TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

GRADE 11 CHEMISTRY
Science Department

2020

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Grade 11 Chemistry
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The Trumbull Board of Education promotes non-discrimination in all of its programs, including educational opportunities and services provided to students, student assignment to schools and classes, and educational offerings and materials.

CORE VALUES AND BELIEFS

The Trumbull School Community engages in an environment conducive to learning which believes that all students will **read** and **write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem-solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.

Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

Grade 11 Chemistry is consistent in the continued development of scientifically literate students, with a concentration on matter, energy, and changes. Authentic scientific and engineering experiences build on one another and increase in complexity throughout students' K-12 education. In 2015, the Connecticut State Board of Education adopted the Next-Generation Science Standards (NGSS), which embody the National Research Council's *Framework for K-12 Science Education* (2012). Both the *Framework* and the NGSS stress the importance of teaching classroom scientific inquiry as practiced by scientists and engineers. The *Framework* provides a vision for American science education in the 21st century, while the NGSS provide grade-level student performance expectations, disciplinary core ideas, and crosscutting concepts. The *Framework* and NGSS indicated a paradigm shift in science education, one in which teachers are to incorporate authentic learning experiences for students that reflect the nature of doing science and engineering.

The *Framework* and NGSS provide clarity to classroom scientific inquiry by stressing the importance of the eight practices of science and engineering. The practices were designed to help students understand how scientific knowledge develops, and to stimulate students' interest in and continued study of science. Three-dimensional learning facilitates student engagement with Science and Engineering Practices and Crosscutting Concepts to deepen their understanding of Disciplinary Core Ideas in order to explain phenomena and solve problems. Three-dimensional learning promotes development of student skills in the following areas:

- Knowing, using, and interpreting scientific explanations of the natural world (Disciplinary Core Ideas, and Crosscutting Concepts)
- Generating and evaluating scientific evidence and explanations (Science and Engineering Practices)
- Participating productively in scientific practices and discourse (Science and Engineering Practices)
- Understanding the nature and development of scientific knowledge (Science and Engineering Practices, and Crosscutting Concepts)

The shift of science education reflects the interconnected nature of science as it is practiced in the real world and builds coherently across grades K-12. The NGSS focus on deeper understanding of content as well as application of content with an alignment to the Connecticut Core Standards. A deeper understanding and application of science and engineering practices prepare students for postsecondary success and citizenship in a world fueled by innovations in science and technology.

In Grade 11 Chemistry, students will further explore many of the systems and processes of the physical and chemical world by investigating the underlying submicroscopic interactions of matter through the topics of general chemistry. By focusing on the changes in matter and energy, scientifically literate students can use this deeper understanding to make predictions, analyze scientific data, and contribute to the greater scientific community.

Grade 11 Chemistry is offered at three separate course levels: Honors, Advanced College Preparatory (ACP), and College Preparatory (CP). All levels will explore each unit of study. The courses are differentiated by pacing of curriculum, rigor of exploration, depth of content knowledge, and the application of quantitative reasoning. The honors course will explore topics with the greatest depth, most rigorous exploration, deepest study of content, and furthest application of quantitative reasoning. More supports will be offered at the ACP course level, with the most supports offered at the CP course level.

COURSE GOALS

The course goals derive from the 2013 Next-Generation Science Standards, the 2010 Connecticut Core Standards, and the ISTE (International Society for Technology in Education) Technology Standards. Goals are listed specific to each unit in this curriculum guide, and developed through unit lessons using the 5-E learning model (engage, explore, explain, elaborate, evaluate) in order to encourage student engagement and foster metacognitive learning strategies through a reflective process. An important role of science education is not to teach "all the facts," but rather to prepare students with sufficient core knowledge so that they can later acquire additional information on their own.

COURSE ENDURING UNDERSTANDINGS

Students will understand that . . .

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. 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. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy, by an amount known as the binding energy, than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

- 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 total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy. 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.

- 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. Chemical processes and properties of materials underlie many important biological and geophysical phenomena.

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve changes in nuclear binding energies. The total number of neutrons plus protons does not change in any nuclear process. Strong and weak nuclear interactions determine nuclear stability and processes. Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials from the isotope ratios present.

