - Students take clear photos of each model.
 - Photo requirements:



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- white background if possible
 - label molecule
 - show full 3D geometry
9. Class Presentation or Gallery Walk: Students show off their completed molecular models in a class-wide gallery walk presentation.

Differentiation:

Walk through the process of making models. Utilize videos from YouTube to assist. Performance based grade and explanation.

Resources Provided:

- <https://d3jc3ahdjad7x7.cloudfront.net/grkOcayFCyrxVUiGjasK1ZBeIKkOSD8CIX2AuUQ5Ixvl eVF4.pdf>



Lesson Plan 3 Template

Content Area: Chemistry
 Time Frame: 1 day

Lesson Title: Sweet 16 Chemical Formulas Tournament

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:
 Mathematics

Integration of Technology:

Students will produce and edit a multi-page digital document for a commercial or professional audience and present it to peers for review.

Equipment Needed:

Activity sheet with rules and chart to fill in

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Familiarize themselves with monatomic and polyatomic ions, ion charges, and writing formulas. - Apply their knowledge of ions to different scenarios.	Lesson Sequence Anchoring Phenomenon 1. Students examine the ingredient labels of common foods, medicines, cleaning products, fertilizers, and consumer products. Many familiar materials are represented by chemical formulas that appear unrelated to their everyday uses. Students are challenged to determine how chemical formulas communicate information about	- Pre-lab questions - Post-lab questions - Tournament Table - Check individual ability to write correct formulas - Observe groups during rounds for reasoning about charges



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composition, structure, and function and why understanding formulas is important in science, industry, and everyday life.

2. Pre-Lab Review: Review Ion Types:
 - Monatomic ions: single atoms with a charge (e.g., Na^+ , Cl^- , Mg^{2+})
 - Polyatomic ions: groups of atoms that act as a unit with a charge (e.g., SO_4^{2-} , NH_4^+ , NO_3^-)
3. Review Crisscross Method for Ionic Formulas:
 - Cross the absolute value of the charges to become subscripts
 - Reduce subscripts to lowest ratio if needed
4. Battle Bracket Activity Setup: Create Brackets
 - Use 16 ions (8 cations, 8 anions) Randomly pair cations and anions for the first round matchups Assign each group of 2–4 students a “battle table” or sheet
5. First round: Write the charges.
6. Second Round: Write the formula.
7. Semifinals: Count how many atoms are in each formula.
8. Final Round: The winner is declared.



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|--|--|--|
| | <p>9. Reflection Questions:</p> <ul style="list-style-type: none">○ How do the charges of ions determine the formulas? What challenges did you face with polyatomic ions? How does counting atoms help in predicting compound properties? <p>10. Extension Options:</p> <ul style="list-style-type: none">○ Battle with molecular compounds (covalent compounds with prefixes) <p>Stoichiometry challenge: calculate mass of each formula after building it</p> <p>ionic properties discussion: link ionic formulas to solubility, conductivity, and crystal lattice structure</p> | |
|--|--|--|

Differentiation:

Guide students through different compound combinations. Group students based on ability. Performance based assessment. Use results to determine new groupings for benchmark lessons.

Resources Provided:

- Flinn Scientific Sweet 16 Chemical Formulas Tournament



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging Strongly and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☐	☒	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☐	☒	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☐	☒	☐
Are differentiated based on student needs	☐	☒	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☐	☒	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science

Grade Level: 10

Unit Title: Inter and Intramolecular Forces

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Chemistry **Grade Level:** 10 **Unit Title:** Chemical Reactions

Unit Summary: In this unit of study, students develop and use models, plan and conduct investigations, use mathematical thinking, and construct explanations and design solutions as they develop an understanding of the substructure of atoms and to provide more mechanistic explanations of the properties of substances. Chemical reactions, including rates of reactions and energy changes, can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. Students also apply an understanding of the process of optimization and engineering design to chemical reaction systems.

Primary Interdisciplinary Connections: Mathematics

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ ICT Literacy
☐ Information Literacy ☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy

Unit Rationale: Students are expected to demonstrate proficiency in developing and using models, planning and conducting investigations, using mathematical thinking, and constructing explanations and designing solutions.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

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

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

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

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets

Standards: HS-PS1; HS-ETS1

Content Statements: Matter and Its Interactions; Engineering Design

CPI#:	Cumulative Progress Indicator (CPI):
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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.
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HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
HS-PS1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
HS-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.
Math.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.
Math.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 .
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.

Science and Engineering Practices:

Developing and Using Models

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

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

Using Mathematics and Computational Thinking

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

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



Constructing Explanations and Designing Solutions

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

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)
- 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-PS1-6)

Disciplinary Core Ideas (DCIs):

PS1.A: Structure and Properties of Matter

- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

PS1.B: Chemical Reactions

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4), (HS-PS1-5)
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-7)

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 (tradeoffs) may be needed. (secondary to HS-PS1-6)

Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-5)

Energy and Matter

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

Stability and Change



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

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

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

Unit Essential Questions:

- How can one explain the structure, properties, and interactions of matter?
- Where do the atoms go during a chemical reaction?
- What is different inside a heat pack and a cold pack?
- Is it possible to change the rate of a reaction or cause two elements to react that do not normally want to?
- What can we do to make the products of a reaction stable?

Unit Enduring Understandings:

- The fact that atoms are conserved, together with the knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.
- The total amount of energy and matter in closed systems is conserved.
- The total amount of energy and matter in a chemical reaction system is conserved.
- 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.
- Changes of energy and matter in a chemical reaction system can be described in terms of energy and matter flows into, out of, and within that system.
- A stable molecule has less energy than the same set of atoms separated; at least this much energy must be provided in order to take the molecule apart.
- 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.
- Changes of energy and matter in a chemical reaction system can be described in terms of collisions of molecules and the rearrangements of atoms into new molecules, with subsequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- 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.
- Patterns in the effects of changing the temperature or concentration of the reacting particles can be used to provide evidence for causality in the rate at which a reaction occurs.



- Much of science deals with constructing explanations of how things change and how they remain stable.
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- 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 may be needed.
- Explanations can be constructed explaining how chemical reaction systems can change and remain stable.

Unit Learning Targets:

Students will....

- Use mathematical representations of chemical reaction systems to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
- Use mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and products and the translation of these relationships to the macroscopic scale, using the mole as the conversion from the atomic to the macroscopic scale.
- Use the fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, to describe and predict chemical reactions.
- Describe changes of energy and matter in a chemical reaction system in terms of energy and matter flows into, out of, and within that system.
- Explain the idea that a stable molecule has less energy than the same set of atoms separated.
- Describe changes of energy and matter in a chemical reaction system in terms of energy and matter flows into, out of, and within that system.
- Describe chemical processes, their rates, and whether or not they store or release energy in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- Develop a model based on evidence to illustrate the relationship between the release or absorption of energy from a chemical reaction system and the changes in total bond energy.
- Use the number and energy of collisions between molecules (particles) to explain the effects of changing the temperature or concentration of the reacting articles on the rate at which a reaction occurs.
- Use patterns in the effects of changing the temperature or concentration of the reactant particles to provide evidence for causality in the rate at which a reaction occurs.
- Apply scientific principles and multiple and independent student-generated sources of evidence to provide an explanation of the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- Construct explanations for how chemical reaction systems change and how they remain stable.
- Design a solution to specify a change in conditions that would produce increased amounts of products at equilibrium in a chemical system based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.
- Break down and prioritize criteria for increasing amounts of products in a chemical system at equilibrium.
- Refine the design of a solution to specify a change in conditions that would produce increased amounts of products at equilibrium in a chemical system based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.



Evidence of Learning

Summative Assessment: Information covered in this unit will be tested on the midterm and final examinations and as individual chapter tests in addition to the formative assessments listed below.

Equipment Needed: iPad and Software, Basic Laboratory Equipment

Teacher Resources: Chemistry textbook and online resources by Pearson.

Formative Assessments:

- Quizzes
- Tests
- Labs
- Projects
- Homework
- Activities
- Practice Problems



Lesson Plans

Lesson	Time Frame
Lesson 1 Reaction in a Bag	1 day
Lesson 2 Fireworks Investigation	1 day
Lesson 3 Bowling Ball-Will it sink or swim?	1 day

Teacher Notes: This Honors Chemistry unit emphasizes laboratory investigations, scientific modeling, quantitative reasoning, data analysis, and evidence-based explanations. Students should connect observations at the macroscopic level to particle-level processes and symbolic representations while applying chemistry concepts to real-world phenomena. Opportunities for collaboration, problem-solving, communication, and the use of technology should be incorporated throughout the unit to support student understanding and scientific literacy.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

- American Association for the Advancement of Science: <http://www.aaas.org/programs>
- American Chemical Society: <http://www.acs.org/content/acs/en/education.html>
- Concord Consortium: Virtual Simulations: <http://concord.org/>
- International Technology and Engineering Educators Association:
<http://www.iteaconnect.org/>
- National Earth Science Teachers Association: <http://www.nestanet.org/php/index.php>
- National Science Digital Library: <https://nsdl.oercommons.org/>
- National Science Teachers Association: <http://ngss.nsta.org/Classroom-Resources.aspx>
- North American Association for Environmental Education: <http://www.naace.net/>
- Phet: Interactive Simulations <https://phet.colorado.edu/>
- Science NetLinks: <http://www.aaas.org/program/science-netlinks>



Lesson Plan 1 Template

Content Area: Chemistry

Lesson Title: Reaction in a Bag

Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

A video of the Reaction in a Bag activity, presented by Jeff Hepburn, is available in Scientific Method Demonstrations, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series. iPads with Google Sheets

Equipment Needed:

- Calcium chloride, 100g
- Phenol red solution, 70mL
- Sodium bicarbonate, 40g
- Water, distilled or deionized, 70mL
- Beakers, 50mL 2, 100mL 2
- Graduated cylinder, 10mL
- Pen, labeling
- Pipet, Beral-type, thin-stem
- Sealable, zipper-lock plastic bags, 10
- Teaspoon and Tablespoon Scoops
- Wash bottle filled with distilled water

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Make observations about changes that occur when several substances are mixed. • Design controlled experiments to identify the substances responsible for the observed changes.	Lesson Sequence Anchoring Phenomenon 1. Students watch the reaction-in-a-bag demonstration in which substances are combined and the bag rapidly inflates while	• Consider at least 4 observations that could be investigated to determine the interactions that are responsible for the observed changes. • Fill in data tables.



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- Collect data
- Analyze data

- temperature changes occur. Students observe evidence of chemical change, including gas production and energy transfer, and are asked how atoms are rearranged during reactions while still obeying the law of conservation of mass.
2. Pre-Lab Review Review Reaction Types. Ask students: What evidence tells us that a chemical reaction occurred? What are the main types of reactions?
 3. Make beakers with solutions
 4. Mix solutions
 5. Observe reactions and describe appearance
 6. Observe and record: Color changes. Formation of precipitate or gas. Temperature change
 7. Discussion Questions:
 8. How does the reaction look?
 9. What is happening at the molecular level?
 10. Observe reaction in a bag: Pour measured solutions into a zip lock bag/ Seal the bag completely. Gently mix by kneading the bag
 11. Write down Observations:
 - o Color changes
 - o Precipitate formation
 - o Gas bubbles
 - o Temperature changes
 12. Compare Observations between reactions in

- Post Demonstration Discussion Questions



- beakers vs bags. Ask students: How does the reaction appear in the bag compared to the beaker? Is it easier or harder to see changes? Why might a bag be a safer or better method for some reactions?
13. Record observations in a data table
14. Discussion Prompts:
- o What evidence of chemical change did you see?
 - o Which reactions were exothermic or caused a noticeable temperature change?
 - o Why is a zip lock bag safer for certain reactions?

Differentiation:

Lab Report to follow demonstration and come up with a similar experiment. Analyze observation in small groups based on student progress.