- 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 strong and weak nuclear interactions are important inside atomic nuclei – for example, they determine the patterns of which nuclear isotopes are stable and what kind of decays occur for unstable ones.

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. "Chemical energy" generally is used to mean the energy that can be released or stored in chemical processes, and "electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.

- Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. The main way in which that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy.

- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. Quantum theory relates the two models.

- Because a wave is not much disturbed by objects that are small compared with its wavelength, visible light cannot be used to see such objects as individual atoms. When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. Photovoltaic materials emit electrons when they absorb light of a high-enough frequency.

- Atoms of each element emit and absorb characteristic frequencies of light, and nuclear transitions have distinctive gamma ray wavelengths. These characteristics allow identification of the presence of an element, even in microscopic quantities.

- 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.

- Global climate models incorporate scientists' best knowledge of physical and chemical processes and of the interactions of relevant systems. Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and on the ways in which these gases are absorbed by the ocean and the biosphere. Hence the outcomes depend on human behaviors as well as on natural factors that involve complex feedbacks among Earth's systems.

- Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly over Earth's history. Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts. 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, as well as to changes in human activities. Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences – for humanity as well as for the rest of the planet.

COURSE ESSENTIAL QUESTIONS

- What is matter, and how is it organized?
- How does the arrangement of subatomic particles affect the properties of matter?

- How does energy transfer in matter interactions?
- How is the Earth influenced by natural and man-made factors?
- How can submicroscale interactions be used to explain macroscopic observations?
- How do scientists quantitatively relate particles of matter to other properties of matter?
- How do intermolecular and intramolecular forces determine the properties of matter?
- What determines the nature of a chemical reaction?

COURSE KNOWLEDGE & SKILLS

Students will understand . . .

- Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
- Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
- Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
- Systems and system models. Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.
- Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
- Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
- Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Students will be able to . . .

- ask questions (for science) and define problems (for engineering).
- develop and use models.

- plan and carry out investigations.
- analyze and interpret data.
- use mathematics and computational thinking.
- construct explanations (for science) and design solutions (for engineering).
- engage in arguments from evidence.
- obtain, evaluate, and communicate information.

COURSE SYLLABUS

Course Name

Grade 11 Chemistry

Level

College-Preparatory, Advanced College-Preparatory, & Honors

Prerequisites

Successful completion of Grade 10 Biology

Materials Required

None

General Description of the Course

This course is aligned to the Next Generation Science Standards (NGSS) Disciplinary Core Ideas for Grade 11. Through the implementation of the Three Dimensions of NGSS (Disciplinary Core Ideas, Science and Engineering Practices and Cross Cutting Concepts), students will further explore many of the systems and processes of the physical and chemical world by investigating the underlying submicroscopic interactions of matter through the topics of general chemistry. By focusing on the changes in matter and energy, scientifically literate students can use this deeper understanding to make predictions, analyze scientific data, and contribute to the greater scientific community. At the Honors level, algebraic reasoning and independent discovery are expected; the CP level mirrors the ACP level with additional guided inquiry.

Assured Assessments

Formative Assessments:

Formative assessments can include, but are not limited to:

- Individual and group lists of safety lessons learned (Unit 1)
- Construction of models (Unit 2)
- Lab activities (Units 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13)
- Creation of a periodic table (Unit 6)
- Covalent bonding model kit activity (Unit 7)
- Data collection and analysis (Units 8, 9, 13)

Summative Assessments:

- End-of-unit assessment with multiple-choice questions (Unit 1)
- End-of-unit assessment with multiple-choice questions, free-response questions, and interpreting and analyzing data (Units 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13)
- Midyear examination
- End-of-year examination

Core Texts

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- University of Colorado Boulder. *PhET Interactive Simulations*. https://phet.colorado.edu/en/simulations/category/new. Accessed January 21, 2020. Web.
- *Uranium: Twisting the Dragon's Tail*. Dir. Wain Fimeri, PBS, 2015. Film.

UNIT 1
Introduction to the Chemistry Laboratory

Unit Goal

At the completion of this unit, students will:

- Be able to safely perform laboratory experiments in accordance with OSHA Lab Safety and National Fire Code Standards.