Resources Provided:

- ChemFax! Flinn Scientific Reaction in a Bag Scientific Method Demonstrations



Lesson Plan 2 Template

Content Area: Chemistry Lesson Title: Fireworks Investigations Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☐ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:
 Mathematics

Integration of Technology:
 Google Sheets, Vernier GoDirect

Equipment Needed:

- Bunsen Burner
- Matches/Striker
- Q-tips
- Distilled Water
- NaNO₃
- Unknowns
- NaCl
- KNO₃
- Na₂CO₃
- CuSO₄
- K₂SO₄

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Analyze different colors produced in fireworks. • Relate this experiment to stars.	Lesson Sequence 1. Introduce the phenomenon of colored fireworks using images or short video clips to engage students in questioning how different elements produce different flame colors. 2. Independent study and guided note-taking on electron excitation,	• Discussion Questions • Collaborative Analysis • Lab Report • Activity sheet



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- emission spectra, atomic structure, and the relationship between energy and light emission.
3. Benchmark lesson on flame tests, electron transitions, and how metal ions emit characteristic colors when energized, followed by guided discussion and formative assessment.
 4. Safety review and teacher demonstration of proper Bunsen burner setup, lighting procedures, flame adjustment, and laboratory safety expectations.
 5. Hands-on flame test investigation where students:
 6. Light the Bunsen burner
 7. Dip a clean Q-tip in water and then into a solid ionic compound
 8. Place the Q-tip into the flame
 9. Observe and record flame color, intensity, and duration
 10. Repeat with multiple compounds
 11. Students compare flame colors of different metal ions such as sodium, potassium, lithium, calcium, copper, and strontium.
 12. Observation and data collection activity including qualitative descriptions, color comparisons, and identification of unknown compounds using known reference samples.



13. Data analysis and CER discussion connecting observed flame colors to electron movement, quantized energy levels, and emission of visible light.
14. Interactive extension activity using emission spectrum diagrams or spectroscope observations to compare visible spectra produced by different elements.
15. Real-world connection discussion exploring the chemistry of fireworks, neon signs, streetlights, and spectroscopy used in astronomy and forensic science.
16. Give the student choice extension activity that allows students to create a fireworks design proposal, infographic, digital presentation, or periodic table color guide based on flame test results.
17. Cross-curricular connections to physics and astronomy through discussions of electromagnetic radiation, wavelengths, and identification of elements in stars.
18. Formative assessments including exit tickets, lab questions, prediction activities, and peer discussion of flame color observations.
19. Summative assessment options including lab reports, CER writing, spectroscopy analysis,



	quizzes on electron transitions, or identification of unknown compounds using flame test evidence.	
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Differentiation:

Make this a teacher demonstration and have students' record observations. Lab Report from this experiment or come up with a comparative one on their own. Group students by ability and provide benchmark check-ins based on student groups.

Resources Provided:

- Read the "Fireworks!" article:
<http://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/articlesbytopic/oxidationandredox/chemmatters-oct2010-fireworks.pdf>



Lesson Plan 3 Template

Content Area: Chemistry Lesson Title: Bowling Ball-Will it sink or swim? Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Google Sheets to assist with analysis, Vernier GoDirect

Equipment Needed:

- Ruler
- String
- Balance
- Bowling Ball
- Other measuring tools

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Carry out measurements and calculations to determine whether a bowling ball will sink or float in water. • Understand the concept of density related to sinking and floating.	Lesson Sequence 1. Introduce the phenomenon by asking students to predict whether a bowling ball will sink or float in water and justify their reasoning using prior knowledge of density and buoyancy. 2. Independent study and guided note-taking on density, mass, volume, buoyancy, and Archimedes' Principle using readings, videos, diagrams, or guided practice problems.	• Explain if a blowing ball will sink or swim in water. • Identify two specific sources of experimental error.



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3. Benchmark lesson on calculating density and predicting flotation based on comparisons to the density of water, followed by formative assessment and discussion.
4. Small group experimental design activity where students devise a method to determine whether a bowling ball will sink or float by measuring mass and volume and organizing all measurements in a data table.
5. Hands-on investigation where students obtain a bowling ball, collect measurements, calculate density, predict flotation, and test predictions when appropriate and safe.
6. Data analysis and CER activity connecting calculations and observations to scientific explanations of buoyancy, density, and fluid displacement.
7. Real-world application discussion exploring how density and buoyancy relate to ships, submarines, cargo transport, and engineering design.
8. Student choice extension activity allows students to design a floating object, compare different objects with varying densities, or create a presentation explaining buoyancy concepts.



- | | | |
|--|--|--|
| | 9. Formative assessments that include prediction questions, density calculations, exit tickets, and peer discussion; summative assessments may include lab reports, CER writing, quizzes, or engineering design reflections. | |
|--|--|--|

Differentiation:

Give students a sheet that will give them ideas on how they could come up with this experiment. Lab Report questions varied.

Resources Provided:

Bowling ball lab sheet



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging Strongly and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☐	☒	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☐	☒	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☐	☒	☐
Are differentiated based on student needs	☐	☒	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☐	☒	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science **Grade Level:** 10 **Unit Title:** Chemical Reactions

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Chemistry **Grade Level:** 10 **Unit Title:** The Chemistry of Gases and Aqueous Solutions

Unit Summary: In Energy of Chemical Systems, students will understand energy as a quantitative property of a system—a property that depends on the motion and interactions of matter and radiation within that system. They will also understand that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Students develop an understanding that energy, at both the macroscopic and the atomic scales, can be accounted for as motions of particles or as energy associated with the configurations (relative positions) of particles.

Primary Interdisciplinary Connections: Mathematics

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ ICT Literacy
☐ Information Literacy ☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy

Unit Rationale: Students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, engaging in argument from evidence, and using these practices to demonstrate understanding of core ideas.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

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

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

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

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets

Standards: HS-PS1; HS-PS3

Content Statements: Matter and Its Interactions; Engineering Design

CPI#: **Cumulative Progress Indicator (CPI):**



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.
HIS-PS3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
Math.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.
Math.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 .
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.

Science and Engineering Practices:

Planning and Carrying Out Investigations

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

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3), (HS-PS3-4)

Disciplinary Core Ideas (DCIs):

PS1.A: Structure and Properties of Matter

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

PS2.B: Types of Interactions



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

PS3.B: Conservation of Energy and Energy Transfer

- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-4)
- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

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. (HS-PS3-4)

Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-3)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4)

Unit Essential Questions:

- Does thermal energy always transfer or transform in predictable ways?
- How can the behavior of gases and aqueous solutions be explained by the motion and interactions of particles?
- How do changes in temperature affect the movement of matter and the transfer of energy?
- How can models be used to describe and predict energy flow within chemical systems?
- Why do systems naturally move toward more uniform energy distributions?

Unit Enduring Understandings:

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Uncontrolled systems always move toward more stable states—that is, toward a more uniform energy distribution.
- Although energy cannot be destroyed, it can be converted into less useful forms—for example, to thermal energy in the surrounding environment.
- The observable properties of gases and aqueous solutions can be explained by the motion, interactions, and energy of particles.



Unit Learning Targets:

Students will....

- Plan and conduct an investigation individually or collaboratively to produce data on transfer of thermal energy in a closed system that can serve as a basis for evidence of uniform energy distribution among components of a system when two components of different temperatures are combined.
- Use models to describe a system and define its boundaries, initial conditions, inputs, and outputs.
- Design an investigation to produce data on transfer of thermal energy in a closed system that can serve as a basis for evidence of uniform energy distribution among components of a system when two components of different temperatures are combined, considering types, how much, and the accuracy of data needed to produce reliable measurements.
- Consider the limitations of the precision of the data collected and refine the design accordingly.
- Explain the behavior of gases using particle models and kinetic molecular theory.
- Analyze how temperature, pressure, and volume affect gas behavior.
- Use quantitative and qualitative data to explain thermal energy transfer.
- Investigate how energy is transferred during physical and chemical processes.
- Construct explanations for how particles interact in aqueous solutions.
- Interpret experimental data to determine patterns of energy transfer and distribution.
- Evaluate the effectiveness and limitations of models used to describe chemical systems.
- Apply evidence from laboratory investigations to support claims about matter and energy interactions.



Evidence of Learning

Summative Assessment: Information covered in this unit will be tested on the midterm and final examinations and as individual chapter tests in addition to the formative assessments listed below.

Equipment Needed: iPad and Software, Basic Laboratory Equipment

Teacher Resources: Chemistry textbook and online resources by Pearson.

Formative Assessments:

- Quizzes
- Tests
- Labs
- Projects
- Homework
- Activities
- Practice Problems



Lesson Plans

Lesson	Time Frame
Lesson 1 Why do substances have specific melting and freezing points?	1 day
Lesson 2 Paintball	1 day
Lesson 3 Salad Dressing Science	2 days

Teacher Notes: This Honors Chemistry unit emphasizes laboratory investigations, scientific modeling, quantitative reasoning, data analysis, and evidence-based explanations. Students should connect observations at the macroscopic level to particle-level processes and symbolic representations while applying chemistry concepts to real-world phenomena. Opportunities for collaboration, problem-solving, communication, and the use of technology should be incorporated throughout the unit to support student understanding and scientific literacy.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

- American Association for the Advancement of Science: <http://www.aaas.org/programs>
- American Association of Physics Teachers: <http://www.aapt.org/resources/>
- American Chemical Society: <http://www.acs.org/content/acs/en/education.html>
- Concord Consortium: Virtual Simulations: <http://concord.org/>
- International Technology and Engineering Educators Association: <http://www.iteaconnect.org/>
- National Earth Science Teachers Association: <http://www.nestanet.org/php/index.php>
- National Science Digital Library: <https://nsdl.oercommons.org/>
- National Science Teachers Association: <http://ngss.nsta.org/Classroom-Resources.aspx>
- North American Association for Environmental Education: <http://www.naaee.net/>
- Phet: Interactive Simulations <https://phet.colorado.edu/>
- Physics Union Mathematics (PUM): <http://pum.rutgers.edu/>
- Science NetLinks: <http://www.aaas.org/program/science-netlinks>



Lesson Plan 1 Template

Content Area: Chemistry
 points?

Lesson Title: Why do substances have specific melting and freezing
 Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

iPad for graphing numbers and making charts using Google Sheets, Vernier GoDirect

Equipment Needed:

- Ice
- Rock Salt
- Lauric Acid
- Oleic Acid
- Palmitic Acid
- Stearic Acid
- Distilled Water
- Temperature sensor kit
- Hot plate
- Test Tubes
- Beaker, 500mL
- Styrofoam Cup

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Determine the melting or freezing point of water, lauric acid, oleic acid, and stearic acid. • Develop a conceptual model to explain differences in melting and freezing points.	Lesson Sequence Engage Phenomenon & Concept Introduction 1. Students observe different substances (ice, wax, salt, metals) melting at different temperatures and respond to the	• Results of the test of the models. • Conclusion questions. • Grade models on rubric.



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question: "Why do substances have specific melting and freezing points?"

2. Independent study and guided note-taking on intermolecular forces, particle motion, phase changes, and energy transfer during melting/freezing.
3. Benchmark lesson explaining heating/cooling curves, energy plateaus, and how intermolecular forces determine phase change temperatures.

Data Collection & Investigation Design

4. In groups, students determine what data is needed to investigate phase changes, including temperature vs. time, phase observations, and identification of melting/freezing points.
5. Students design and complete a heating/cooling curve investigation for one or more substances, collecting and organizing data in structured tables.

Data Analysis & Model Development

6. Students graph heating/cooling curves, identify phase change plateaus, and compare melting/freezing points across substances.



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7. Groups develop particle-level conceptual models explaining differences in phase change temperatures based on intermolecular forces and energy interactions.

Model Testing, CER, & Application

8. Students test and refine models by predicting phase behavior of new substances and evaluating peer models for accuracy.
9. Students complete a CER explanation connecting data, graphs, and particle models to explain why substances have specific melting and freezing points.
10. Extension discussions connect concepts to real-world applications such as food science, metallurgy, and climate systems.
11. Formative and summative assessments include exit tickets, graph analysis, CER writing, lab reports, and model presentations.

Differentiation:

Determine the molar masses of all compounds used. Connect to the different types of investigations that happen in science. Split students into groups based on formative assessment data.

Resources Provided:

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?



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2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?
 - Your report should answer these questions in two pages or less. The report must be typed and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!



Lesson Plan 2 Template

Content Area: Chemistry

Lesson Title: Paintball

Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Students will create a report from a relational database consisting of at least two tables
 Google Sheets

Equipment Needed:

Article, paintball

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Find the density of a paintball. - Understand what paintballs are made of. - Model the forces in a paintball. - Relate to magic markers.	Lesson Sequence Engage Phenomenon & Article Analysis - Students begin by reading an article about paintball technology, focusing on how paintballs are designed, how they break on impact, and how they are manufactured. - Class discussion introduces the driving question: "How is paintball an application of chemistry?" Students make initial connections between materials, forces, and chemical composition. - Chemistry Connections & Composition Investigation - Students analyze the makeup of a paintball, including the	- Quiz - Activity sheet - Discussion Questions - Relationship to chemistry



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gelatin capsule, dye solution, and water-based internal mixture.

5. Mini-lesson connects paintball components to chemical concepts such as solutions, polymers, viscosity, solubility, and material properties.
6. Students identify how chemical design choices affect performance (e.g., shell strength, solubility in water, and stability under pressure).

Density Investigation & Data Collection

7. Students experimentally determine the density of a paintball by measuring mass and volume (using water displacement or geometric approximation).
8. Data is recorded in a structured table and compared across multiple paintballs or sample batches if available.
9. Students use results to predict behavior under different conditions such as impact, storage, or environmental exposure.

Concept Discussion & Real-World Chemistry Application

10. Students discuss how chemical principles explain paintball behavior, including pressure, phase behavior upon impact, and energy transfer causing rupture.
11. Connections are made to broader chemistry concepts such as polymers in materials science, solution chemistry in



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dyes, and safety design in consumer products.

12. Students complete a CER response explaining how chemistry is essential to paintball design, performance, and function.

Extension & Assessment

13. Students extend learning by designing an improved paintball (changing composition, durability, or environmental impact) or comparing paintballs to other polymer-based systems.
14. Formative assessment includes discussion questions and quick checks on density and materials concepts, while summative assessment may include a CER write-up, lab report, or design proposal.

Differentiation:

The teacher can demonstrate the lab to small groups of students based on formative assessment data.

Resources Provided:

- <https://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/articlesbytopic/solutions/chemmatters-april2007-paintball.pdf>
- http://newsnc.cheminst.ca/articles/1994_paintballs_e.html Paintballs and Canadian National Chemistry Week.
- Enotes.com. <http://science.enotes.com/how-productsencyclopedia/paintball> How paintballs are made.
- Madpaintballer.com. http://www.madpaintballer.com/make_paintballs.php How to make paintballs and more.



Lesson Plan 3 Template

Content Area: Chemistry Lesson Title: Salad Dressing Science Time Frame: 2 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Student iPads for research, data collection, collaboration, and analysis
 Google Sheets for organizing data, calculating averages, and graphing emulsion stability
 Molecular modeling resources and simulations to visualize polar and nonpolar interactions
 Digital presentation tools for communicating recommendations and product designs

Equipment Needed:

- Student iPads
- 20 mL test tubes and racks
- Graduated cylinders
- Electronic balances
- Stopwatches
- Vinegar
- Vegetable oil
- Assorted emulsifiers (egg yolk, mustard, lecithin, xanthan gum, etc.)
- Stirring rods
- Labels and markers
- Safety goggles
- Data collection sheets

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Investigate how molecular structure influences the stability of emulsions.	Lesson Sequence Anchoring Phenomenon 1. Students examine several commercially available salad dressings and observe that	• Experimental design plan • Data tables and observations



- Design and conduct an experiment to evaluate the effectiveness of different emulsifying agents.
- Collect and analyze quantitative data related to emulsion stability.
- Construct explanations using evidence and particle-level interactions.
- Evaluate the effectiveness of emulsifiers for food and industrial applications.
- Develop and communicate evidence-based recommendations for a product design challenge.

2. The teacher shakes a bottle of oil and vinegar dressing and asks students why two liquids can temporarily mix but eventually separate.
3. Students generate initial explanations and questions about what makes certain mixtures more stable than others.
4. Students investigate the structure and purpose of emulsifiers in foods, cosmetics, pharmaceuticals, and other consumer products.
5. Student teams are presented with a challenge: design a salad dressing that remains mixed as long as possible while remaining practical and cost-effective to produce.
6. Teams develop a testable hypothesis regarding which emulsifier will produce the most stable emulsion.
7. Students measure equal amounts of oil, vinegar, and selected emulsifiers.
8. Teams prepare multiple emulsion samples using consistent procedures.
9. Students shake each sample for a controlled amount of time and immediately record observations.
10. Teams monitor separation over time, recording quantitative data and qualitative observations.
11. Students repeat trials to improve reliability and identify patterns in the data.
12. Using Google Sheets, students organize data, calculate

- Graphs showing emulsion stability over time
- Analysis questions
- Particle-level explanation of emulsion formation
- Claim-Evidence-Reasoning (CER) response explaining which emulsifier performed best
- Product recommendation supported by scientific evidence
- Group presentation and discussion



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- averages, create graphs, and compare emulsifier performance.
13. Students examine molecular models and discuss how emulsifiers interact with polar and nonpolar substances to stabilize mixtures.
 14. Teams evaluate the effectiveness, practicality, availability, and potential cost of each emulsifier.
 15. Students develop a recommendation for a company seeking to manufacture a new salad dressing and justify their choice using experimental evidence.
 16. Groups present findings and defend their recommendations to peers.

Differentiation:

Students may access content through demonstrations, laboratory investigations, visual models, readings, videos, and collaborative discussions.

Students may demonstrate understanding through written explanations, diagrams, presentations, CER responses, multimedia products, or physical models.

Guided notes, structured data tables, graphic organizers, and scaffolded analysis questions may be provided as needed.

Extension opportunities include investigating industrial emulsifiers, analyzing ingredient labels from commercial products, or designing a new consumer product using emulsion chemistry.

Resources Provided:

- Laboratory procedures and data collection templates
- Molecular structure diagrams
- Emulsion chemistry reference materials
- Commercial product labels for comparison
- Relevant class notes and instructional resources



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly**, **Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging Strongly and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☐	☒	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☐	☒	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☐	☒	☐
Are differentiated based on student needs	☐	☒	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☐	☒	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science
Aqueous Solutions

Grade Level: 10

Unit Title: The Chemistry of Gases and

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Chemistry **Grade Level:** 10 **Unit Title:** Reactions and Equilibrium

Unit Summary: In this unit of study, students use cause and effect to develop models and explanations for the ways that feedback among different systems control types of reactions occurring. Students begin to examine the ways that reactions change according to pH, equilibrium, and oxygen. Students understand the interactions of hydrogen ions and hydroxide ions. Students model the flow of energy and matter between different chemical reactions.

Primary Interdisciplinary Connections: Engineering, mathematics

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ ICT Literacy
☐ Information Literacy ☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy

Unit Rationale: Here students will use data to explain acids, bases, and neutralization reactions. Students will analyze titrations and buffer systems. Oxidation and reduction reactions will also be studied and understood. Equilibrium and reaction rates will be modeled using mathematical analysis.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

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

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

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

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets

Standards: HS-PS1; HS-ESS3

Content Statements: Matter and Its Interactions; Earth and Human Activity

CPI#: **Cumulative Progress Indicator (CPI):**

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.
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HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
HS-PS1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
HS-ESS3-2	Evaluate competing design solutions for developing, conserving, managing, and utilizing energy and mineral resources based on the associated economic, social, environmental, and geopolitical costs and risks, as well as benefits.
Math.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.
Math.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 .
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.

Science and Engineering Practices:

Developing and Using Models

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

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

Constructing Explanations and Designing Solutions

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

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)
- Refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)

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 natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

Disciplinary Core Ideas (DCIs):

PS1.A: Structure and Properties of Matter

- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. (HS-PS1-4)

PS1.B: Chemical Reactions

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-4), (HS-PS1-5)
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)

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 (tradeoffs) may be needed. (secondary to HS-PS1-6)

ESS3.A: Natural Resources

- 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)

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-ESS3-2)

Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-5)

Energy and Matter



- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4)

Stability and Change

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

Connections to Engineering, Technology, and Applications of Science

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

- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2)
- Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS3-2)

Connections to Nature of Science

Science Addresses Questions About the Natural and Material World

- Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2)
- Science knowledge indicates what can happen in natural systems— not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)
- Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

Unit Essential Questions:

- How do various factors affect how quickly a reaction reaches completion?
- Why are some systems more stable than others?
- What are the characteristics of a chemical reaction system that never reaches completion?
- How can the rate of a chemical reaction be controlled?
- Why do some reactions occur naturally?
- What are the different ways chemists define acids and bases?
- What does the pH of a solution mean?
- How do chemists use acid-base reactions?
- What happens during oxidation and reduction?
- How can you balance redox equations?

Unit Enduring Understandings:

- In chemistry, the rate of a chemical reaction, or the reaction rate is usually expressed as the change in the amount of reactant or product per unit time.
- At chemical equilibrium, both the forward and reverse reaction continue, but because their rates are equal, no net change occurs in the concentration of the reaction compounds.



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- According to Arrhenius, acids are hydrogen containing compounds that ionize to yield hydrogen ions in aqueous solution. Bases are compounds that ionize to yield hydroxide ions in aqueous solutions.
- According to the Bronsted-Lowry theory, an acid is a hydrogen-ion donor and a base is a hydrogen-ion acceptor.
- According to Lewis, an acid accepts a pair of electrons and a base donates a pair of electrons.
- A solution with a pH less than 7 is acidic. A solution with a pH of 7 is neutral. A solution with a pH greater than 7 is basic.
- Acids and bases are classified as strong or weak based on the degree to which they ionize in water.
- In general, acids and bases react to produce a salt and water.
- A buffer is a solution of a weak acid and one of its salts or a weak base and one of its salts.
- A substance that undergoes oxidation gains oxygen or loses electrons, while a substance that undergoes reduction loses oxygen or gains electrons.
- An increase in the oxidation number of an atom or ion indicates oxidation. A decrease in the oxidation number of an atom or ion indicates reduction.

Unit Learning Targets:

Students will....

- Describe how to express the rate of a chemical reaction.
- Identify four factors that influence the rate of a chemical reaction.
- Define an acid and a base according to Arrhenius, Lewis, and Bronsted-Lowry.
- Classify a solution as neutral, acidic, or basic.
- Describe how acids and bases are classified as either strong or weak.
- Identify the products that form when an acid and a base react.
- Describe what happens when a substance that undergoes oxidation and a substance that undergoes reduction.
- Define oxidation and reduction in terms of a change in oxidation number.
- Identify the two classes of chemical reactions.



Evidence of Learning

Summative Assessment: Information covered in this unit will be tested on the midterm and final examinations and as individual chapter tests in addition to the formative assessments listed below.

Equipment Needed: iPad and Software, Basic Laboratory Equipment

Teacher Resources: Chemistry textbook and online resources by Pearson.