Unit Essential Question

- How do we safely perform experiments in the science laboratory?

Scope and Sequence

- Common lab equipment
- Lab techniques
- Lab safety rules
- Locations and use of safety equipment
- Safety Data Sheets

Assured Assessments

Formative Assessment:

- Individual and group lists of safety lessons learned from Calais Weber (or similar) story
- Bunsen burner explanation and ignition
- Activity using Safety Data Sheets to determine an unknown substance

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions related to safety in the chemistry lab. Students must score a 100% on the assessment before performing a lab experiment in the classroom.

Resources

Core

- *Flinn Scientific Safety Contract*. Print.
- *Flinn Scientific Safety Data Sheets*. https://www.flinnsci.com/sds/. Accessed January 21, 2020. Web.

Supplemental

- *After the Rainbow*. https://www.bing.com/videos/search?q=youtube+after+the+rainbow&view=detail&mid=F8646A3D7B5AC00206D1F8646A3D7B5AC00206D1&FORM=VIRE. Accessed January 21, 2020. Web.

Time Allotment

- Approximately one week

UNIT 2
Studying Matter

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
NGSS.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
CCS.ELA-Literacy.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
CCS.ELA-Literacy.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Empowered Learner (Standard 1d)	Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use, and troubleshoot current technologies, and be able to transfer their knowledge to explore emerging technologies.
ISTE Creative Communicator (Standard 6a)	Choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.

Unit Essential Questions

- How are properties of matter used to classify matter?
- What distinguishes a physical property from a chemical property?
- What distinguishes a physical change from a chemical change?
- How can particles of matter be represented?
- How can properties be used to identify a sample of matter?

Scope and Sequence

1. Classifications of matter
2. Physical versus chemical properties and changes
3. States of matter
4. Mixtures versus pure substances
5. Particle pictures

Assured Assessments

Formative Assessment:

- Construction of models to demonstrate understanding on the microscopic level
- Lab activity differentiating chemical from physical properties/changes
- Lab activity based on methods of separating a mixture
- Qualitative analysis lab activity

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to matter.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- Modeling kits
- Online interactive review and reinforcement questions

Time Allotment

- Approximately three weeks

UNIT 3
Atomic Structure and the Mole

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.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.
NGSS.HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
CCS.ELA-Literacy.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
CCS.ELA-Literacy.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What defines an atom?
- How are elements identified and represented?
- What factors make one element different from another?
- How can scientists quantitatively represent groups of atoms?

Scope and Sequence

1. Subatomic particles
2. Periodic table and element symbolization

3. Nuclear pull
4. Mole-Mass relationships
5. Dimensional analysis

Assured Assessments
Formative Assessment:
- Lab activity based on scientists' use of the mole to quantify very small things like atoms and molecules
- Lab activity analyzing the law of conservation of matter
- Lab activity calculating mole-mass conversions
- Lab activity interpreting chemical equations with the mole

Summative Assessment:
- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to atomic structure and the mole.

Resources
Core
- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- University of Colorado Boulder. *PhET Interactive Simulations: Build an Atom*. https://phet.colorado.edu/en/simulation/build-an-atom. Accessed January 21, 2020. Web.

Supplemental
- Online interactive review and reinforcement questions
- NOVA. *Hunting the Elements*. https://www.pbs.org/wgbh/nova/video/hunting-the-elements. Accessed January 21, 2020. Web.
- "Starstruck." Adapted from Ruth, Carolyn. "Where Do Chemical Elements Come From?" *ChemMatters* October 2009: 6-8. Print.

Time Allotment

- Approximately three weeks

UNIT 4
Nuclear Chemistry

Unit Goals

At the completion of this unit, students will:

NGSS.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.
CCS.ELA-Literacy.RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCS.ELA-Literacy.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Empowered Learner (Standard 1d)	Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use, and troubleshoot current technologies, and be able to transfer their knowledge to explore emerging technologies.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
ISTE Innovative Designer (Standard 4d)	Exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.

Unit Essential Questions

- What are the differences between nuclear reactions and chemical reactions?
- What happens to atoms during nuclear decay?
- What are the characteristics of alpha, beta, and gamma radiation?
- How can a nuclide’s half-life be used to determine the amount remaining over time, and how can half-life indicate the age of once-living artifacts?