Formative Assessments:

- Quizzes
- Tests
- Labs
- Projects
- Homework
- Activities
- Practice Problems



Lesson Plans

Lesson	Time Frame
Lesson 1 Acid-Base Lab — Investigating the Chemistry of Everyday Substances	2 days
Lesson 2 Energy in Reactions — Investigating Energy Transfer and Chemical Equilibrium	3 days
Lesson 3 What is Electrochemistry? — Generating Electricity Through Chemical Reactions	2 days

Teacher Notes: This unit explores reaction rates, chemical equilibrium, acid-base chemistry, and oxidation-reduction reactions. Students investigate how chemical systems change over time and how chemists can control reactions to improve efficiency, product yield, and real-world applications.

Instruction should emphasize hands-on laboratory experiences, data analysis, evidence-based reasoning, and connections between observable chemical changes and particle-level models. Students should regularly construct explanations using experimental data and apply concepts to contexts such as industrial processes, environmental systems, batteries, corrosion, and energy technologies.

Common misconceptions to address include the belief that equilibrium means equal amounts of reactants and products, that reactions stop at equilibrium, that strong acids are always concentrated, and that oxidation always involves oxygen. Students should leave the unit with an understanding of how chemical systems respond to changing conditions and how chemistry is used to solve real-world problems.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

- American Association for the Advancement of Science: <http://www.aaas.org/programs>
- American Chemical Society: <http://www.acs.org/content/acs/en/education.html>
- Concord Consortium: Virtual Simulations: <http://concord.org/>
- International Technology and Engineering Educators Association: <http://www.iteaconnect.org/>
- National Earth Science Teachers Association: <http://www.nestanet.org/php/index.php>
- National Science Digital Library: <https://nsdl.oercommons.org/>
- National Science Teachers Association: <http://ngss.nsta.org/Classroom-Resources.aspx>
- North American Association for Environmental Education: <http://www.naaee.net/>
- Phet: Interactive Simulations <https://phet.colorado.edu/>
- Science NetLinks: <http://www.aaas.org/program/science-netlinks>



Lesson Plan 1 Template

Content Area: Chemistry
Everyday Substances

Lesson Title: Acid-Base Lab — Investigating the Chemistry of
Time Frame: 2 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:
Mathematics

Integration of Technology:

Student iPads for data collection, analysis, research, and collaboration
Vernier Go Direct pH sensors for collecting quantitative pH measurements
Google Sheets for organizing data, graphing results, and identifying patterns
Digital presentation tools for communicating findings and supporting scientific claims

Equipment Needed:

- Student iPads
- Vernier Go Direct pH sensors
- pH paper
- Red cabbage indicator juice
- Pipettes
- Well plates
- Lemon juice
- Aspirin dissolved in water
- Milk
- Coke
- Borax water solution
- White vinegar
- Tums
- Baking soda
- 409 cleaner
- Water
- Clorox with bleach
- Saliva
- 0.1 M HCl
- 0.01 M NaOH
- Safety goggles
- Gloves
- Data collection sheets



Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Predict and compare the pH values of common household substances. • Investigate acid-base properties using indicators and pH sensors. • Model reactions between acids and bases at the particle level. • Analyze patterns in pH data and classify substances as acidic, basic, or neutral. • Construct explanations for observed color changes and reactions. • Apply acid-base concepts to real-world products and systems. • Communicate evidence-based conclusions using data and scientific reasoning.	Lesson Sequence Anchoring Phenomenon 1. Students examine several everyday products including lemon juice, Coke, baking soda, bleach, and antacids. 2. The teacher asks: "How can substances that look similar behave so differently when used for cleaning, digestion, cooking, or health care?" 3. Students generate initial explanations and make predictions about the acidity or basicity of each substance. 4. Students use a prediction table to estimate whether each of the 12 household substances is acidic, basic, or neutral and rank them by expected pH. 5. Groups discuss their reasoning and identify evidence from prior experiences that supports their predictions. 6. Students test each substance using pH	• Prediction table • Observation charts • pH data tables • Graphs created in Google Sheets • Analysis questions • Particle-level acid-base models • Claim-Evidence-Reasoning (CER) explanation of an acid-base reaction • Lab report summarizing procedures, data, analysis, and conclusions



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- paper and red cabbage indicator.
7. The collector in each group uses pipettes to transfer solutions to the well plates.
 8. The recorder documents color changes and qualitative observations.
 9. Students repeat testing using Vernier Go Direct pH sensors to obtain quantitative pH measurements.
 10. Groups compare indicator observations with sensor data and discuss similarities and differences.
 11. Students organize data in Google Sheets and create graphs comparing the pH values of the tested substances.
 12. Teams identify trends among foods, medicines, cleaning products, and biological samples.
 13. Students investigate acid-base reactions by combining selected acidic and basic substances in small, controlled amounts.
 14. Groups observe evidence of chemical change, including bubbling, temperature changes, and indicator color changes.
 15. Students develop particle-level models



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- explaining how acids and bases interact and how neutralization occurs.
16. Teams evaluate real-world applications of acid-base chemistry, including antacids, water treatment, agriculture, environmental monitoring, food production, and consumer products.
17. Students write a conclusion explaining how their predictions compared to the collected data and how acid-base chemistry impacts everyday life.

Differentiation:

Students may access content through demonstrations, laboratory investigations, visual models, readings, videos, and collaborative discussions.

Students may demonstrate understanding through written explanations, diagrams, presentations, models, videos, or multimedia products.

Guided notes, structured data tables, graphic organizers, and scaffolded analysis questions may be provided as needed.

Extension opportunities include investigating environmental samples, comparing indicator effectiveness, designing an antacid investigation, or researching industrial acid-base applications.

Resources Provided:

- Activity sheet
- Vernier Go Direct pH sensor guides
- Acid-base reference materials
- Data collection templates
- Relevant class notes and instructional resources
- www.ngsslifescience.com



Lesson Plan 2 Template

Content Area: Chemistry
and Chemical Equilibrium

Lesson Title: Energy in Reactions — Investigating Energy Transfer
Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Student iPads for data collection, research, collaboration, and analysis
Vernier Go Direct temperature probes for collecting real-time temperature data
Google Sheets for organizing data, graphing temperature changes, and analyzing trends
Digital simulations and molecular models to visualize energy transfer and equilibrium shifts
Digital presentation tools for communicating findings and supporting scientific claims

Equipment Needed:

- Student iPads
- Vernier Go Direct temperature probes
- Water
- Ammonium chloride
- Steel wool
- Vinegar
- Beakers
- Styrofoam coffee cups (calorimeters)
- Thermometers
- Electronic balances
- Graduated cylinders
- Calculators
- Rosen Digital's Core Concepts: Chemistry resources
- Safety goggles
- Gloves
- Data collection sheets

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Investigate energy changes that occur during chemical and physical processes.	Lesson Sequence Anchoring Phenomenon 1. Students observe two instant cold packs and	• Pre-lab prediction questions • Temperature data tables



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|---|--|--|
| <ul style="list-style-type: none">• Distinguish between endothermic and exothermic reactions using experimental evidence.• Analyze temperature data to determine whether energy is absorbed or released.• Explain the relationship between energy transfer and chemical stability.• Develop models to describe dynamic equilibrium.• Predict how changes in temperature and concentration affect equilibrium systems.• Apply Le Châtelier's Principle to real-world chemical processes.• Communicate evidence-based explanations using data and scientific reasoning. | <ol style="list-style-type: none">hand warmers being activated.The teacher asks: "Why do some chemical reactions get colder while others get hotter, and how do industries use these energy changes to maximize production?"Students generate initial explanations and discuss situations where controlling reaction conditions is important.Students activate cold packs and hand warmers and record observations about temperature changes.Groups develop initial hypotheses regarding energy transfer in chemical reactions.Students conduct a calorimetry investigation using ammonium chloride dissolved in water and steel wool reacting with vinegar.Students measure initial and final temperatures using Vernier probes and thermometers.Teams collect quantitative data and identify whether each process is endothermic or exothermic.Students organize data in Google Sheets and create graphs showing temperature changes over time.Groups compare results and discuss sources of experimental error.Students construct | <ul style="list-style-type: none">• Graphs generated in Google Sheets• Calorimetry calculations• Analysis questions• Particle-level energy models• Equilibrium scenario predictions• Claim-Evidence-Reasoning (CER) explanation of an equilibrium shift• Post-lab reflection• Lab report• Quiz |
|---|--|--|



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- particle-level models explaining how bond breaking and bond formation relate to energy absorption and release.
12. Students review the concept of chemical equilibrium using molecular simulations and visual models.
 13. The teacher introduces dynamic equilibrium and addresses the misconception that equal amounts of reactants and products are required.
 14. Students examine the Haber Process as a case study in industrial chemistry.
 15. Teams analyze how temperature, concentration, and pressure influence ammonia production.
 16. Students consider economic, environmental, and engineering tradeoffs involved in maximizing product yield.
 17. Student groups are assigned different equilibrium scenarios and use Le Châtelier's Principle to predict how systems will respond to changes.
 18. Groups justify predictions using evidence and particle-level reasoning.
 19. Students develop recommendations for how a chemical manufacturer could optimize a reaction while



considering cost, efficiency, energy use, and environmental impact.

20. Students conclude by explaining how energy transfer and equilibrium help chemists design and control chemical processes.

Differentiation:

Students may access content through demonstrations, laboratory investigations, simulations, visual models, readings, and collaborative discussions.

Students may demonstrate understanding through written explanations, diagrams, presentations, models, videos, or multimedia products.

Guided notes, scaffolded calculations, structured data tables, and graphic organizers may be provided as needed.

Extension opportunities include researching industrial equilibrium processes, investigating environmental applications, or designing an optimized chemical production system.

Resources Provided:

Activity sheet for laboratory investigation

Rosen Digital's Core Concepts: Chemistry resources

Equilibrium simulations and molecular models

Data collection templates

Relevant class notes and instructional resources



Lesson Plan 3 Template

Content Area: Chemistry
Through Chemical Reactions

Lesson Title: What is Electrochemistry? — Generating Electricity
Time Frame: 2 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:
Mathematics

Integration of Technology:

Student iPads for data collection, research, collaboration, and analysis
Vernier Go Direct sensors and multimeters for measuring voltage and current
Google Sheets for organizing data, graphing results, and identifying trends
Digital simulations and molecular models to visualize oxidation-reduction reactions and electron transfer
Digital presentation tools for communicating findings and engineering recommendations

Equipment Needed:

- Student iPads
- Well plate with at least 6 wells
- Zinc strips
- Copper strips
- Magnesium strips
- Tin strips
- 0.1 M zinc sulfate solution
- 0.1 M copper sulfate solution
- 0.1 M magnesium sulfate solution
- 0.1 M tin chloride solution
- Filter paper strips
- Saturated sodium chloride solution
- Tweezers
- Alligator clips
- Multimeter
- Vernier Go Direct voltage sensor (if available)
- Safety goggles
- Data collection sheets



Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Investigate how chemical reactions can be used to generate electrical energy. - Analyze oxidation-reduction reactions occurring within electrochemical cells. - Construct and test galvanic cells using different metal combinations. - Develop an activity series based on experimental evidence. - Balance oxidation and reduction half-reactions. - Relate electrochemistry to batteries, renewable energy systems, and emerging technologies. - Communicate evidence-based conclusions using data and scientific reasoning.	Lesson Sequence Anchoring Phenomenon - Students examine a collection of everyday devices powered by batteries, including smartphones, electric vehicles, wireless headphones, and solar energy storage systems. - The teacher asks: "How can a chemical reaction produce electricity powerful enough to run modern technology?" - Students generate initial explanations and predictions about how energy stored in chemicals can be converted into electrical energy. - Students investigate examples of electrochemical technologies, including rechargeable batteries, electric vehicles, corrosion prevention systems, and solar energy storage. - Groups discuss why efficient energy storage is increasingly important for transportation, communication, and renewable energy infrastructure. - Students are introduced to galvanic cells and review the concepts of oxidation, reduction, electron transfer, and energy conversion.	- Pre-lab prediction questions - Voltage data tables - Experimental activity series - Graphs generated in Google Sheets - Particle-level electrochemical cell models - Balanced oxidation and reduction half-reactions - Analysis questions - Claim-Evidence-Reasoning (CER) explanation of the highest-performing galvanic cell - Battery design recommendation - Lab report



7. Student teams construct electrochemical cells using different combinations of zinc, copper, magnesium, and tin electrodes.
8. Students assemble salt bridges using filter paper soaked in sodium chloride solution.
9. Groups connect electrodes to multimeters and measure voltage produced by each metal pair.
10. Students systematically test all possible metal combinations and record voltage data.
11. Teams identify patterns and determine which combinations generate the greatest electrical potential.
12. Students organize results in Google Sheets and create tables and graphs comparing cell performance.
13. Groups use experimental evidence to construct an activity series ranking the metals from most reactive to least reactive.
14. Students develop particle-level models showing electron flow, oxidation at the anode, reduction at the cathode, and ion movement through the salt bridge.
15. Students balance oxidation and reduction half-reactions associated with their highest-performing galvanic cell.



16. Student teams are challenged to recommend the most effective metal combination for a battery manufacturer seeking to maximize energy output while considering material availability, cost, environmental impact, and safety.
17. Groups present recommendations supported by experimental evidence and scientific reasoning.
18. Students conclude by explaining how electrochemistry connects chemical reactions, electricity generation, corrosion, battery design, and renewable energy technologies.

Differentiation:

Students may access content through demonstrations, laboratory investigations, simulations, visual models, readings, and collaborative discussions.

Students may demonstrate understanding through written explanations, diagrams, presentations, models, videos, or multimedia products.

Guided notes, scaffolded reaction balancing, structured data tables, and graphic organizers may be provided as needed.

Extension opportunities include investigating commercial battery technologies, fuel cells, corrosion prevention systems, or renewable energy storage solutions.

Resources Provided:

- Activity sheet
- Electrochemistry reference materials
- Oxidation-reduction reaction guides
- Data collection templates
- Relevant class notes and instructional resources



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging Strongly and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☐	☒	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☒	☐	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☐	☒	☐
Are varied to address different student learning styles and preferences	☒	☐	☐
Are differentiated based on student needs	☒	☐	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☒	☐	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science

Grade Level: 10

Unit Title: Reactions and Equilibrium

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Science **Grade Level:** 10 **Unit Title:** Chemistry of Earth and Climate Systems

Unit Summary: This unit explores how chemical processes drive interactions among Earth's atmosphere, hydrosphere, geosphere, and biosphere. Students investigate energy transfer, thermodynamics, chemical reactions, equilibrium, and carbon cycling to explain climate patterns, feedback systems, and the effects of human activity on Earth systems. Through data analysis, modeling, and engineering design, students evaluate evidence-based solutions to environmental and energy-related challenges facing society.

Primary Interdisciplinary Connections: Engineering, Environmental Science

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ ICT Literacy
☒ Information Literacy ☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy

Unit Rationale: Understanding how chemical principles govern Earth systems enables students to apply scientific and engineering practices to real-world environmental and climate challenges that affect both natural systems and human society.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

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

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

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

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets

Standards: HS-PS1, HS-PS3, HS-ESS2, HS-ESS3, HS-ETS1

Content Statements: Matter and Its Interactions, Energy, Earth's Systems, Earth and Human Activity, Engineering Design

CPI#: **Cumulative Progress Indicator (CPI):**

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.
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HS-PS1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
HS-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 temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
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.
HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.
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.
HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change).
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.
Math.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 .
8.2.12.ED.6	Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
8.2.12.EC.2	Assess the positive and negative impacts of emerging technologies on developing



countries and evaluate how individuals, non-profit organizations, and governments have responded.

Science and Engineering Practices:

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-ESS2-6)
- Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4)

Planning and Carrying Out Investigations

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

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-4)

Using Mathematics and Computational Thinking

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

- Use mathematical representations of phenomena to support claims. (HS-PS1-7)
- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-PS3-1)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

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

Constructing Explanations and Designing Solutions



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

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6)
- Construct 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-ESS3-1)
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ESS3-4), (HS-ETS1-2)

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)

Asking Questions and Defining Problems

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Disciplinary Core Ideas (DCIs):

PS1.B: Chemical Reactions

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (HS-PS1-5)
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. (HS-PS1-6)
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-7)

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. (HS-PS3-1)

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. (HS-PS3-1)
- 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. (HS-PS3-1)
- The availability of energy limits what can occur in any system. (HS-PS3-1)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4)
- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). (HS-PS3-4)

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. (HS-PS3-4)

ESS1.B: Earth and the Solar System

- Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4)

ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

ESS2.D: Weather and Climate

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's reradiation into space. (HS-ESS2-2), (HS-ESS2-4)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6), (HS-ESS2-4)



- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6), (HS-ESS2-7)

ESS2.E: Biogeology

- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)

ESS3.A: Natural Resources

- Resource availability has guided the development of human society. (HS-ESS3-1)

ESS3.B: Natural Hazards

- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)

ESS3.C: Human Impacts on Earth Systems

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

ESS3.D: Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

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. (HS-ETS1-1)
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

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 HS-ESS3-4)

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 (tradeoffs) may be needed. (HS-ETS1-2), (secondary to HS-PS1-6)



Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-5)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4), (HS-ESS3-6)
- 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)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4), (HS-ESS3-1)

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (HS-PS1-7), (HS-ESS2-6)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6), (HS-ESS2-7)
- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS2-2), (HS-ESS3-4)
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-5)

Scientific Investigations Use a Variety of Methods

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

Scientific Knowledge is Based on Empirical Evidence

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

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems



- Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7), (HS-PS3-1)

Connections to Engineering, Technology, and Applications of Science

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

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS2-2), (HS-ETS1-1)
- Modern civilization depends on major technological systems. (HS-ESS3-1)
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-4)

Unit Essential Questions:

- How do chemical and energy changes within Earth systems influence climate and environmental stability?
- How do matter and energy move through Earth's atmosphere, hydrosphere, geosphere, and biosphere?
- How can chemical principles help explain climate change and human impacts on Earth systems?
- How do feedback mechanisms stabilize or destabilize Earth systems?
- How can scientific data, models, and engineering design be used to address global environmental challenges?
- How do human activities alter natural systems and the cycling of matter and energy on Earth?
- How do scientists use evidence and models to predict changes in Earth systems over time?

Unit Enduring Understandings (Crosscutting Concepts):

- Patterns in chemical reactions, climate data, and Earth systems can provide evidence for cause-and-effect relationships.
- Earth systems are interconnected, and changes in one system can affect other systems through feedback loops and energy transfer.
- Models are useful tools for explaining and predicting the behavior of complex systems, although all models have limitations.
- Cause-and-effect relationships in natural systems are supported through empirical evidence and scientific investigation.
- Matter and energy are conserved as they cycle through chemical reactions and Earth systems.
- Stability and change in Earth systems are influenced by energy flow, chemical processes, and positive and negative feedback mechanisms.
- Rates of change in Earth systems can be measured, modeled, and used to predict future environmental conditions.
- Scientific knowledge is based on empirical evidence gathered through a variety of investigative methods and technologies.
- Scientific explanations are strengthened when supported by multiple sources of evidence.



- Natural systems follow consistent laws and patterns that can be studied and modeled scientifically.
- Technological advances can positively and negatively impact society and the environment.
- Engineering design applies scientific knowledge to improve technologies while balancing societal needs, environmental impacts, costs, and risks.

Unit Learning Targets:

Students will be able to:

- Analyze how thermal energy transfers within and between Earth systems.
- Model how energy entering and leaving Earth's systems affects climate patterns and environmental conditions.
- Explain how chemical reactions and equilibrium processes influence Earth systems and climate.
- Use mathematical and computational models to describe conservation of matter and energy in chemical and Earth systems.
- Analyze carbon cycling among the atmosphere, hydrosphere, geosphere, and biosphere.
- Interpret geoscience and climate data to identify patterns, trends, and feedback mechanisms in Earth systems.
- Construct evidence-based explanations for how human activities impact climate and natural systems.
- Evaluate evidence regarding climate change, natural resources, and environmental hazards.
- Design and refine engineering solutions that reduce human impacts on Earth systems.
- Analyze the benefits, risks, and limitations of technologies used to address environmental and energy-related challenges.
- Conduct scientific investigations related to energy transfer, chemical reactions, and environmental systems.
- Develop and use models to explain interactions among Earth systems at both macroscopic and molecular scales.
- Construct scientific arguments using empirical evidence from investigations, models, and data analysis.
- Apply chemistry concepts such as thermodynamics, reaction rates, equilibrium, and conservation laws to real-world Earth and environmental phenomena.



Evidence of Learning

Summative Assessment: Information covered in this unit will be tested on the midterm and final examination and as individual chapter tests in addition to the formative assessments listed below.

Equipment Needed: iPad and Software, Basic Laboratory Equipment

Teacher Resources: Chemistry textbook and online resources by Pearson.

Formative Assessments:

Quizzes will be given to assess student learning after every 3-4 lessons.

In class assignments will be completed to practice a lesson.

Homework will be given 2-3 times per week.

Projects will be given ample time to complete and may be individual or group assignments.

Lab Reports

Do Now Questions

Exit Slips

Group Assignments



Lesson Plans

Lesson	Time Frame
Lesson 1: Energy Transfer and the Greenhouse Effect	2 days
Lesson 2: Chemical Equilibrium and Ocean Acidification	2 days
Lesson 3: Engineering Solutions for Climate and Energy Challenges	2 days

Teacher Notes:

This unit is intended to integrate Earth and Space Science concepts into a traditional Chemistry course through the lens of thermodynamics, chemical reactions, equilibrium, and energy transfer. Teachers should emphasize how core chemistry principles explain large-scale Earth systems and climate phenomena. Opportunities for modeling, data analysis, engineering design, and evidence-based argumentation should be embedded throughout the unit. Whenever possible, students should engage with authentic climate, atmospheric, or geoscience datasets and connect molecular-level chemistry concepts to observable environmental systems.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

<https://phet.colorado.edu/>

<https://www.noaa.gov/climate>

<https://science.nasa.gov/earth/earth-observatory/>



Lesson Plan 1 Template

Content Area: Science Lesson Title: Energy Transfer and the Greenhouse Effect Time Frame: 2 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
- ☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
- ☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Engineering, Environmental Science

Integration of Technology:

Google Sheets, Vernier GoDirect

Equipment Needed:

Infrared heat lamps or strong incandescent lamps
Two identical clear containers or bottles with lids
Thermometers or digital temperature probes
Baking soda and vinegar (to generate carbon dioxide)
Timer or stopwatch
Plastic wrap or rubber stoppers
Data collection sheets
Graph paper or digital graphing software
Markers/chart paper or whiteboards
Safety goggles
Infrared thermometer or thermal imaging camera
PhET simulations or climate modeling simulations

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Explain how radiation, conduction, and convection transfer energy through Earth systems. - Model how greenhouse gases influence the movement of thermal energy in the atmosphere.	Lesson Sequence - Present students with the anchoring phenomenon: - Despite receiving nearly the same amount of incoming solar energy, Earth's average global temperature has increased significantly over the past century.	- Student-generated questions about the anchoring phenomenon - Lab data tables and temperature graphs - Observation notes during demonstrations and investigations - Group discussions and systems diagrams



- Analyze temperature and climate data to identify patterns and relationships.
- Construct evidence-based explanations for the greenhouse effect and climate change.
- Develop and use models to describe how changes in energy flow affect Earth's climate systems.
- Collaborate to design, conduct, and analyze investigations involving energy transfer.