- What are benefits of and drawbacks from the use of nuclear energy in society?
- What are the differences between nuclear fission and fusion?
- How do nuclear power plants generate electricity?

Scope and Sequence

1. Early understanding and discovery of radiation
2. Isotype stability
3. Radioactive decay
4. Types of radiation
5. Fission and fusion reactions
6. Nuclear weapons
7. Nuclear power
8. Ionizing radiation
9. Half-life and carbon dating
10. Applications of radiation

Assured Assessments

Formative Assessment:

- Lab activity based on half-life and radiometric dating

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to nuclear chemistry.

Resources

<u>Core</u>

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- *Uranium: Twisting the Dragon's Tail*. Dir. Wain Fimeri, PBS, 2015. Film.

<u>Supplemental</u>

- Activity to evaluate personal perception of risk compared to the risk of exposure to radiation
- Activity to investigate applications of nuclear chemistry
- "The Death of Alexander Litvinenko." Adapted from Keown, Audrey. "The Death of Alexander Litvinenko." *ChemMatters* April 2007: 18-19. Print.
- Lab activity on applications of nuclear reactions
- "Learning the Facts about Artifacts." Trumbull High School.

- Marder, Jenny. “Mechanics of a Nuclear Meltdown Explained.” *Science* March 15, 2011. https://www.pbs.org/newshour/science/mechanics-of-a-meltdown-explained. Accessed January 21, 2020. Web.
- Weatherall, Steve. “Radioactivity: Expect the Unexpected.” https://www.youtube.com/watch?v=TJgc28csgV0. Accessed January 21, 2020. Web.

Time Allotment

- Approximately four weeks

UNIT 5
Electrons

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.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.
NGSS.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.
NGSS.HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
NGSS.HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
NGSS.HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
NGSS.HS-ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
CCS.ELA-Literacy.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
ISTE Innovative Designer (Standard 4d)	Exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.
ISTE Computational Thinker (Standard 5c)	Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Unit Essential Questions

- How does an atom's electron configuration affect its chemical properties?
- What is the relationship between an element's electron configuration and its valence shell?
- What is the significance of core electrons versus valence electrons, and how can that be represented?
- What patterns exist in atoms' radii on different groups and periods of the periodic table?
- How is an element's electron configuration affected by its need for stability?
- What happens to electrons when energy is added?
- How are energy, wavelength, and frequency of waves related?
- How can a flame test be used to identify elements?
- What are the parts of the electromagnetic spectrum?

Scope and Sequence

1. Electron configurations and orbital diagrams
2. Valence electrons and stability
3. Lewis dot diagrams
4. Ground state and excited states
5. Absorption and emission
6. Color and energy
7. Wavelength, frequency, energy
8. Emission and absorption spectra
9. Flame test

Assured Assessments

Formative Assessment:

- Lab activity investigating relationships among color, wavelength, and relative amounts of absorbed energy
- Lab activity using a flame test to analyze data and identify an unknown

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to electrons.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- De Antonis, Kathy. "Fireworks!" *ChemMatters* October 2010: 8-10. file:///C:/Users/jbudd/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/chemmatters-oct2010-fireworks%20(1).pdf. Accessed January 21, 2020. Web.
- Lab activity to investigate how ions and ionic compounds are formed
- University of Colorado Boulder. *PhET Interactive Simulations*. https://phet.colorado.edu/en/simulations/category/new. Accessed January 21, 2020. Web. [for modeling waves]

Time Allotment

- Approximately three weeks

UNIT 6
The Periodic Table

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.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.
NGSS.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.
NGSS.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
NGSS.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How is the periodic table organized?
- How can physical and chemical properties be predicted and explained based on periodic table location?
- How can the periodic law be used to select materials to meet societal needs?