3. Students analyze a collection of media sources including:
 - o Global temperature anomaly graphs
 - o Satellite images of Arctic ice loss
 - o News headlines related to climate events
 - o Maps showing heat waves, droughts, flooding, or wildfire trends in different regions
4. Students discuss how scientific information is communicated to the public and evaluate which claims are supported by evidence.
 - o Facilitate a class brainstorming session where students generate investigable questions such as:
 - o Why is Earth warming?
 - o How does energy move through Earth systems?
 - o How do greenhouse gases affect climate?
 - o Why are climate impacts different across regions and communities?
 - o What role do human activities play?
5. Introduce energy transfer through interactive demonstrations involving:

- Exit ticket explaining how greenhouse gases affect energy transfer
- CER (Claim-Evidence-Reasoning) written response connecting experimental results to climate change
- Teacher questioning during investigations and data analysis
- Peer feedback during collaborative model construction



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- o Radiation using heat lamps
 - o Conduction using heated materials
 - o Convection using water or air circulation models
- 6. Students rotate through stations, collect observations, and collaboratively explain how each process operates in Earth systems.
- 7. Student groups design and conduct a greenhouse effect investigation:
 - o One container contains normal air.
 - o One container contains elevated carbon dioxide generated using baking soda and vinegar.
 - o Both systems are exposed to identical light sources.
 - o Students determine how to collect reliable temperature data and identify variables that must be controlled.
- 8. Students use digital probes or thermometers to collect temperature data over time and create graphs using spreadsheet software or graphing tools.
- 9. Student groups analyze experimental data and



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- compare findings with authentic climate datasets from scientific organizations. Students identify similarities, limitations, and possible sources of uncertainty in their classroom model.
10. Students use a climate simulation or interactive model to investigate how changes in greenhouse gas concentrations influence:
 - o Atmospheric temperature
 - o Sea ice extent
 - o Sea level
 - o Weather patterns
 - o Human populations and infrastructure
 11. Facilitate a collaborative systems-mapping activity where students model interactions among:
 - o Atmosphere
 - o Hydrosphere
 - o Biosphere
 - o Geosphere
 - o Human activity
 - o Energy flow
 12. Students identify feedback loops and predict how changes in one system affect others.
 13. Student teams evaluate possible strategies for reducing greenhouse gas emissions, such as:
 - o Renewable energy technologies
 - o Public transportation systems
 - o Energy-efficient buildings



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ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

- o Carbon capture technologies
- 14. Groups discuss scientific, economic, environmental, and societal trade-offs associated with each solution.
- 15. Students develop a public-facing product communicating scientific findings to a broader audience. Examples may include:
 - o Infographics
 - o Public service announcements
 - o Brief presentations
 - o Scientific posters
 - o Short videos
- 16. Students must support claims using evidence from laboratory investigations, simulations, and climate data.
- 17. Conclude the lesson with students constructing a scientific explanation addressing the anchoring phenomenon using:
 - o Experimental evidence
 - o Climate datasets
 - o Systems models
 - o Scientific reasoning
 - o Evaluation of possible societal responses to climate change

Differentiation:

- Provide guided lab procedures or partially completed data tables for students needing additional support.
- Offer extension opportunities involving quantitative climate data analysis or independent research on feedback loops.



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- Use visuals, diagrams, and simulations to support multilingual learners and visual learners.
- Allow students to demonstrate understanding through multiple formats such as written explanations, diagrams, presentations, or recorded responses.
- Group students strategically to support collaboration and peer modeling.
- Provide vocabulary supports and sentence starters for scientific argumentation.
- Offer scaffolded graphing tools or digital graphing options for students needing mathematical support.

Resources Provided:

- Greenhouse effect laboratory procedure
- Data collection and graphing sheets
- CER writing template
- Climate data sets and graphs
- Teacher presentation slides
- Systems diagram template
- Guided notes on energy transfer mechanisms
- Simulation exploration guide
- Vocabulary reference sheet
- Exit ticket prompts
- Safety guidelines for laboratory activities



Lesson Plan 2 Template

Content Area: Science

Lesson Title: Chemical Equilibrium and Ocean Acidification

Time Frame: 2 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Engineering, Environmental Science

Integration of Technology:

Google Sheets, Vernier GoDirect

Equipment Needed:

Clear cups or beakers
 Distilled water
 Straws or pipettes
 pH paper or digital pH probes
 Red cabbage indicator solution or universal indicator
 Carbonated water/seltzer
 Baking soda
 Vinegar
 Calcium carbonate samples (chalk, shells, limestone, or antacid tablets)
 Balances
 Hot plates or warm water baths
 Thermometers
 Graph paper or digital graphing software
 Safety goggles and aprons
 Equilibrium simulation software or PhET simulations

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: Explain how carbon dioxide interacts with water to form carbonic acid.	Lesson Sequence - Present students with the anchoring phenomenon: - Scientists have observed that ocean water is becoming more acidic,	- Student-generated questions related to the anchoring phenomenon - Lab observations and pH measurements



- Describe how equilibrium systems respond to changes in concentration and temperature.
- Model how ocean acidification affects marine systems and carbonate materials.
- Analyze how chemical equilibrium principles apply to Earth systems and climate processes.
- Use evidence from investigations and data analysis to explain the effects of increased atmospheric carbon dioxide on ocean chemistry.
- Develop models connecting chemical reactions, carbon cycling, and environmental impacts.

- while coral reefs and shell-forming organisms around the world are experiencing increasing damage and population decline.
3. Students analyze a collection of media and scientific resources including:
 - o Images of healthy and damaged coral reefs
 - o Graphs showing rising atmospheric carbon dioxide levels
 - o Ocean pH trend data
 - o News reports discussing impacts on fisheries, tourism, and marine ecosystems
 4. Students evaluate how scientific information is presented to the public and identify claims supported by evidence.
 5. Facilitate a class discussion in which students generate questions such as:
 - o How can atmospheric gases change ocean chemistry?
 - o Why does ocean pH matter to marine organisms?
 - o How are human activities connected to ocean systems?
 - o What chemical reactions are

- Balanced chemical equations and reaction models
- Graphs showing pH or mass-change trends
- Group equilibrium models and systems diagrams
- CER (Claim-Evidence-Reasoning) written explanations
- Teacher questioning during investigations and discussions
- Exit ticket explaining how increasing atmospheric carbon dioxide affects ocean chemistry
- Peer review of models and scientific explanations



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- | | | |
|--|--|--|
| | <p>occurring in seawater?</p> <ul style="list-style-type: none">o What solutions might reduce or slow ocean acidification? <p>6. Introduce equilibrium concepts using interactive particle-level models and demonstrations of reversible reactions. Students collaboratively predict how equilibrium systems respond to changes in:</p> <ul style="list-style-type: none">o Concentrationo Temperatureo Pressure <p>7. Students conduct a hands-on investigation modeling ocean acidification:</p> <ul style="list-style-type: none">o Students blow exhaled air through straws into water containing pH indicator solution.o Students observe and record pH changes as carbon dioxide dissolves in water.o Student groups write balanced chemical equations representing the formation of carbonic acid and related equilibrium reactions. <p>8. Student groups investigate the effects of acidic conditions on</p> | |
|--|--|--|



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calcium carbonate materials:

- o Chalk, shells, limestone, or antacid tablets are exposed to solutions with varying pH levels.
 - o Students collect both qualitative observations and quantitative mass data.
 - o Groups compare rates of reaction and identify patterns in the data.
9. Students use digital probes, spreadsheets, or graphing software to organize and analyze experimental results. Students compare classroom data with authentic ocean chemistry datasets from scientific organizations.
10. Facilitate a simulation or modeling activity in which students manipulate variables affecting equilibrium systems and observe impacts on:
- o Ocean pH
 - o Carbonate ion concentration
 - o Shell formation
 - o Marine ecosystem stability
11. Students work collaboratively to construct systems diagrams showing interactions among:
- o Atmospheric carbon dioxide



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- o Ocean chemistry
- o Marine organisms
- o Human industrial activity
- o Carbon cycling processes
- 12. Students identify feedback loops and predict long-term environmental impacts.
- 13. Student teams investigate real-world case studies involving communities affected by ocean acidification, such as:
 - o Fisheries
 - o Coral reef tourism economies
 - o Coastal ecosystems
 - o Food supply systems
- 14. Students discuss environmental, economic, and societal implications.
- 15. Groups evaluate and propose possible engineering or technological solutions to reduce ocean acidification impacts, such as:
 - o Carbon emission reduction strategies
 - o Carbon capture technologies
 - o Marine protected areas
 - o Alternative materials or aquaculture methods
- 16. Students consider benefits, limitations, cost, feasibility, and



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- unintended consequences.
17. Students create a public communication product intended for a community audience, such as:
- o Infographics
 - o Scientific posters
 - o Short presentations
 - o Awareness campaigns
 - o Brief informational videos
18. Students must use evidence from investigations, models, and scientific data to support their conclusions.
19. Conclude the lesson with students constructing an evidence-based scientific explanation addressing the anchoring phenomenon using:
- o Laboratory investigations
 - o Equilibrium models
 - o Chemical equations
 - o Ocean chemistry data
 - o Evaluation of possible societal and technological responses

Differentiation:

- Provide scaffolded chemical equations or partially completed reaction models for students needing additional support.
- Use color-coded visuals and molecular diagrams to support conceptual understanding.



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- Offer structured data tables and graphing templates.
- Allow students to demonstrate understanding through diagrams, presentations, written explanations, or digital products.
- Provide extension activities involving quantitative pH calculations or independent research on coral reef ecosystems.
- Strategically group students to support peer collaboration and discussion.
- Provide vocabulary supports and sentence starters for scientific explanations and argumentation.
- Use simulations and hands-on modeling to support multiple learning styles.

Resources Provided:

- Ocean acidification laboratory procedure
- pH data collection sheets
- Chemical equation practice materials
- CER writing template
- Ocean chemistry data sets and graphs
- Teacher presentation slides
- Equilibrium systems graphic organizer
- Carbon cycle diagram template
- Guided notes on equilibrium and Le Châtelier's Principle
- Simulation exploration guide
- Vocabulary reference sheet
- Exit ticket prompts
- Laboratory safety guidelines



Lesson Plan 3 Template

Content Area: Science

Lesson Title: Effects of temperature on equilibrium

Time Frame: 2 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Engineering, Environmental Science

Integration of Technology:

Google Sheets, Vernier GoDirect

Equipment Needed:

Engineering design notebooks or journals
 Chart paper, markers, sticky notes
 Cardboard, tape, scissors, glue, and other prototyping materials
 Small solar panels or solar-powered kits
 Insulating materials (foam, cotton, foil, fabric, etc.)
 Plastic bottles, cups, and recycled materials
 Thermometers or temperature probes
 Heat lamps
 Balances and measuring tools
 Calculators
 Presentation materials or digital presentation software
 Safety goggles
 Energy simulation software or carbon footprint calculators

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Analyze how scientific and engineering solutions can reduce human impacts on Earth systems. - Evaluate advantages, limitations, costs, and trade-offs of various climate and energy technologies.	Lesson Sequence - Present students with the anchoring phenomenon: - Communities around the world are facing increasing environmental and energy-related challenges connected to climate change, resource	- Student-generated questions related to the anchoring phenomenon - Engineering design notebook entries - Prototype sketches and systems diagrams - Research summaries and source evaluations



- Apply chemistry concepts related to energy transfer, thermodynamics, and chemical reactions to real-world environmental challenges.
- Design, test, and refine a prototype or engineering solution addressing a climate-related problem.
- Use evidence and data to support engineering decisions and proposed solutions.
- Collaborate effectively to solve complex environmental and technological challenges.

- use, and rising energy demands.
3. Students analyze a collection of real-world case studies and media sources related to:
 - o Extreme weather events
 - o Rising energy consumption
 - o Air pollution
 - o Renewable energy development
 - o Coastal flooding
 - o Drought and water shortages
 - o Community responses to climate challenges
 4. Students evaluate how scientific information, technology, economics, and public policy interact in addressing these issues.
 5. Facilitate a collaborative discussion where students generate questions such as:
 - o How can science and engineering reduce environmental impacts?
 - o What makes an energy source sustainable?
 - o What trade-offs exist between different technologies?
 - o How should communities balance environmental, economic, and societal needs?