Scope and Sequence

1. Periods and groups
2. Periodic law
3. Atomic and ionic size trend
4. Reactivity trend
5. Ionization energy and trend [for Honors & ACP]
6. Electronegativity and trend [for Honors & ACP]

Assured Assessments

Formative Assessment:

- Activity creating a periodic table
- Lab activity exploring periodic trends
- Lab activity investigating alloys

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to the periodic table.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- Lab activity based on properties of metals and nonmetals
- "Activity: From Mine to Mobile." Trumbull High School. Adapted from Prendergast, John, and Sasha Lezhnev. "From Mine to Mobile Phone: The Conflict Minerals Supply Chain." The Enough Project, n.p.: 2009. https://enoughproject.org/files/minetomobile.pdf. Accessed January 21, 2020. Print.
- NOVA. *Hunting the Elements*. https://www.pbs.org/wgbh/nova/video/hunting-the-elements. Accessed January 21, 2020. Web.
- "Secrets of the Super Elements." Dir. Laura Mulholland. BBC, 2017. https://www.bbc.co.uk/programmes/b08rv9r6. Accessed January 21, 2020. Web.
- "TBQ: The Nature of Things." Adapted from Goho, Alexandra. "The Nature of Things." *Science News* Oct. 21, 2003. https://www.sciencenews.org/article/nature-things. Accessed January 21, 2020. Web.

Time Allotment

- Approximately two weeks

UNIT 7
Bonding: Intramolecular Attraction

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.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.
NGSS.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.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- Why do most atoms form chemical bonds while a few do not?
- How can the positions of elements on the periodic table be used to predict how they form compounds with other elements?
- How are ionic and covalent bonds formed, and how does the bond type influence the properties of compounds?

Scope and Sequence

1. Octet Rule and valence electrons
2. Ion formation and electrostatic attraction between ions
3. Naming and writing formulas for ionic compounds
4. Naming and writing formulas for covalent compounds
5. Drawing molecules with the appropriate shape

6. Differences in properties of atoms, ionically bonded compounds, and covalently bonded compounds
7. Determining percent composition and empirical formulas [for Honors]

Assured Assessments
Formative Assessment:

- Lab activity forming ionic compounds
- Lab activity identifying a hydrate [for Honors]
- Covalent bonding model kit activity

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to bonding.

Resources
Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- University of Colorado Boulder. *PhET Interactive Simulations*. https://phet.colorado.edu/en/simulations/category/new. Accessed January 21, 2020. Web. [for online molecule simulations]

Supplemental

- Lab activity making esters
- Speed Match: Practice with Ionic Names/Formulas." Trumbull High School. [card-matching activity]
- "TBQ: How Does Your Nose Know?" SAT practice article adapted from Börsch, Angelika. "Small Molecules Make Scents." *Science in School* 6 (Sept. 18, 2007). https://www.scienceinschool.org/2007/issue6/scents. Accessed January 21, 2020. Web.
- "TBQ: Paintball." Adapted from Rohrig, Brian. "Paintball: Chemistry Hits Its Mark." *ChemMatters* April 2007: 4-7. Print.

Time Allotment

- Approximately three weeks

UNIT 8
Intermolecular Forces

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.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.
NGSS.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
NGSS.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
NGSS.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’s systems.
NGSS.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.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How do electronegativity and molecular shape determine the polarity of a molecule?
- How do the type of bond and the polarity of a molecule determine the interactions between neighboring molecules, the characteristics of different substances, and the formation of solutions?
- What properties make water essential for life on planet Earth?
- How is the level of CO_2 dissolved in the ocean affected by climate change, and what impact does this have on Earth's systems?
- How can the energy involved in changes in state be quantified and expressed graphically?
- How does the melting of land ice perpetuate a forward feedback loop that contributes to climate change?
- How does changing the albedo of glaciers affect the sea level?

Scope and Sequence

1. Electronegativity values and determination of bond type
2. Polarity of bonds
3. Polarity of molecules
4. Intermolecular forces between neighboring molecules due to polarity
5. Shape, polarity, and properties of water
6. Solubility, solute, solvent, and formation of solutions
7. Oceanic CO_2 levels in relation to climate change
8. Relationships among intermolecular forces, energy, and state of matter
9. Phase changes
10. Relationships among melting land ice, sea level rise, and climate change

Assured Assessments
Formative Assessment:

- Lab activity creating a non-Newtonian fluid
- Lab activity exploring polar and nonpolar interactions
- Lab activity determining boiling point or freezing point of substances
- Data collection and analysis of oceanic carbon dioxide levels and their relation to climate change

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to intermolecular forces.

Resources
<u>Core</u>

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]

- *Evidence of Sea Level Rise*. Adapted from:
    - *Greenland Is Melting & Bonded Labor*. HBO, 2014. https://www.youtube.com/watch?v=7Yq-sfWSWLg. Accessed January 21, 2020. Web.
    - *Is Miami Beach Drowning?* CBC, 2014. https://www.youtube.com/watch?v=5fPSYLhx7ls. Accessed January 21, 2020. Web.
    - *Our Rising Oceans*. HBO, 2015. https://www.youtube.com/watch?v=Kp6_sDiup6U. Accessed January 21, 2020. Web.
    - *The World Is Sinking: Preventative Measures*. HBO, 2013. https://www.youtube.com/watch?v=JXKW7Ozhx8I. Accessed January 21, 2020. Web.
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

<u>Supplemental</u>

- Guided activity on water and its properties
- Online interactive review and reinforcement questions

Time Allotment

- Approximately three weeks

UNIT 9
Chemical Reactions

Unit Goals
At the completion of this unit, students will:

NGSS.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.
NGSS.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.
NGSS.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.
NGSS.HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
NGSS.HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.
NGSS.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
NGSS.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
NGSS.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’s systems.
NGSS.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.
CCS.ELA-Literacy.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are

	used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
CCS.ELA-Literacy.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
CCS.ELA-Literacy.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3b)	Evaluate the accuracy, perspective, credibility, and relevance of information, media, data, or other resources.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
ISTE Computational Thinker (Standard 5c)	Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Unit Essential Questions

- What are the characteristics of the five basic reaction types?
- How can an activity series be used to predict the outcome of a single replacement reaction?
- How can a solubility chart be used to predict the outcome of a double replacement reaction?
- What are the natural parts of the carbon cycle?
- What is the difference between complete combustion and incomplete combustion?
- How does carbon monoxide affect the human body?
- What is the influence of fossil fuel combustion on the carbon cycle?

- How does the greenhouse effect work?
- What is the relationship between an industrial society and rising atmospheric temperatures?
- What evidence do we have that the Earth's changing climate is due to human activity?

Scope and Sequence

1. Identifying the parts of a chemical equation
2. Characteristics and general form of reaction types
3. Using an activity series
4. Using a solubility chart
5. Natural carbon cycle
6. Human influence on the carbon cycle
7. Complete combustion vs. incomplete combustion
8. Carbon monoxide
9. Types of greenhouse gases and how they are measured
10. Greenhouse effect
11. Effects of climate change

Assured Assessments

Formative Assessment:

- Lab activity showing chemical reactions in solution
- Lab activity/demonstration showing each type of chemical reaction
- Data collection and analysis of greenhouse gases

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to chemical reactions.

Resources

<u>Core</u>

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

<u>Supplemental</u>

- Online interactive review and reinforcement questions
- *Cosmos: A Spacetime Odyssey: The World Set Free*. Dir. Brannon Braga. National Geographic, 2014. Film.

Time Allotment

- Approximately three weeks

UNIT 10 (Unit 11 for Honors)
Energy

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.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.
NGSS.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
NGSS.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.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What causes some physical and chemical changes to release energy while others gain energy?
- How is the law of conservation of energy expressed in chemical systems?
- How can the energy transferred in chemical and physical systems be quantified and expressed graphically?

Scope and Sequence

1. System vs. surroundings

2. Different types of energy (kinetic, potential, chemical, thermal)
3. Conservation of energy
4. Enthalpy changes and endothermic vs. exothermic reactions
5. Graphically depicting energy involved in physical and chemical changes
6. Calculations with heat, mass, change in temperature, and specific heat
7. Calculating the heat of chemical processes using calorimetry

Assured Assessments

Formative Assessment:

- Lab activity observing energy changes in chemical reactions
- Lab activity measuring energy changes in chemical reactions

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to energy.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- Online interactive review and reinforcement questions
- *Making Stuff Colder*. PBS, 2013. https://www.pbs.org/wgbh/nova/video/making-stuff-colder/. Accessed January 21, 2020. Web.