- Data tables and prototype testing results
- Peer feedback during brainstorming and revision stages
- Teacher observation during collaborative work sessions
- Group presentations and design justifications
- CER (Claim-Evidence-Reasoning) responses explaining design decisions
- Exit ticket evaluating trade-offs among proposed solutions



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- o What role should governments, businesses, scientists, and citizens play?
- 6. Introduce students to the engineering design process and criteria/constraints framework:
 - o Define the problem
 - o Research existing solutions
 - o Develop criteria and constraints
 - o Design and test prototypes
 - o Evaluate and improve solutions
- 7. Student teams select or are assigned a climate- or energy-related engineering challenge such as:
 - o Designing an energy-efficient structure
 - o Reducing heat absorption in urban environments
 - o Improving insulation systems
 - o Developing a small-scale carbon capture model
 - o Creating a renewable energy proposal
 - o Designing a water conservation or filtration system
- 8. Students conduct background research using scientific articles,



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- datasets, videos, and engineering resources. Teams evaluate the reliability of sources and collect evidence to support design decisions.
9. Teams brainstorm multiple possible solutions and create initial sketches, diagrams, and systems models. Students identify:
- o Required materials
 - o Expected energy transfers
 - o Chemical or physical processes involved
 - o Environmental impacts
 - o Cost considerations
 - o Practical limitations
10. Students build and test prototypes or models using available materials. During testing, students collect quantitative and qualitative data such as:
- o Temperature changes
 - o Energy efficiency
 - o Material performance
 - o Heat retention
 - o Structural effectiveness
11. Student teams analyze results and identify strengths, weaknesses, and unintended consequences of their



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- designs. Students revise and improve prototypes based on evidence gathered during testing.
12. Facilitate a gallery walk or design showcase where teams present their solutions to classmates acting as community stakeholders, scientists, engineers, or policymakers. Students ask questions, critique evidence, and evaluate competing solutions.
13. Student groups compare technologies and discuss broader societal implications including:
- o Environmental sustainability
 - o Public health impacts
 - o Economic accessibility
 - o Resource availability
 - o Ethical considerations
 - o Community needs
14. Students create a final public-facing product communicating their proposed solution and supporting evidence. Examples may include:
- o Engineering proposal presentations
 - o Digital infographics
 - o Scientific posters
 - o Video pitches
 - o Prototype demonstrations



- o Community awareness campaigns
- 15. Conclude the lesson with students reflecting on how chemistry, Earth systems science, and engineering can work together to address global environmental and energy challenges.

Differentiation:

- Provide structured design templates or guided engineering notebooks for students needing additional support.
- Allow students to choose from multiple engineering challenges based on interest and readiness level.
- Offer extension opportunities involving advanced calculations, independent research, or digital modeling tools.
- Use visuals, diagrams, videos, and hands-on modeling to support diverse learners.
- Provide vocabulary supports and sentence starters for scientific and engineering discussions.
- Strategically group students to encourage collaboration and peer support.
- Allow multiple methods for demonstrating understanding, including presentations, models, written explanations, or multimedia products.
- Provide scaffolded research resources with varying reading levels.

Resources Provided:

- Engineering design process guide
- Design notebook templates
- Prototype planning sheets
- CER writing template
- Climate and energy data sets
- Teacher presentation slides
- Research organizer templates
- Systems diagram graphic organizers
- Prototype testing data tables
- Rubrics for presentations and engineering solutions
- Vocabulary reference sheet
- Reflection prompts
- Laboratory and classroom safety guidelines



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Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly**, **Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging Strongly and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☒	☐	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☒	☐	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☒	☐	☐
Are differentiated based on student needs	☐	☒	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☒	☐	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☐	☒	☐

Curriculum Design Template

Content Area: Science **Grade Level:** 10 **Unit Title:** Chemistry of Earth and Climate Systems

Created: 2026

Board Approved on:



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**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21st CENTURY
GLOBAL SKILLS**

IEP AND 504 ACCOMMODATIONS AND MODIFICATIONS FOR EARLY CHILDHOOD AND ELEMENTARY SCHOOL STUDENTS:

Large print textbooks
Textbooks for at-home use
Additional time for assignments
Review of directions
Use of mnemonics
Have student restate information
Concrete examples
Adaptive writing utensils
Support auditory presentations with visuals
Use of a study carrel
Assistance in maintaining uncluttered space
Weekly home-school communication tools (notebook, daily log, phone calls or email messages)
Space for movement or breaks
Study sheets and teacher outlines
Extra visual and verbal cues and prompts
Math sheets with highlighted instructions
Graph paper to assist in organizing or lining up math problems
Use of computers and calculators
Books on tape
Graphic organizers
Quiet corner or room to calm down and relax when anxious
Preferential seating
Alteration of the classroom arrangement
Reduction of distractions
Answers to be dictated
Hands-on activities
Use of manipulatives
No penalty for spelling errors or sloppy handwriting
Follow a routine/schedule
Alternate quiet and active time
Teach time management skills
Rest breaks
Verbal and visual cues regarding directions and staying on task
Agenda book and checklists
Adjusted assignment timelines
Visual daily schedule



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**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Varied reinforcement procedures
Immediate feedback
Work-in-progress check
Personalized examples

TESTING AND ASSESSMENT ACCOMMODATIONS AND MODIFICATIONS:

Answers to be dictated
Frequent rest breaks
Additional time
Oral testing
Untimed tests
Choice of test format (multiple-choice, essay, true-false)
Alternate ways to evaluate (projects or oral presentations instead of written tests)
Accept short answers
Open-book tests
Read test and directions to student
Provide study outline prior to tests
Highlight key directions
Test in alternative site
Use of calculator
Extra credit option
Preview test procedures
Simplified test wording; rephrased test questions and/or directions

GENERAL ACCOMMODATIONS AND MODIFICATIONS:

Use of alternative books or materials on the topic being studied
Computerized spell-check support
Word bank of choices for answers to test questions
Provision of calculator and/or number line for math tests
Reworded questions in simpler language
Projects instead of written reports
Highlighting important words or phrases in reading assignments
Modified workload or length of assignments/tests
Modified time demands
Modified grades based on IEP

BEHAVIOR ACCOMMODATIONS MODIFICATIONS:



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GLOBAL SKILLS

Breaks between tasks
Cue expected behavior
Daily feedback to student
Have contingency plans
Use de-escalating strategies
Use positive reinforcement
Use proximity/touch control
Use peer supports and mentoring
Model expected behavior by adults
Have parent sign homework
Have parent sign behavior chart
Set and post class rules
Chart progress and maintain data



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GLOBAL SKILLS

IEP AND 504 ACCOMODATIONS AND MODIFICATIONS FOR MIDDLE AND HIGH SCHOOL STUDENTS:

Large print textbooks
Textbooks for at-home use
Additional time for assignments
A locker with adapted lock
Review of directions
Review sessions
Use of mnemonics
Have student restate information
Provision of notes or outlines
Concrete examples
Adaptive writing utensils
Support auditory presentations with visuals
Weekly or bi-weekly home-school communication
Space for movement or breaks
Study sheets and teacher outlines
Extra visual and verbal cues and prompts
Lab and math sheets with highlighted instructions
Graph paper to assist in organizing or lining up math problems
Use of tape recorder for lectures
Use of Interactive notebook
Use of a scribe
Use of computers and calculators
Books on tape
Graphic organizers
Quiet corner or room to calm down and relax when anxious
Preferential seating
Alteration of the classroom arrangement
Reduction of distractions
Answers to be dictated
Hands-on activities
Ability to type all assignments
Follow a routine/schedule
Teach time management and organizational skills
Rest breaks
Verbal and visual cues regarding directions and staying on task
Agenda book and checklists
Daily check-in with case manager or special education teacher
Adjusted assignment timelines
Visual daily schedule



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**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Varied reinforcement procedures
Immediate feedback
Work-in-progress check
Personalized examples

TESTING AND ASSESSMENT ACCOMMODATIONS AND MODIFICATIONS:

Answers to be dictated
Frequent rest breaks
Additional time
Oral testing
Choice of test format (multiple-choice, essay, true-false)
Alternate ways to evaluate (projects or oral presentations instead of written tests)
Accept short answers
Open-book or open-note tests
Read test and directions to student
Provide study guides prior to tests
Highlight key directions
Test in alternative site
Use of calculator
Extra credit option
Pace long-term projects
Preview test procedures
Simplified test wording; rephrased test questions and/or directions

GENERAL ACCOMMODATIONS AND MODIFICATIONS:

Allow outlining, instead of writing for an essay or major project
Use of alternative books or materials on the topic being studied
Computerized spell-check support
Word bank of choices for answers to test questions
Provision of calculator for math tests
Film or video supplements in place of reading text
Reworded questions in simpler language
Projects instead of written reports
Highlighting important words or phrases in reading assignments
Modified workload or length of assignments/tests
Modified time demands



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**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Pass/no pass option
Modified grades based on IEP

BEHAVIOR ACCOMMODATIONS FOR STUDENTS:

Breaks between tasks
Cue expected behavior
Daily feedback to student
Have contingency plans
Use de-escalating strategies
Use positive reinforcement
Use proximity/touch control
Use peer supports and mentoring
Model expected behavior by adults
Have parent sign homework
Set and post class rules
Chart progress and maintain data



SPRINGFIELD PUBLIC SCHOOLS

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS

Accommodations and Modifications for ESL Students

- Give tests orally
- Give instructions/directions in writing and orally
- Assign a peer tutor, same language or English speaking
- Allow use of bilingual/translation dictionary
- Provide summaries of text or study guides of particular chapters
- Allow errors in speaking
- Allow errors in writing
- Accept writing in first language
- Highlight key vocabulary
- Reduce amount of work required
- Assess comprehension through demonstration or other alternative means (gestures, drawings)
- Rephrase questions, directions, and explanations
- Reduce multiple choices on assessments
- Provide study guides and/ or outlines
- Shorten reading assignments
- Allow extended time for test/project completion
- Use of audio books
- Use of graphic organizers
- Use reduced text, so that print is not dense
- Use visuals/pictures throughout lesson/unit/assignment
- Adapt homework to reflect language proficiency/home support
- Adapt homework to reflect home support
- Provide hands-on activities and explanations
- Allow extended time to answer questions, and permit drawing, as an explanation
- Use of translation dictionaries to locate words in the native language
- Use anecdotal records and portfolio of work as forms of assessment
- Use story retellings to assess comprehension

What Does the Gifted and Talented Experience Look Like? *Springfield Public Schools*

Mission Statement

The Gifted and Talented Program of the Springfield Public Schools aims to provide a meaningful and rigorous education that instills the value of lifelong learning and empowers all students to reach their full potential and become self-fulfilled creative leaders in accordance with the comprehensive standards of our state. We accomplish this by offering challenging, real-world experiences in a student-centered environment.

We recognize that students come from diverse socioeconomic, cultural, and ethnic backgrounds, and the mission of the gifted and talented program is to provide opportunities for students to explore their intellectual, creative, and artistic gifts and talents within the classroom and with beyond-the-classroom experiences. It is essential to provide diverse, appropriate, and ongoing learning experiences and environments that incorporate students' academic, psychological, and social needs. Our responsibility is to provide students with educational alternatives that teach, challenge, and expand their knowledge, while simultaneously stressing the development of independent and self-directed learners who continuously generate questions, analyze, synthesize, and evaluate information and ideas.

New Jersey Administrative Code 6A:8-3.1 defines students who are gifted and talented as those students who possess or demonstrate high levels of ability in one or more content areas when compared to their chronological peers in the local district and who require modification of their educational program if they are to achieve in accordance with their capabilities.