Time Allotment

- Approximately three weeks

UNIT 11 (Unit 10 for Honors)
Stoichiometry

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
CCS.ELA-Literacy.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
ISTE Innovative Designer (Standard 4a)	Know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
ISTE Computational Thinker (Standard 5c)	Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Unit Essential Questions

- How is the law of conservation of matter represented in chemical reactions?
- How is the ideal mole ratio related to the quantity of reactants or products in a chemical reaction?
- How can we use a balanced equation to calculate chemical quantities during a reaction?
- What causes reactions to stop?
- How is the actual yield in a reaction related to the predicted yield?

Scope and Sequence

1. Translating sentences into chemical equations
2. Balancing equations and the law of conservation of matter
3. Stoichiometry, limiting reactants, and excess reactants
4. Why reactions continue, why they stop
5. Percent yield [for Honors]

Assured Assessments

Formative Assessment:

- Lab activity qualitatively determining limiting and excess reactants
- Lab activity quantitatively using the law of conservation of matter

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to stoichiometry.

Resources

<u>Core</u>

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

<u>Supplemental</u>

- Online interactive review and reinforcement questions

Time Allotment

- Approximately two weeks

UNIT 12
Reaction Forces

Unit Goals

At the completion of this unit, students will:

NGSS.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.
NGSS.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.
CCS.ELA-Literacy.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How does the collision theory explain the rates and changes in rates of chemical reactions?
- What is chemical equilibrium, and what factors affect the equilibrium of a reversible reaction?
- How can Le Chatelier’s principle be used to predict the effect of changes (stresses) in concentration, temperature, and pressure on a system at equilibrium?

Scope and Sequence

1. Collision theory and deciding whether or not a reaction will occur
2. Factors that influence the rate of reaction
3. Reversible reactions
4. Equilibrium

5. Stressing a reaction and Le Chatelier's principle

Assured Assessments

Formative Assessment:

- Lab activity exploring the relationship between reactant factors (such as concentration or temperature) and reaction rate
- Lab activity exploring the effect of stresses on a reversible reaction

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to reaction forces.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- Online simulation of reversible reactions

Supplemental

- Online interactive review and reinforcement questions

Time Allotment

- Approximately two weeks

UNIT 13
Gases

Unit Goals

At the completion of this unit, students will:

ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What are the properties of gases?
- How are the properties of gases related?
- How can the properties of gases be mathematically represented and calculated?

Scope and Sequence

1. Assumptions of gases
2. Ideal gas law
3. Changes in conditions
4. Partial pressures of gases

Assured Assessments

Formative Assessment:

- Data analysis to determine trends between air pressure and altitude
- Lab activity exploring the relationships among pressure, volume, and temperature of a sample of gas

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to gases.
- Following Unit 13, students will participate in the end-of-year examination.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]

- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- Online simulations demonstrating relationships among pressure, volume, and temperature of a gas

<u>Supplemental</u>

- Online interactive review and reinforcement questions
- *Everest*. Dir. Greg MacGillivray. MacGillivray Freeman, 1998. Film.
- "Everest to Deep Sea." Adapted from:
    - Belleman, Melissa. "Scuba: The Chemistry of an Adventure." *ChemMatters* February 2001: 7-9. Print.
    - Rohrig, Brian. "Climbing into Thin Air." *ChemMatters* February 2000: 4-6. Print.
- "Would a Vacuum Work in a Vacuum?" Adapted from Becker, Bob. "Question from the Classroom." *ChemMatters* October 2003: 4-5. Print.

Time Allotment

- Approximately three weeks

COURSE CREDIT

1.25 credits in science
One class period daily, plus laboratory, for a full year

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Writing Rubric (attached)
- Trumbull High School School-Wide Problem-Solving Rubric (attached)
- Trumbull High School School-Wide Independent Learning and Thinking Rubric (attached)

Trumbull High School School-Wide Writing Rubric

Category/ Weight	Exemplary 4 Student work:	Goal 3 Student work:	Working Toward Goal 2 Student work:	Needs Support 1-0 Student work:
Purpose X_______	• Establishes and maintains a clear purpose • Demonstrates an insightful understanding of audience and task	• Establishes and maintains a purpose • Demonstrates an accurate awareness of audience and task	• Establishes a purpose • Demonstrates an awareness of audience and task	• Does not establish a clear purpose • Demonstrates limited/no awareness of audience and task
Organization X_______	• Reflects sophisticated organization throughout • Demonstrates logical progression of ideas • Maintains a clear focus • Utilizes effective transitions	• Reflects organization throughout • Demonstrates logical progression of ideas • Maintains a focus • Utilizes transitions	• Reflects some organization throughout • Demonstrates logical progression of ideas at times • Maintains a vague focus • May utilize some ineffective transitions	• Reflects little/no organization • Lacks logical progression of ideas • Maintains little/no focus • Utilizes ineffective or no transitions
Content X_______	• Is accurate, explicit, and vivid • Exhibits ideas that are highly developed and enhanced by specific details and examples	• Is accurate and relevant • Exhibits ideas that are developed and supported by details and examples	• May contain some inaccuracies • Exhibits ideas that are partially supported by details and examples	• Is inaccurate and unclear • Exhibits limited/no ideas supported by specific details and examples
Use of Language X_______	• Demonstrates excellent use of language • Demonstrates a highly effective use of standard writing that enhances communication • Contains few or no errors. Errors do not detract from meaning	• Demonstrates competent use of language • Demonstrates effective use of standard writing conventions • Contains few errors Most errors do not detract from meaning	• Demonstrates use of language • Demonstrates use of standard writing conventions • Contains errors that detract from meaning	• Demonstrates limited competency in use of language • Demonstrates limited use of standard writing conventions • Contains errors that make it difficult to determine meaning

Trumbull High School School-Wide Problem-Solving Rubric

Category/ Weight	**Exemplary 4**	**Goal 3**	**Working Toward Goal 2**	**Needs Support 1-0**
Understanding X_______	• Student demonstrates clear understanding of the problem and the complexities of the task	• Student demonstrates sufficient understanding of the problem and most of the complexities of the task	• Student demonstrates some understanding of the problem but requires assistance to complete the task	• Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X_______	• Student gathers compelling information from multiple sources including digital, print, and interpersonal	• Student gathers sufficient information from multiple sources including digital, print, and interpersonal	• Student gathers some information from few sources including digital, print, and interpersonal	• Student gathers limited or no information
Reasoning and Strategies X_______	• Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	• Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	• Student demonstrates some critical thinking skills to develop a plan integrating some strategies	• Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X_______	• Solution shows deep understanding of the problem and its components • Solution shows extensive use of 21st-century technology skills	• Solution shows sufficient understanding of the problem and its components • Solution shows sufficient use of 21st-century technology skills	• Solution shows some understanding of the problem and its components • Solution shows some use of 21st-century technology skills	• Solution shows limited or no understanding of the problem and its components • Solution shows limited or no use of 21st-century technology skills

Trumbull High School School-Wide
Independent Learning and Thinking Rubric

Category/ Weight	**Exemplary 4**	**Goal 3**	**Working Toward Goal 2**	**Needs Support 1-0**
Proposal X_______	• Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work	• Student demonstrates initiative by generating appropriate questions, creating original projects/work	• Student demonstrates some initiative by generating questions, creating appropriate projects/work	• Student demonstrates limited or no initiative by generating few questions and creating projects/work
Independent Research & Development X_______	• Student is analytical, insightful, and works independently to reach a solution	• Student is analytical, and works productively to reach a solution	• Student reaches a solution with direction	• Student is unable to reach a solution without consistent assistance
Presentation of Final Product X_______	• Presentation shows compelling evidence of an independent learner and thinker • Solution shows deep understanding of the problem and its components • Solution shows extensive and appropriate application of 21st-century skills	• Presentation shows clear evidence of an independent learner and thinker • Solution shows adequate understanding of the problem and its components • Solution shows adequate application of 21st-century skills	• Presentation shows some evidence of an independent learner and thinker • Solution shows some understanding of the problem and its components • Solution shows some application of 21st-century skills	• Presentation shows limited or no evidence of an independent learner and thinker • Solution shows limited or no understanding of the problem and its components • Solution shows limited or no application of 21st-century skills