Goals:

To support our mission, we have established the following goals to guide our work:

- To infuse into the general education program a broad range of activities for high-level learning that will challenge all students to perform at advanced levels, and provide extended opportunities, resources, and support in particular areas where student interest or talent is demonstrated.
- To provide a continuum of gifted education services that will strengthen the total school program, offer enriching and challenging learning opportunities for all students, and provide specialized learning experiences
- To promote achievement of students' best potentials and increased ability.

Through a productive and collaborative relationship among the building principals, classroom teachers, and the Gifted and Talented teacher, our schools can create programming that will enhance the learning experience for every student and serve the unique and specialized needs of students currently demonstrating gifted behaviors.

Elements of the Schoolwide Enrichment Model, W.I.N (What I Need), differentiated instruction, advanced classes, or individual programs into a student's regular instruction program are integral to this overarching framework for gifted education in the Springfield School District.

Reference Board Policy and Regulation 2464 – Gifted and Talented Pupils (M)

Early Childhood Center **Edward V. Walton**

Schoolwide Virtual Enrichment

All first and second grade students have access to the [Gifted and Talented Virtual Classroom](#). This virtual classroom is a space for students to complete various challenges and enrichment opportunities at their own pace. Students can receive feedback and additional adaptable resources to meet their individual learning needs. The virtual classroom design expands accessibility to enrichment resources and allows students to choose learning activities according to their unique interests and abilities. The purpose of the activities is to encourage problem-solving, develop critical thinking

skills, and expand curiosity and imagination. Activities are aligned to the New Jersey Student Learning Standards.

Gifted and Talented Teacher as a Resource

The Gifted and Talented teacher serves as a resource to all teachers within Edward V. Walton School. Teachers seeking resources for their high-ability learners will receive additional support from the Gifted and Talented teacher in various ways. This support may include additional units of study, challenging resources, and student projects.

Elementary Schools

James Caldwell

Thelma L. Sandmeier

The goal is to engage small groups of students in intensive learning experiences through standards-based, rigorous, and relevant units of study that supplement, not supplant, the grade-level curriculum and support students' unique learning needs.

Enrichment Experience Grade 3

Beginning in third grade, the G&T teacher will cycle through all classrooms to work on problem-solving and enrichment tasks with students. Driven by assessment data, academic performance, student interest, and teacher observation, small groups of students will meet with the G&T teacher during W.I.N. (What I Need) periods throughout the week that the teacher is assigned to their classroom teacher. Groupings will be flexible and monitored to best meet each student's needs throughout the school year. Activities will include brain teasers, puzzles, strategic thinking, problem-solving, and STEM challenges.

Targeted Gifted and Talented Programing Grades 4-5

Students may become identified as Gifted and Talented in fourth grade. Students that are identified may receive support from the G&T Teacher for up to five periods (200 minutes) a week during W.I.N. (What I Need) periods. Identified students will meet to explore grade-level content while incorporating depth and complexity in a student-centered, problem-based environment. The Gifted and Talented Program aims to provide students with various advanced and challenging learning experiences across content areas to promote independent thinking skills, refine critical thinking and communication skills, cultivate joy in learning, and expand student interests through problem-solving. The instruction that students receive incorporates 21st Century Skills and advanced content that is challenging, hands-on, and relevant to the real world.

Strategies and Practices that Support Gifted and Talented Students

- Adjusted Pace of Lessons
- Inquiry-Based Instruction
- Higher-Order Thinking Activities
- Interest-Based Content
- Real World Problem Solving/Problem Based Learning
- Independent Study/Passion Projects
- Units of Study with Like-Minded Peers

Schoolwide Virtual Enrichment

All JCS and TLS students have access to grade level-specific [Gifted and Talented Virtual Classrooms](#). These virtual classrooms are a space for students to complete various challenges and enrichment opportunities at their own pace. Students are able to receive feedback and additional opportunities based on their needs. The virtual classrooms have expanded the accessibility of enrichment resources directly to the students and allows for students to choose opportunities according to their interests and abilities. The purpose of the activities is to encourage problem solving, develop critical thinking skills, and expand curiosity and imagination in conjunction with the New Jersey Student Learning Standards.

Gifted and Talented Teacher as a Resource

In addition to classroom support, the Gifted and Talented teacher also serves as a resource to all teachers in the building. Teachers that are seeking resources for their high ability learners will receive additional support from the Gifted and Talented teacher in various ways. This may include additional units of study, challenging resources, student projects, and meeting with the G&T teacher as needed.

Additional Enrichment Opportunities

Across all grade levels 3-5, as recommended by the classroom teacher, students exhibiting a need for additional enrichment may have the opportunity to meet with the G&T teacher as the schedule allows. Groupings will be flexible and monitored to best meet the students' needs throughout the school year. Activities will include, brain teasers, puzzles, strategic thinking activities, problem-solving challenges, and STEM challenges. Students engage in an extended process of asking questions, using resources, and developing answers that lead to thinking about what and how they are learning. Students are held accountable for how they work and use their time by demonstrating their learning through products or presentations.

Students self-select to participate in individual and/or group projects based on interest and commitment. The classroom teacher and/or the enrichment teacher will help guide and monitor student exploration of chosen topics, facilitating their learning with resources and teaching of needed skills.

Secondary Schools
Florence M. Gaudineer Middle School
Jonathan Dayton High School

Grades 6-12: Access to specific content programs with higher levels of academic challenges (i.e. Pre-Algebra, Accelerated Communication Arts, and Advanced Placement Classes)

Dual Credit Courses provide students the opportunity to obtain high school credit, and college credit, simultaneously through partnerships with several institutions.

Project Lead the Way (PLTW) students become builders of technology by engaging in real world activities. Students are empowered as design thinkers collaborating on real world projects.

Gifted and Talented Identification Criteria

The Springfield Schools Gifted and Talented Program recognizes that students require differentiated learning experiences beyond the core curriculum being taught because of their advanced abilities in one or more content areas. These students may also have other cognitive qualities such as curiosity, creativity, motivation, leadership, and passion that require modifications to their academic experience.

Multiple Measures of Eligibility

Kindergarten through grade twelve identification process for gifted and talented students includes multiple measures. Multiple measures may include but are not limited to: achievement test scores; grades; student performance or products; intelligence testing; parent, student, and/or teacher recommendation; and other appropriate measures. The identification methodology is developmentally appropriate, non-discriminatory, and related to the programs and services offered by the Springfield School District. The identification procedures are reviewed annually.

According to N.J.A.C. 6A:8-3.1, all public school districts must have a board-approved gifted and talented identification process and provide services for identified students enrolled in the grades of that school district. The regulations require that identification and services be made available to students in grades K-12.

When students are recommended for the Gifted and Talented Program there are multiple measures that are considered to determine if services are necessary and appropriate. The assessments used are as follows:

- Cognitive Abilities Test (CogAT)
- Classroom Performance/Student Portfolios
- DRA2 Level
- iReady Diagnostic Scores
- Gifted Indicators Checklist
- Start Strong/NJSLA Assessment Data

The N.J.A.C. requires that students be compared to their chronological peers in the local school district. The New Jersey Department of Education has not established state-level criteria for identifying students who are gifted, such as mandated tests or assessments, grade point averages, or IQ scores. Local school districts must use multiple measures to identify students.

Procedures

<https://www.straussesmay.com/seportal/Public/DistrictPolicy.aspx?policyid=2464&id=b8a33a9f505e4998a6db3fb8e1de778b>

Gifted and Talented Program Identification Matrix

Minimum Score Required for Consideration: 14 Points

1 Point	2 Points	3 Points
Cogat Assessment Overall Stanine Score of a 7	Cogat Assessment Overall Stanine Score of an 8	Cogat Assessment Overall Stanine Score of a 9
iReady Math Assessment Just Below Current Grade Level	iReady Math Assessment On Grade Level	iReady Math Assessment ½ Year + Above Current Level
iReady ELA On Grade Level	iReady ELA ½ Year Above Current Level	iReady ELA One Full Grade Level + Above Current Level
NJSLA Math Approaching Expectations	NJSLA Math Met Expectations	NJSLA Math Exceed Expectations
NJSLA ELA Approaching Expectations	NJSLA ELA Met Expectations	NJSLA ELA Exceed Expectations
HOPE Teacher Rating Scale Raw Score: 11 - 29	HOPE Teacher Rating Scale Raw Score: 30 - 49	HOPE Teacher Rating Scale Raw Score: 50-66

Team meetings present the opportunity to review data and assess the educational needs of all students. Teacher provides examples of student work exhibiting above and beyond grade level expectations, creativity, leadership, critical and abstract thinking. Programs for gifted and talented students will be periodically evaluated for their continuing efficacy and adjusted accordingly. The parent of any student identified as gifted or talented shall be consulted regarding any program designed to address the student's particular needs.

Resource Links

https://riversideinsights.com/cognitive_abilities_test

<https://www.curriculumassociates.com/programs/i-ready-learning>

<https://www.nj.gov/education/assessment/resources/>

<https://www.routledge.com/HOPE-Teacher-Rating-Scale-Involving-Teachers-in-Equitable-Identification/Gentry-Pereira-Peters-McIntosh-Fugate/p/book/9781618214522#:~:text=The%20HOPE%20Teacher%20Rating%20Scale,making%20it%20easy%20to%20use.>

Gifted and talented student: The "[*Strengthening Gifted and Talented Education Act*](#)" defines a gifted and talented student as a "student who possesses or demonstrates a high level of ability in one or more content areas when compared to their chronological peers in the school district and who require modifications of their educational program if they are to achieve in accordance with their capabilities."

Twice-exceptional (2E) students: A twice-exceptional (2E) student is defined as "a student who is both gifted and a student with a disability. These students may also be referred to as having dual exceptionalities or as being gifted with learning disabilities (GT/LD). This also applies to students who are gifted with ADHD or gifted with autism" (New Jersey Association for Gifted Children, www.nagc.org).

Instructional adaptation: An adjustment or modification to instruction enabling a student who is gifted and talented to participate in, benefit from, and demonstrate knowledge and application of the New Jersey Student Learning Standards in one or more content areas at the instructional level of the student, not just the student's grade level.

Identifying gifted and talented students: The focus of identification is to provide programming and services in which students' specific learning needs and potential are appropriately addressed and met. In every New Jersey school district, there are students who require modifications to the general education curriculum if they are to achieve in accordance with their abilities. By identifying a student's general intellectual ability, creativity, or specific academic area aptitudes, we are acknowledging that they need programming and services outside of the general education/grade level curriculum to advance their learning.

[NJDOE Fast Facts](#)

<https://www.nj.gov/education/standards/gifted/>

<https://www.nj.gov/education/standards/gifted/legislation.shtml>

Supplemental Resources/Programming for Gifted Students

Edward V. Walton

- PETS Program – Primary Education Thinking Skills
- Group Solutions/Group Solutions 2 – Cooperative Logic Activities
- Lollipop Logic
- Beginning Thinking Skills
- AIMS Education Programming

James Caldwell and Thelma L. Sandmeier

Math/ELA

- Project M3: Mentoring Mathematical Minds
- Junior Great Books
- AIMS Education Programming
- Borenson Hands on Equations
- BizWorld
- Perplexors
- Advanced Math Explorations grade 3-5
- Challenging Units for Gifted Learners (ELA and Math)
- Creative Curriculum Extenders
- Differentiated Lessons & Projects
- Challenge Math Grades 4+
- Differentiating Instruction with Menus (All Content Areas)
- Jacob's Ladder
- Genius Hour/Passion Project
- Spatial Reasoning
- Logic Puzzles, Brain Games, Analogies

STEM

- Engineering is Elementary
- Engineer Throughout the Year
- PBS Design Squad
- DefinedSTEM
- Project Lead the Way (PLTW)

Enrichment Events

Experience for all students to be enriched through events related to the curricular or extracurricular activities. Examples include after school clubs, PTA-sponsored events, leadership opportunities, visual and performing arts, and community service opportunities.